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Behavior–emotion decoupling as micro-level spatial injustice: Why urban villages morphology fails to heal marginalised groups in China

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Behavior–emotion decoupling as micro-level spatial injustice: Why urban villages morphology fails to heal marginalised groups in China

Abstract：

Urban villages host tens of millions of rural-to-urban migrants in Chinese cities, yet their dense, fragmented morphology is widely assumed to erode residents' mental health (Wu, 2016). Drawing on spatial justice theory and environmental psychology, this study asks whether urban villages morphology shapes healing environments differently for marginalised groups versus indigenous residents.Using Kuidong Village (Xuzhou, China) as a case study, we integrate Baidu POI and heatmap data, SegNet-based street view segmentation, behavioral observation, and a seven-dimension emotion survey (N=162) into a multi-group mediation framework linking spatial configuration, daily behavior, and emotional perception. We identify systematic behavior–emotion decoupling among migrants: their activity patterns respond to spatial form, yet no behavior produces emotional returns. All three mediation pathways (enclosure via necessity to depression, greenery via spontaneity to safety, and permeability via sociality to relaxation) fail for migrants while remaining significant for indigenous residents. Healing resources thereby remain visible yet unusable. We interpret this decoupling as a form of micro-level spatial injustice, extending spatial justice theory from the macro distribution of resources to micro psychological pathways. We accordingly propose differentiated spatial interventions to restore migrants' behavior–emotion linkage, transforming urban villages from mere dwelling spaces into healing places.

Keywords:urban villages; marginalised groups; spatial justice; built environment; psychological wellbeing; behavioral mediation

Source of the Project：

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1. Introduction

1.1 Research Background

China's rapid urbanisation has reshaped the urban economic geography while embedding numerous heterogeneous patches into the urban fabric, namely urban villages (Webster, 2013). As original rural collective settlements preserved in situ amid urban expansion (Song et al., 2008), urban villages accommodate tens of millions of rural–urban migrants thanks to their low rental costs and favourable locations (Wu et al., 2013). They serve as the first urban foothold for low-income marginalised groups, including food delivery couriers, service sector workers and newly graduated university students. Although these populations underpin the basic functioning of cities, they endure severe livelihood pressure alongside the identity anxiety of being physically present yet socially invisible, driven by inequitable resource distribution (Wong et al., 2007).

Evidence from environmental psychology indicates that the built environment is not a neutral backdrop for daily life; instead, it exerts subtle, cumulative impacts on individuals' emotions by constraining and encouraging routine behaviours (Evans, 2003; Kaplan & Kaplan, 1989; Kaplan, 1995). Stress-affect theory posits that prolonged exposure to high-density and disordered spatial stimuli keeps individuals in a persistent state of stress arousal, leading to the gradual accumulation of negative emotions (Stokols, 1972). Accordingly, the constraint–behaviour–emotion sequence forms a mediating pathway through which the built environment influences mental health, elevating space from a passive contextual variable to a structural determinant of psychological wellbeing (Altman, 1975).

This mechanism manifests itself particularly prominently in urban villages. Densely packed handshake buildings, disorganised street layouts and inadequate public spaces collectively form a suppressive built environment. Residents' daily behaviours are confined to subsistence-oriented commutes and functional movement, whereas venues and opportunities for restorative experiences, social interaction and emotional expression are systematically restricted. Chronic exposure to such surroundings continuously erodes residents' psychological resilience, resulting in the progressive build-up of loneliness, helplessness and social isolation(Stokols, 1976).

This study conceptualises the above process as behaviour–emotion decoupling. Under conditions of spatial deprivation, individuals can barely sustain basic behavioural functioning, yet the intrinsic coupling between daily behaviours, emotional restoration and social bonding is systematically severed by spatial configurations. Behaviour–emotion decoupling serves as a mechanistic manifestation of micro-level spatial injustice. Unlike macro-level inequities in resource distribution, it refers to the systematic constriction of access opportunities: marginalised groups are structurally denied the possibility of gaining psychological comfort and social connectedness through spatial engagement (Lefebvre, 1991). This conceptual framework shifts the discourse of spatial justice from macro-level resource allocation down to lived everyday experiences, rendering the ownership structure of spatial rights and the distribution of associated benefits as the core analytical lens for examining urban villages regeneration.

1.2 Literature Review

Scholars have developed a rich research framework addressing urban marginalised groups and their residential environments, spanning spatial justice theory, residential environmental stress, and community therapeutic capacity (Lefebvre, 1996). Theoretically, studies grounded in spatial justice and social exclusion have uncovered the mechanisms of psychological deprivation imposed by high-density, low-quality living environments on low-income populations and migrants, demonstrating that physical spatial marginalisation is frequently accompanied by the erosion of social entitlements (Casey, 2001; Marcuse, 2009).

