



Vitality-Safety Coexistence: Sustainable Micro-renewal Design Strategies for Streets in Old Neighborhoods

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Abstract. Against the backdrop of urban stock-based renewal, streets within aging residential communities confront inherent spatial tensions between pedestrian safety and grassroots commercial vitality. Rigid one-size-fits-all crackdowns on roadside business occupation frequently undermine authentic neighborhood contextual features. From a behavior-led design logic, this paper investigates micro-regeneration strategies for block-scale streets. Taking the crisscross alley network of Changqing Erwan Community in Wuhan as a practical case, the research identifies residents' spatiotemporal activity characteristics via field monitoring, behavioral mapping and Baidu heatmap calibration. A three-pronged intervention framework is accordingly constructed: spatiotemporal separation, boundary interface reshaping, and traffic calming. With minimally invasive micro-interventions including soft flexible boundaries, time-shared space utilization, modular storefront facades and integrated traffic calming facilities, the scheme optimizes the redistribution of limited street spatial resources. This low-impact approach resolves two core spatial conflicts: unreasonable right-of-way allocation and chaotic cross-flow of pedestrian and vehicle streams. Ultimately, the design realizes the symbiotic balance between pedestrian travel safety and localized commercial vitality, delivering empirical evidence for the inclusive, sustainable renewal of narrow alley spaces in high-density aging neighborhoods.

Keywords: Old Neighborhood Renewal, Micro-regeneration, Behavior-driven Design, Inclusive Street Design.

1 Introduction

As China shifts towards renewing existing urban fabrics, low-intervention micro-regeneration has become a mainstream pathway for sustainable community development^[1-2]. However, streets in older neighborhoods often face conflicts between pedestrian safety and commercial vitality. Conventional top-down management typically eliminates informal street vending to tidy the streetscape; yet, this inadvertently strips away the original neighborhood atmosphere, resulting in streets that are orderly yet desolate.

Existing theoretical frameworks often struggle to resolve this tension. Traditional morphological theories (e.g., Figure-Ground Theory^[3]) focus on static physical forms, overlooking the dynamic ways in which people utilize space. Conversely, conventional

traffic planning (e.g., Street Hierarchy) prioritizes vehicular segregation, often sacrificing spontaneous social vitality for the sake of order. Even human-centric approaches like New Urbanism or Placemaking often rely on standardized physical interventions in practice. In reality, rigidly applying a single established theoretical paradigm to specific application scenarios often leads to a "Procrustean bed" dilemma, where the theory forces the reality to fit, rather than adapting to it.

Addressing this dilemma, this study investigates users' spatiotemporal behavioral patterns to develop a tailored micro-regeneration framework. Taking Changqing Erwan as a representative case, this research explores inclusive renewal strategies for high-density narrow alleys. By integrating site reconnaissance with time-segmented heat maps, on-site micro-behavioral mapping was conducted to analyze residents' spatiotemporal patterns regarding commuting, consumption, and leisure. Based on these findings, a tripartite intervention framework—incorporating spatiotemporal separation, interface reshaping, and traffic calming—is proposed. Unlike conventional models focusing on physical retrofitting, this framework innovates by establishing a coupling mechanism between spatial attributes and behavioral patterns, shifting the focus from mere environmental beautification to inclusive social governance, providing a dynamic methodology to balance safety with street vitality.

2 Investigation & Spatiotemporal Characteristics of Users

Built in 1991, Changqing Erwan is a high-density open community with 31.19% building coverage and only 8.39% green space. As a core pilot for the 2021 Wuhan Community Planner System in Hanyang Street, it anchors a continuous neighborhood fabric integrating Changqing Sanwan and Hexiangli. Following sustained micro-regeneration—notably the 2022 "Fireworks Cross Street" design—this study focuses on its staggered cross-shaped street network, where a 9 m mixed-traffic road intersects a 6 m shared lane. The convergence of diverse activities within this narrow cross-section leads to intense competition for spatial resources (Fig. 1).

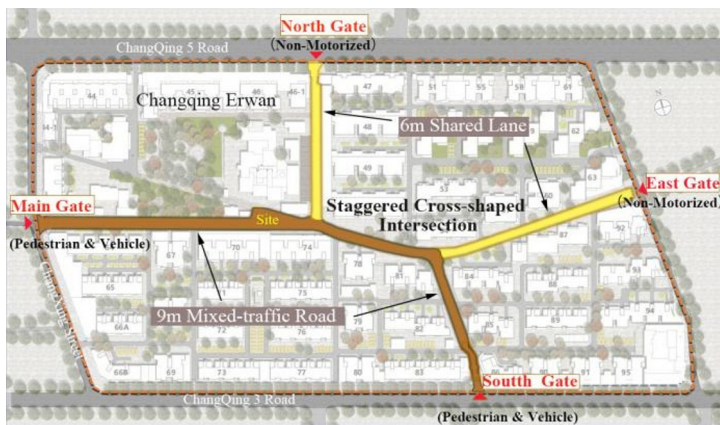


Fig. 1. Current Road Network Structure and Traffic Organization of Changqing Erwan

The study carried out field surveys and continuous tracking across three observation windows: morning peak (7:00–9:00), noon off-peak (12:00–14:00), evening peak (17:00–19:00). Intensive pedestrian-vehicle conflicts concentrated in two core periods: 7:00–8:00 and 18:00–19:00, while moderate midday activities were excluded; only peak-hour data were adopted for statistical analysis. Behavioral mapping and on-site photography recorded residents’ diversified spatiotemporal activity patterns, and GPS positioning identified and archived conflict points to support subsequent traffic calming optimization design.

