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Adaptive Reuse of Urban Public Space and Optimization of Urban Living Environment

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Abstract: With the rapid development, densification, and transformation of urban areas, the adaptive reuse of public spaces has emerged as a critical concern, profoundly shaping the quality, inclusivity, and livability of contemporary urban life. This study examines the multifaceted dimensions of urban public space, including spatial utilization, temporal dynamics, and everyday experiential patterns, to investigate how underutilized or "idle" spaces can be effectively transformed into vibrant, community-oriented environments that support diverse social, cultural, and recreational activities. Through detailed analysis of pedestrian accessibility, social interaction potential, spatial flexibility, and activity adaptability, the research develops a spatial response model aimed at optimizing the functionality and inclusiveness of public spaces in line with the practical needs and behavioral patterns of urban residents. This model emphasizes not only physical accessibility and spatial connectivity but also the creation of affective and experiential environments that enhance community engagement and foster a sense of belonging. The findings demonstrate that strategic interventions in underutilized urban spaces can significantly strengthen the relationship between public spaces and the urban living environment, promoting dynamic interactions, social cohesion, and sustainable urban development. By providing a systematic framework for understanding and implementing adaptive reuse strategies, this study offers valuable insights for urban planners, architects, and policymakers seeking to create more responsive, inclusive, and lively urban settings that cater to the evolving needs of contemporary cities.

Keywords: urban public space; urban voids; adaptive reuse; urban quotidian dynamics; spatial adaptability; environmental optimization

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1. Introduction

As a fundamental component linking urban structure with everyday life, public spaces play an increasingly prominent role in contemporary urban environments. However, due to evolving societal needs and shifting spatial demands, traditional urban spaces often fail to fully accommodate the complexities of modern urban life. Many urban spaces remain underutilized, serving only superficial or residual functions, rather than fostering meaningful interactions between space and its users. This study explores the adaptive reuse of urban public spaces with a particular emphasis on their integration into residents' daily lives. By proposing strategic optimization pathways, this research seeks to provide both theoretical insights and practical solutions for improving the urban living environment.

2. Core Concept of Urban Public Space

Urban public spaces serve not only as transit zones but also as critical social arenas that sustain communal life and interpersonal relationships. As urban spatial structures evolve and patterns of human activity shift, the definition of public space has expanded beyond its physical dimensions to encompass social and experiential aspects. The

fundamental value of public spaces lies not in their openness per se but in their active use, engagement, and interpretation by the public. Successful public spaces should exhibit openness, adaptability, and inclusivity, accommodating diverse activities while naturally facilitating interactions between individuals and the urban environment.

Nonetheless, many urban spaces suffer from marginalization due to inadequate scale, inefficient functional zoning, and limited accessibility, often becoming "urban voids" or "residual spaces" within the cityscape [1]. Moreover, the significance of space is not solely determined by its physical design but also by its capacity to facilitate everyday life. In Life Between Buildings, Jan Gehl highlights that spaces between structures should not merely serve as passageways but should actively support social and recreational activities. Figure 1 illustrates an example of adaptive activation strategies for underutilized spaces.

Figure 1. The Underline: Adaptive Revitalization of Urban Voids.

3. Adaptive Reuse Practice of Urban Public Space

3.1. Restructuring Spatial Scale through Pedestrian Activity Patterns and Dwell Time

The density and continuity of activities in public spaces are closely related to spatial scale and human mobility patterns. However, many contemporary urban spaces prioritize vehicular traffic over pedestrian experience, resulting in oversized, uninviting environments that discourage active engagement. Pedestrian rhythm refers to the way individuals perceive spatial segmentation and visual continuity while moving at a natural walking pace (approximately 5 km/h) [2]. Optimizing spatial design based on pedestrian movement and dwell time can enhance user experience and space utilization.

Before its transformation, the space beneath Miami's elevated Metrorail was a neglected urban void-an underutilized, disconnected corridor dominated by infrastructure, offering little to no public engagement. This linear stretch of land, characterized by concrete, shadows, and barriers, contributed to urban fragmentation rather than connectivity. However, through adaptive revitalization, The Underline (Figure 1) has reimagined this void as a dynamic, multi-functional public space. By integrating green infrastructure, pedestrian and cycling pathways, public art, and community spaces, the project has transformed an overlooked transit-adjacent area into an active urban corridor. It now fosters social interaction, ecological sustainability, and mobility, serving as both a recreational and connective artery for Miami. The Underline exemplifies how strategic urban interventions can reclaim residual spaces, enhancing both the physical and social fabric of the city [3].