Practically, Wedyan et al. (Wedyan et al., 2024) integrated therapeutic landscape design into spatial interventions for disadvantaged neighbourhoods. By reshaping natural elements and public realms, their work alleviated residents' livelihood anxieties and crises of identity. Ghasemieshkaftaki et al. (Ghasemieshkaftaki et al., 2023) further indicates that inclusive community spatial design can markedly strengthen the sense of social belonging and psychological resilience among marginalised cohorts, partially offsetting the adverse impacts of structural inequalities.

Domestic scholarship has developed along three interrelated strands: socio-spatial dynamics, therapeutic environments and spatial governance, forming a dual logic of urban renewal coupled with social governance (Wang et al., 2022).

First, from a socio-spatial perspective, Li and Liu (Li & Liu, 2011) characterised the spatial differentiation of social networks among new migrants through questionnaire surveys across eight urban villages in Guangzhou. Their research revealed that the differential mode of association rooted in regional and kinship ties serves as a critical criterion for defining membership within these social networks, and the social divide between migrant populations and indigenous residents has not been fully eliminated.

Second, with regard to the therapeutic environment lens, He, Xu and colleagues (He et al., 2025) constructed a three-tier progressive theoretical framework of therapeutic environments, namely the control of therapeutic risk factors, sustained retention of therapeutic benefits, and stimulation of high-quality therapeutic effects. This framework provides an analytical instrument for environmental interventions at the neighbourhood scale.

Third, from the spatial governance standpoint, Xu and co-authors (Shi et al., 2025) framed the housing predicaments of vulnerable groups within a social governance orientation. They emphasised that safeguarding all stakeholders' rights to use community space and advocating the co-construction, co-governance and shared benefits model can advance the value pursuit of spatial justice.

The aforementioned studies have respectively established a practical paradigm integrating spatial justice and therapeutic design, as well as an integrated logic combining urban renewal with social governance, offering twofold references for the environmental optimisation of urban villages (Sharifi & Yamagata, 2018; Relph, 1976). Nevertheless, two critical research gaps remain when benchmarked against the actual contextual conditions of urban villages.

First, it has yet to be unpacked how the morphological characteristics of urban villages exert differentiated impacts on indigenous villagers and marginalised migrant

groups. Existing scholarship largely treats all inhabitants as a homogeneous collective, leaving spatial interventions without a solid basis for population segmentation.

Second, prevailing spatial justice research predominantly focuses on macro-scale resource distribution and institutional arrangements, failing to delve into the micro psychological dimension reflected by behaviour–emotion decoupling. Consequently, the normative value of spatial justice cannot be translated into actionable spatial intervention strategies targeted at the psychological healing of disadvantaged groups.

1.3 Research Questions, Methodology and Contributions

Accordingly, this paper adopts spatial justice as its normative standpoint and behaviour–emotion decoupling as the analytical framework, and puts forward two progressive research questions. First, whether and how does urban villages morphological configuration affect marginalised groups' sense of safety, belonging and social bonding through the mediation of daily behaviours? Second, does this mechanism generate heterogeneous outcomes between indigenous villagers and marginalised migrant groups?

To address the above questions, this study selects Kuidong Village as the empirical case and employs a multi-source data integrated approach. It couples precise spatial topological measurements with data on residents' daily activity patterns and psychological perceptions, so as to unpack the mediating effect of urban villages morphology on psychological outcomes via routine behaviours.

This study aims to propose low-cost and replicable spatial intervention strategies, develop a localised therapeutic environmental system adapted to high-density built contexts, and centre the psychological dignity of marginalised groups within the agenda of urban renewal. Its contributions fall into three dimensions.

Theoretically, it conceptualises and operationalises the notion of behaviour–emotion decoupling, shifting the discourse of spatial injustice from macro-level resource distribution down to micro psychological mechanisms. Methodologically, it achieves the integration of morphological quantification, behavioural tracking and psychological measurement across multi-source datasets (Ulrich et al., 1991; Grahn & Stigsdotter, 2010; Jiang et al., 2014; Hartig et al., 2014), generating a replicable analytical pathway for future urban villages research. Practically, it delivers locally tailored intervention schemes embedded with both therapeutic functions and spatial justice values, which serve to mitigate spatial suppression, improve residents' psychological wellbeing and advance social integration (Bratman et al., 2019; Helbich et al., 2019; Wang et al., 2019).

2. Study Area and Subject Characteristics

2.1 Case Site: Kuidong Village

Kuidong Village is situated in the southern part of Xuzhou, with its settlement history dating back to the Northern Song Dynasty. It ranks among the urban villages retaining the most complete historical strata within the built-up area of Xuzhou.