All detected conflict hotspots were categorized into three root-cause types: spatial squeeze from public space occupation by shops and vendors, space encroachment from illegal on-street parking, and dynamic interference from crossing vehicle and pedestrian streams. Baidu heat maps captured at 7:00 and 18:00 peaks (Figs. 2a and 2b) calibrated conflict spatial distribution and verified the typicality of surveyed streets. Multi-stakeholder engagement ran through the fieldwork: we interviewed residents, shop owners and vendors, and communicated with the community committee and property management to collect grassroots demands, which were correlated with classified conflict points to formulate bottom-up targeted renewal strategies. This paper centers on proposing regeneration design strategies, and the above surveys merely serve as qualitative supporting evidence rather than quantitative empirical analysis.



Fig. 2. Spatial distribution of street activities at different times.

Table 1 illustrates the street-front business distribution of the community, which offers full daily living services including catering, grocery, hairdressing and chess rooms. Some catering stores operate in a time-sharing mode for morning breakfast and afternoon chess activities, forming the block’s double-peak pedestrian volume and concentrated peak-time pedestrian-vehicle conflicts.

Table 1. Street-front shop statistics.

Shop Type	N-S Road	E-W Road
Catering & Breakfast	9	3
Hardware & Materials	3	2
Beauty & Apparel	9	6
Fresh Food Retail	14	5
Entertainment	3	2

3 Core Contradictions in Aging Community Streets

Based on peak-hour field classification of pedestrian-vehicle conflict points and quantitative street-front commercial data in Section 2, this study attributes street spatial disorder to competing occupation and encroachment by four parties: fixed shop operators, mobile vendors, pedestrians and all types of vehicles. Such conflicts lead to a cascading effect of spatial extrusion: fixed merchants occupy sidewalks through outdoor commodity display, mobile vendors further reduce effective walking width, which compels pedestrians to walk within vehicle passages and aggravates safety risks caused by cross-flow of pedestrian and vehicle streams.

Overlapping mixed functions overload narrow alley capacity and break the rational right-of-way allocation balance. Since rigid conventional regulations cannot coordinate conflicting demands among residents, shop operators and vehicle users, this study abandons crude roadside blanket bans and adopts refined spatial restructuring through targeted spatiotemporal zoning to curb disorderly occupation and balance pedestrian safety with grassroots neighborhood vitality in renewal.

4 Design Strategies for Street Micro-Regeneration

To address spatial overload and pedestrian-vehicle conflicts, this section proposes three interventions: spatiotemporal separation, interface reshaping, and traffic calming. The first two primarily mitigate merchant encroachment, while the latter enhances safety; collectively, they reconcile slow mobility with commercial vitality.

4.1 Spatiotemporal Separation

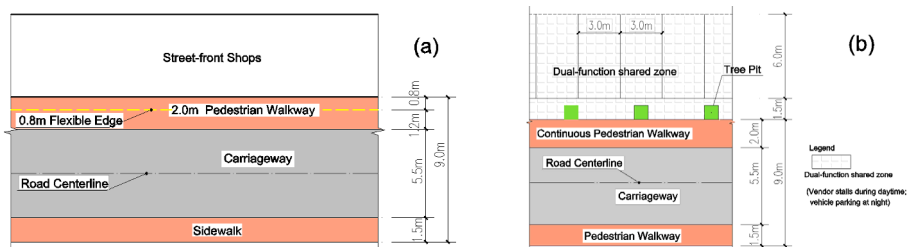


Fig. 3. Cross-section schemes of the spatiotemporal separation strategy. (a) Flexible sidewalk edge layout; (b) Dual-function shared zone.

To tackle spatial scarcity, this strategy replaces static right-of-way allocation with a dynamic mechanism driven by zoning and time-sharing. Within the 9-m cross-section (Fig. 3a), road rights are clearly delineated: a 2.0-m continuous sidewalk along shop fronts incorporates a 0.8-m flexible business boundary. Time-based management permits outdoor displays during off-peak hours but strictly prohibits them during the morning peak (7:00–8:00) to ensure unobstructed flow. At high-traffic intersections, time-shared vendor zones utilize interstitial spaces between tree pits and parking spots (Fig.