For instance, in Shanghai, adjusting sidewalk widths and incorporating seating areas increased average dwell time by 41.8%. Similarly, in Beijing, redesigning primary pedestrian pathways and modifying terrain features led to a 32.5% increase in spatial utilization. Table 1 presents case studies highlighting the impact of pedestrian-centric design interventions on urban space usage.

Table 1. presents case studies highlighting the impact of pedestrian-centric design interventions on urban space usage.

City	Pedestrian flow pattern Measures	Increase in Average Dwell time (%)	Increase in Space Reuse (%)	Data source
Shenzhen (2023)	Introduction of continuous shaded pathways and visual wayfinding	35.2	28.9	<Annual Evaluation Report of Shenzhen Slow Driving System (2023)>
Shanghai (2022)	Optimization of sidewalk dimensions and addition of rest areas	41.8	36.4	<White Paper on Monitoring the Vitality of Shanghai's Public Spaces (2022)>
Chengdu (2024)	Transformation of small urban squares with flexible seating	38.7	30.2	<Chengdu Urban Street Space Survey (2024)>
Guangzhou (2023)	Integration of greenery and flexible dwell spaces	33.5	26.7	<Guangzhou Walkable Friendly City Index Report (2023)>
Beijing (2022)	Redevelopment of primary pedestrian corridors and micro-topographical adjustments	40.1	32.5	<Research on District Renewal and Human-Scale Evaluation in Beijing (2022)>

These findings indicate that optimizing pedestrian flow patterns and dwell time significantly enhances the longevity and frequency of public space utilization, with average improvement rates exceeding 30%.

3.2. Enhancing Social Interaction through Spatial Layout and Boundary Design

Public spaces play a vital role in fostering social connections, particularly in contemporary urban settings where incidental encounters increasingly replace traditional forms of social organization. As a result, furniture placement and boundary configurations have emerged as critical factors in stimulating spontaneous social interactions.

In Life Between Buildings, Jan Gehl emphasizes that social relationships often arise from "chance encounters" facilitated by spatial conditions that encourage lingering. Strategic placement of seating, communal dining areas, and semi-enclosed spaces can function as "activity catalysts," shaping interaction patterns-direct-facing arrangements encourage conversation, while parallel configurations support private exchanges. Furthermore, spatial enclosures should be neither overly rigid nor excessively open; soft boundaries (e.g., vegetation, stepped seating, or semi-enclosed structures) can provide a sense of security while maintaining visual permeability, thereby naturally promoting social interaction in public spaces [4].

The content of the table is collated from: Jan Gehl (2011), MDPI (2023) and ResearchGate (2023) empirical research on the trigger mechanism of furniture configuration and soft boundaries on low-intensity social interaction.

As shown in Table 2, the design of furniture and spatial boundaries not only shapes the physical environment but also influences people's behaviors and emotional responses within public spaces. By optimizing display configurations and boundary treatments, spaces can be intentionally curated to foster interpersonal connections, enhance social

engagement, and ultimately facilitate the functional transformation of public spaces into more interactive and community-oriented environments.

Table 2. Influences of furniture and boundary design on intimate communication in public space.

Design element	Content description
Furniture type	Chairs, backrest chairs, shared tables, awnings, etc
Layout logic	The arrangement around the stopping point of the flow of people forms a social micro-environment
Boundary form	Use of green, balustrade, landscape walls and other soft boundary control
Intimate interaction	Enhancing interpersonal engagement and increases opportunities for spontaneous encounters.
Typical case	Opposing street benches, small shaded spaces.

3.3. Activating Underutilized Urban Voids through Lightweight Interventions

Urban voids-often-overlooked spaces adjacent to buildings, infrastructure, and transportation-often suffer from underutilization due to their fragmented distribution and undefined functions. As Jan Gehl emphasizes, a space's true value lies not in its size but in its ability to foster human interaction. Recent interventions, such as strategic lighting, street art, and pop-up markets, have demonstrated how these spaces can be revitalized with minimal investment.

A prime example is *The Lawn On D* in South Boston, which transformed an empty lot into a vibrant social hub through lightweight, temporary elements like movable furniture, swings, LED-lit art installations, and lawn games. These adaptable features create a dynamic environment that shifts with community needs and events, proving that high social and recreational value can emerge without permanent redevelopment (As shown in Figure 2).

Figure 2. Day and Night at The Lawn On D: Transforming South Boston's Urban Space.

Similar successes have been observed internationally-Shanghai's Yangpu District saw a 45.1% increase in foot traffic after hosting a market, while Shenzhen's Futian District experienced a 42.3% rise following cultural installations. These cases illustrate how thoughtful, low-cost interventions can reactivate urban voids, turning overlooked spaces into vital community assets [5].