Subject to multiple external disturbances including the administrative eastward relocation in 1992 and shantytown renovation in 2018, its spatial morphology has been superimposed layer upon layer under the alternating forces of market-driven self-built construction and policy-led demolition and reconstruction. The village therefore exhibits typical features of a high floor area ratio (FAR = 1.79), substandard living quality and cumulative historical layering. The ratio of registered permanent residents to floating population within the neighbourhood reaches 1:2.3, forming a compound community structure characterised by the long-term coexistence of indigenous villagers and incoming marginalised groups.

2.2 Research Subjects: Three Dimensions of Marginality for Marginalised Groups

Drawing on data from the Seventh National Population Census (2020) and field investigations, the marginalised groups in Kuidong Village (predominantly floating migrants) demonstrate systematic marginality manifested coherently across three dimensions: psychological, behavioural and social.

Psychological dimension: heightened sensitivity, elevated anxiety and a low sense of belonging. Cramped living quarters and insufficient supporting facilities render residents highly susceptible to environmental stimuli, triggering frequent neighbourhood disputes. Meanwhile, floating migrants generally hold a transient mindset regarding their urban residency, resulting in extremely weak community identification and a diminished sense of belonging.

Behavioural dimension: pendulum-style subsistence and solidified spatial activity spheres. Most members of this cohort are employed in labour-intensive industries with a daily working duration exceeding 10 hours, leading to highly fixed commuting trajectories. Constrained by financial resources and limited spare time, approximately 70 per cent of their daily consumption takes place within a 500-metre radius of their dwellings. Such rigidly bounded activity spheres further narrow the spatial interface through which they can integrate into mainstream urban society.

Social dimension: atomised living and inadequate emotional support. Dual deprivation in both physical space and social ties severely restricts their interpersonal interactions, embodying typical features of social atomisation. Notably, the marginalised population in Kuidong Village is markedly younger and dominated by wage labourers, which creates an inverted age structure in stark contrast to the overall ageing profile of Quanshan District (where residents aged 60 and above account for 20.82 per cent). This discrepancy erects inherent cultural and generational barriers when they attempt to integrate into a community largely composed of elderly indigenous villagers, exacerbating their social isolation to a greater degree.

3. Research Design and Analytical Methodology

3.1 Integrated Analytical Framework of Space – Behaviour – Psychology

This study establishes an integrated analytical framework of Spatial Configuration – Behavioural Patterns – Emotional Perception, which aims to unpack the functional mechanism through which urban villages spaces facilitate the psychological healing of marginalised groups and identify pathways for their social integration.

Centring on facility provision, spatial vitality and built environment quality as the core dimensions of spatial configuration, the framework adopts necessary, spontaneous and social behavioural patterns as mediating variables (Baron & Kenny, 1986; Preacher & Hayes, 2008; Markevych et al., 2017; Hayes, 2018; Hayes & Rockwood, 2020), takes stress reflected in emotional perception as the outcome indicator of psychological recovery (Gross, 2015), and ultimately leads to a normative evaluation based on the value of spatial justice.

3.2 Variable System and Measurement Methodology

3.2.1 Independent Variables: Elements of Spatial Configuration

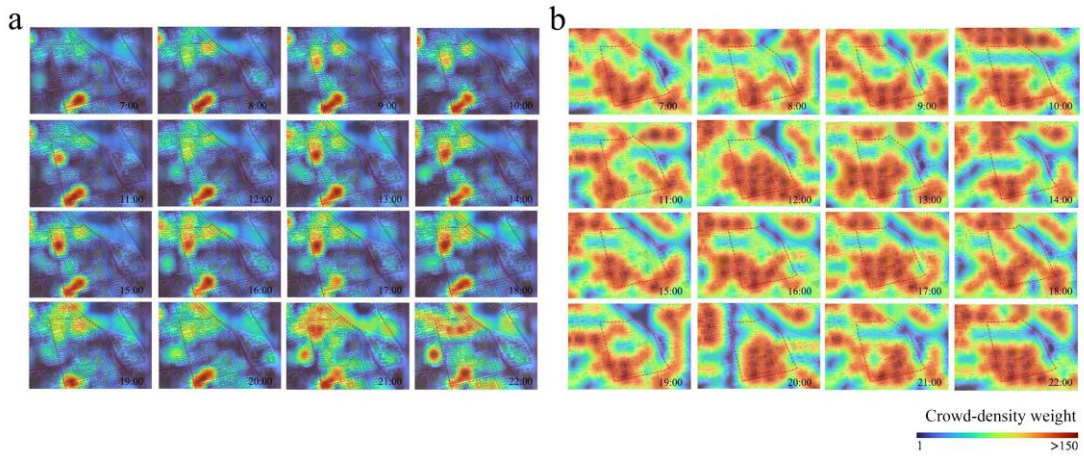
Table 1 Elements of Spatial Configuration