3b). Adopting a staggered model—day vending, night parking—provides fixed locations for mobile vendors, effectively alleviating chaotic occupation. Ultimately, integrating spatial zoning with temporal management resolves right-of-way conflicts, balancing the needs of merchants, vendors, pedestrians, and vehicles.

4.2 Interface Reshaping

To address signage clutter and costly renovations that often arouse merchant resistance, this strategy adopts micro-interventions and low-cost fixtures to overcome the drawbacks of traditional painted lines. A modular signage system featuring a permanent steel frame base and replaceable PVC panels (Fig. 4a) allows seamless business turnover through simple panel replacement, substantially cutting renovation costs. Guided by the Sponge City concept^[4-5], permeable brick sidewalks and asphalt carriageways guarantee drainage and anti-slip performance while preserving visual continuity. A high-contrast marking strip set 0.8 m from facades defines a stable yet flexible boundary within the 2.0-m slow-traffic corridor (Fig. 3a). Such a “soft boundary” works synergistically with the traffic calming measures elaborated in Section 4.3, regulating spatial order and improving ecological resilience.

4.3 Traffic Calming

Severe pedestrian-vehicle conflicts in historic alleys render rigid physical barriers unsuitable for lanes with variable widths and intensive human activities. Grounded in a “human-vehicle coexistence” philosophy^[6-7], this strategy constructs a traffic calming system at key nodes by combining static physical isolation with dynamic flexible management: it restricts vehicle speed via hard facilities and directs traffic flow through soft regulatory measures. At the West Gate, guardrails and warning bollards physically segregate motorized/non-motorized traffic and pedestrians to slow vehicles down (Fig. 4b); for constrained entrances such as the narrow South Gate where rigid physical facilities are infeasible, a coordinated mode of manual diversion and intelligent parking early warning is adopted, with dynamic peak-hour traffic regulation supported by dual-mode smart parking decision logic (Fig. 5).

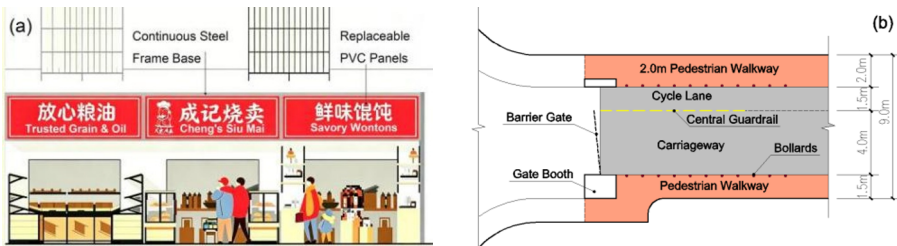


Fig. 4. Strategies for storefront renewal and traffic calming: (a) Modular signage system with replaceable panels; (b) Physical isolation measures at the entrance.

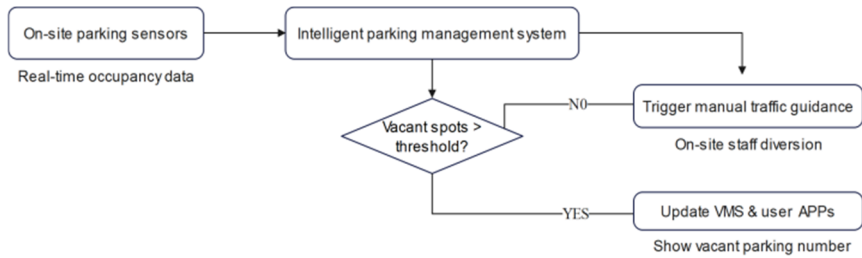


Fig. 5. Dual-mode decision logic of intelligent parking guidance

Combining hard spatial demarcation and soft auxiliary management, the system balances renovation feasibility and traffic flexibility in old residential alleys.

5 Conclusion and Outlook

Based on the representative case of Changqing Erwan, this study proposes a feasible micro-regeneration framework for high-density narrow alleys. It offers a replicable methodology to balance safety and vitality in similar old neighborhoods. From a behavior-led design perspective, this study reconstructs the street system of Changqing Erwan Community through three coordinated measures: spatiotemporal separation, boundary interface reshaping and traffic calming facilities. This synergistic three-pronged framework resolves two core spatial conflicts prevalent in old neighborhoods: unreasonable road right-of-way allocation and chaotic cross-flow of pedestrian and vehicle streams. Rather than rigid one-size-fits-all clearance of street-side businesses, the research reshapes street spatial order via micro-interventions including flexible boundaries, time-shared space allocation, modular interface renovation and differentiated pedestrian-vehicle separation. The proposed low-intervention, human-centric design framework provides actionable design references for inclusive micro-regeneration of narrow alleys within high-density aging residential communities. However, certain limitations remain. The single-case research limits the external generalizability of the proposed design strategies; current operational management relies heavily on manual labor and static hardware; and the modular signage system has yet to be fully implemented. Future research could delve into practical issues such as funding mechanisms and the refined design of signage implementation, continuously enhancing the traffic safety, street-level vitality, and long-term sustainable operation of streets in old communities.

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