This data comes from ResearchGate (2023): Urban voids: identifying and optimizing urban voids potential as a revitalization source in enhancing developing countries' city income, which provides data on urban void activation projects, emphasizes on improving the use effect of urban void through design optimization and technology integration. As shown in Figure 3, improving accessibility and scene implementation can increase the use of various types of gap space by more than 40% on average, highlighting that mild interventions are key to activating urban voids.

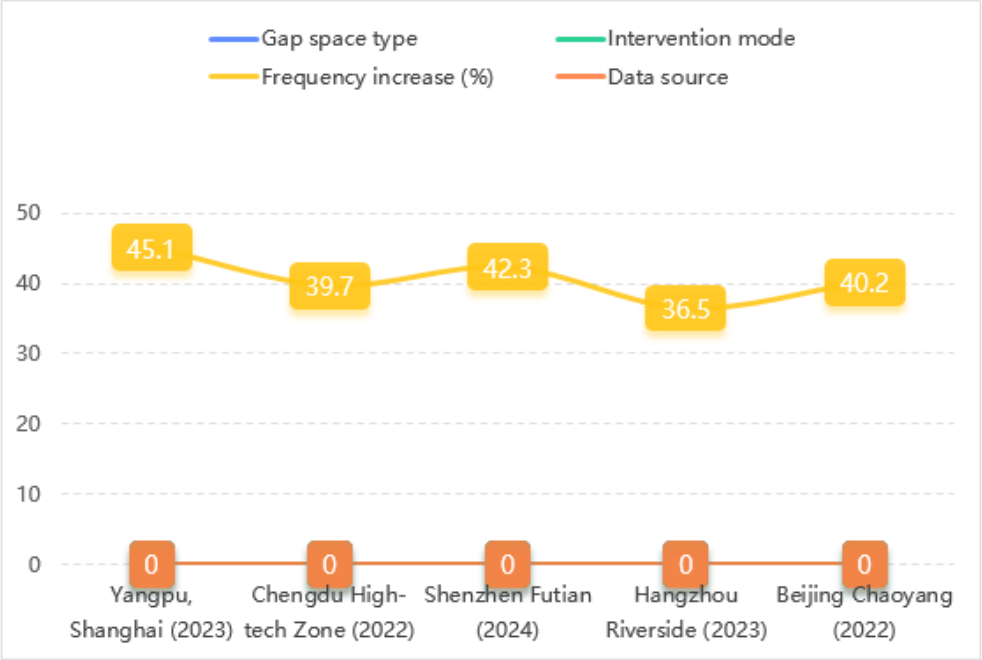

Figure 3. Effectiveness data of urban void activation project.

3.4. Establishing a Multi-Function Conversion Mechanism to Meet Diverse Temporal Needs

In the face of the complexity and ever-changing nature of urban life, a single-purpose space is often inadequate to fulfill the diverse needs of people across different times, settings, and activities. As Jan Gehl once stated, the most dynamic communities are "multi-functional" and "moderate in frequency," meaning they can adapt their openness and usage patterns based on time and people's behaviors. Flexible usage is crucial for enhancing spatial adaptability.

From a temporal perspective, spaces should be able to shift their functional environment, such as transitioning from a wet market in the morning to a night market in the evening. Furthermore, user activity factors must be considered to accommodate various needs, including moments for meditation, short-term interactions, and group activities. This can be achieved early in the planning phase through the use of movable elements (e.g., folding furniture, temporary shelters, etc.), detachable components, or adaptable platforms that can be quickly reconfigured. Collaboration with local communities to establish guidelines and management plans for using these spaces is also essential.

Table 3. outlines the core principles and implementation process for spatial multi-function conversion:

Table 3. Key mechanisms and implementation of spatial multifunctional conversion.

Elastic mechanism	Content description
Time conversion	Different time periods carry different usage modes
Functional transformation	For example, the space functions as a market during the day and a leisure gathering space at night.
Behavioral adaptation	Supports individual, interactive, and spontaneous activities, enabling flexible transitions.
Facilities are mobile	Facilities can be disassembled, moved, and reassembled to suit different needs

Community co-construction mechanism	Community involvement in setting rules and adjusting content

As shown in Table 3, multiple transformation methods enhance the flexibility of space across time and actions. Rather than serving only specific purposes or groups, various arrangements and open positioning of equipment and management create an interactive link between space and people's needs, thus increasing the daily functionality and sustainability of public spaces.

4. Optimization Path and Spatial Response Mechanism of Urban Human Settlements

4.1. Strengthening Perceptual Experience and Responding to the Shift from Facilities to Experience

The quality of the use of public space is determined by people's subjective feelings, not only by the quantity and type of equipment. Improving the quality of life of city dwellers affects whether people here have the opportunity to feel a continuous, relaxing and dynamic environment. From a visual point of view, it is necessary to adjust the size of the space and strengthen the depth of the interface to reduce the pressure and cold feeling brought by the large space and single layout. From a sound perspective, green plants, enclosed buildings and absorbent materials need to be used to reduce traffic noise that interferes with conversation and stationary activities. From a temperature point of view, shelter, water and greenery systems can be used to allow the space to meet the needs of people in different seasons and weather conditions. The selection of materials needs to take into account the impact of materials on people when they are in contact, such as reflecting too strong light and transmitting overheating surfaces, so that people can stay in space longer and produce more material connection with space. From the perspective of light, the design of lighting can extend the use time and use safety, such as the light layout, color and visibility at night, will affect people's willingness to stay in the space.

As an urban park transformed from an abandoned railway, the High Line Park places a strong emphasis on the design of various sensory experiences. The park's design skillfully utilizes greenery, incorporating different plant heights, colors, and layouts to create a rich landscape with varied visual layers. The open vistas and tree-shaded spots throughout the park allow visitors to enjoy the aesthetic changes brought about by the changing seasons. In terms of auditory experience, the design addresses the need for noise isolation from the surrounding urban environment by incorporating greenery and soundproof materials in certain areas, which reduce noise from nearby roads and provide a quieter space for visitors. Additionally, the park's material selection focuses on natural materials like wood and steel, which not only enhance the aesthetic appeal but are also durable enough to withstand high temperatures. These materials help to avoid excessive sunlight reflection and heat conduction, ensuring a comfortable environment for people to stay longer and enjoy the space. (As shown in Figure 4)

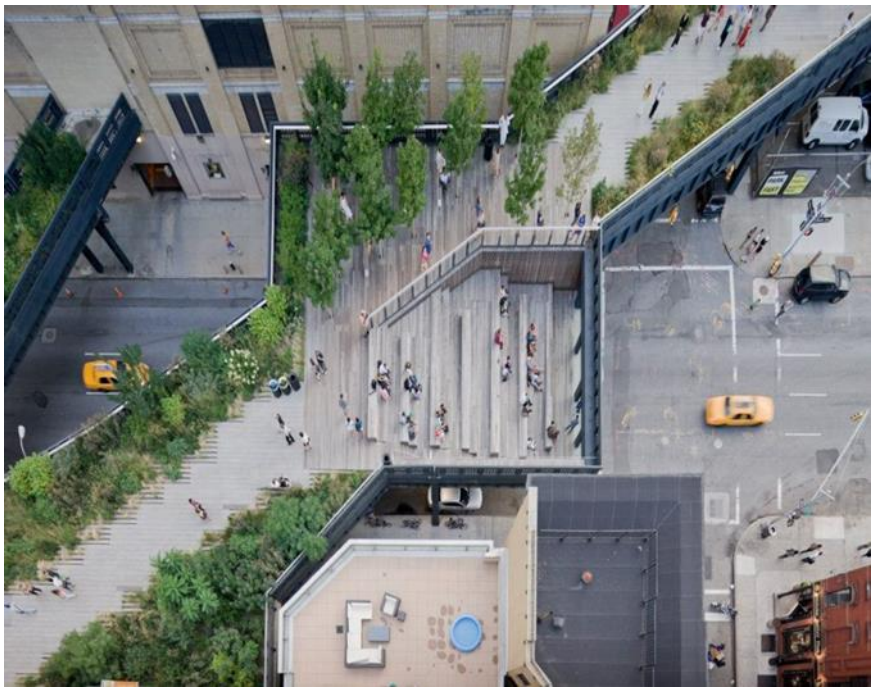

Figure 4. The High Line, New York.

4.2. Reconstructing Communication Structures to Adapt to the Shift from Stability to Fragmentation

The evolution of urban public life has led to a shift from fixed, continuous interpersonal relationships to more unstable, discontinuous, and loosely connected forms of social interaction. As a result, traditional interpersonal structures-those based on stable, closed groups and enclosed spaces-are gradually becoming less effective. To address this change, it is essential to create spaces that foster diversity, resilience, and coexistence, thus meeting the evolving needs of urban residents. In contemporary urban environments, spaces are no longer merely tools for organizing social interactions; they serve as the backdrop for such interactions. The role of these spaces now hinges on their ability to facilitate connections between strangers, support brief exchanges, and encourage repeated human contact. As Jan Gehl suggests, "gathering is not about pre-arrangement, but about the right space environment." This shift necessitates moving beyond the traditional "functional one-to-one correspondence" of space design, and towards a more dynamic "communication network" comprised of elements such as vision, posture, movement pathways, and facilities. These elements significantly influence the speed of actions, the perception of time, and sensory experiences, ultimately shaping the potential for social interaction. The interrelationship between these factors defines the communicative capacity of urban spaces:

$$IP = \{[(Vs \times Ps) + (St \times Dm)] \times (1 - Bi)\} + \{[(Af + So) \times Tm] \div Oc\} \quad (1)$$

This model illustrates that interactivity (IP) serves as the fundamental factor in enhancing the accessibility between individuals, facilitated by visual visibility (Vs) and spatial accessibility (Ps). The flexibility (St) and density (Dm) of physical change further improves the uniformity and synchronicity of the behavioral processes within the space.

However, edge intrusion (Bi) can disrupt these factors, diminishing their effectiveness. Simultaneously, the motivation (Af) and the frequency of social activities (So) provided by the space influence the social behavior through its optimal timing of interactions (Tm). Open control (Oc) refers to the degree of regulation imposed by organizations or authorities, which affects the nature and quality of social interactions within the space. Therefore, the model illustrates the complex interplay between the "physical,"

"behavioral," and "institutional" dimensions, highlighting the interconnectedness of these factors in shaping the dynamics of urban environments.

4.3. Promoting Flexible Use and Adapting to Short-Term Behavioral Changes

As people's behavior toward space changes, the time spent in public spaces has decreased, with frequent and fragmented short-term activities becoming more common. Traditional spatial planning, which relies on long-term stays and single-function zones, can no longer meet the needs of contemporary users. Today, people seek to complete tasks quickly, such as instant communication, brief rests, rapid shopping, and quick performances. This requires a high level of flexibility and adaptability in space design. The space must be able to accommodate the easy transformation of human behavior and support multiple functions through movable devices, adjustable boundaries, and temporary functional units.

Facilities like small plazas, seating areas, and mobile units can facilitate brief stops and quick exchanges, as opposed to long seating areas and single-purpose spaces. The design of the floor, lighting, and concealment elements should allow for easy transformation to meet different needs during the day or night. Space is no longer a static place; it has evolved into a dynamic framework where activities take place. At the management level, systems should also be flexible, avoiding rigid functional constraints, and enabling the public to use spaces according to their immediate needs.

4.4. Integrating into Daily Life to Expand the Physical Environment into Everyday Life

The perception of public space usage is increasingly determined by how well it is integrated into everyday life. This means that beyond simply acknowledging the space's existence, it must be recognized as a specific living environment that can be reused. The effectiveness of this integration depends on people's subjective behavior and awareness. Only when a space is endowed with life-like elements-such as markets, food areas, resting spots, and informal social interaction spaces-can it accommodate relaxed, meaningful, and regular behaviors, making it feel like an integral part of daily life. To achieve this, the structure of physical space must be flexible over time, open to various behaviors, compatible with different functions, and designed with an embedded social logic that supports interaction. This will enable the space to synchronize with the rhythm of urban life, including work, travel, and leisure.:

$$\mathrm{LE} = \mathrm{f}_1\{[(\mathrm{F} \times \mathrm{D}) + \sqrt{}(\mathrm{S}^2 + \mathrm{T}^2)] \times \log(\mathrm{A} \times \mathrm{Cn})\} \div \mathrm{f}_2\{[\mathrm{Bd} \times \mathrm{Fx} + \mathrm{Rv})]\text{^}\alpha\} \quad (2)$$

Life embeddedness (LE) is shaped by multiple positive factors, such as functional diversity, intensity of participatory activities, environmental adaptability, and depth of engagement, etc. Conversely, negative impacts arise from factors such as boundary fragmentation, functional rigidity, and restrictive regulations. To quantify the interaction between space and daily life, a nonlinear mathematical model is employed, capturing the dynamic relationship between these elements.

5. Conclusion

The real value of public spaces lies in their capacity to connect meaningfully with people's everyday lives. This significance extends far beyond physical improvements or aesthetic upgrades; it centers on addressing the evolving needs, habits, and expectations of diverse user groups. To truly optimize spatial organization, planners and designers must consider dynamic factors such as travel speeds, patterns of social interaction, and broader changes in lifestyle brought about by urbanization and technological development. Only when these human-centered dimensions are fully integrated can public spaces effectively influence behavior, foster social engagement, and serve as catalysts for healthier, more vibrant urban life.

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