Dimension	Measurement Indicators	Method / Data Source
Facility Provision and Spatial Vitality	POI density, average population from heatmap, vitality discrepancy between working days and rest days	Baidu POI and Baidu heatmaps, used to characterise the capacity of livelihood support
Built Environment Quality	Green View Index (GVI), Sky View Factor (SVF), building line coverage ratio, interface permeability, density of resting facilities	SegNet semantic segmentation of street view images combined with field counting method, comprehensively reflecting the supportive level of the environment for therapeutic effects

(1) Dimension of Facility Provision and Spatial Vitality

This dimension intends to reveal the spatial differentiation pattern of living convenience within Kuidong Village through a coupled analysis of static resource provision and dynamic crowd responses. On the one hand, POI density is adopted to characterise the degree of facility agglomeration and spatial accessibility, serving as a critical indicator for judging whether marginalised groups are excluded from the urban resource network. Uneven spatial distribution directly translates into disparities in livelihood opportunities: higher facility density corresponds to greater spatial accessibility to basic services including medical care, commerce and transportation. Conversely, residents have to travel longer physical and topological distances to access essential amenities.

On this basis, Baidu heatmap data are incorporated to verify the coupling relationship between facility provision and actual utilisation. As illustrated in Figure 1, data were collected hourly from 07:00 to 22:00 on Wednesday 14th May and Saturday 17th May 2025. Typical days with mild temperatures and no precipitation were selected to objectively reflect the spatiotemporal rules of crowd behaviours under regular daily conditions.



a. Time-segmented heatmap of crowd activity on working days b. Time-segmented heatmap of crowd activity on non-working days

Figure 1 Crowd Density Heatmap of Kuidong Village

(2) Dimension of Environmental Characteristics

This dimension focuses on the supportive effects of the built environment on the psychology and behaviours of marginalised groups. Drawing on the Theory of Supportive Environments (Liu et al., 2012), five indicators are selected for quantitative measurement: Green View Index, Sky View Factor, building line coverage ratio, interface permeability and resting facility density, which respectively quantify the potential of natural exposure, spatial enclosure, interface continuity, visual penetration and behavioural support.

Given the complexity and informality of urban villages spatial morphology, a purposive sampling method is adopted to select eight key nodes covering core functional zones including residential, commercial and traffic areas. In-depth analysis is carried out instead of superficial general scanning to more accurately interpret the actual living surroundings. Data collection integrated SegNet street-view semantic segmentation, pixel proportion calculation from human-perspective images and the field counting method to quantitatively decode streetscape photographs of the selected nodes, as detailed in Table 2.

Table 2 Environmental Characteristic Indicators

Indicator	Definition	Environmental Implications
Green View Index (GVI)	The ratio of pixels covered by green vegetation to the total valid pixels within the frame.	Reflects the level of natural exposure, correlated with stress relief and psychological restoration.
Sky View Factor (SVF)	The ratio of sky-area pixels to the total valid pixels within the frame.	Characterises the degree of vertical openness, affecting the sense of spatial enclosure and natural daylighting.
Building Line Coverage Ratio	The proportion of the continuous length of building frontages along the street to the total street frontage length.	Reflects the enclosure continuity of the interface, linked to territorial perception and street boundary definition.
Interface Permeability	The proportion of transparent segments (doors, windows, glass panels, openings, etc.) to the total	Represents visual permeability, influencing the eyes-on-the-street effect and perceived

Indicator	Definition	Environmental Implications
	area of building street facades.	spatial safety.
Resting Facility Density	The quantity of public resting facilities converted into the supply per 100 metres of street frontage.	Measures behavioural support capacity and determines opportunities for lingering, social interaction and physical and mental recovery.

3.2.2 Dependent Variables: Perceived Emotional Stress

As stress constitutes an implicit psychological load that cannot be directly observed, this study operationalises emotional states as its measurable proxy based on the Stress-Emotion Theory in environmental psychology.

A seven-dimensional perceived emotion scale is developed covering positive dimensions (pleasure, relaxation, sense of safety), negative dimensions (depression, irritability, loneliness) and a bidirectional dimension (excitement). As presented in Table 3, a 5-point Likert scale is adopted, and the difference value between positive and negative emotions is calculated to reflect the level of psychological stress experienced by marginalised groups at different spatial nodes. The scale has been verified to possess satisfactory content validity following expert review.

Data collection was carried out across the eight typical sampling nodes, yielding a total of 162 valid questionnaires. Respondents filled in the scale according to their real-time on-site spatial experiences, as summarised in Table 3.

Table 3 Summary of Mean Emotional Perception Scores of Marginalised Groups and Indigenous Residents at Different Nodes in Kuidong Village

Subject Group	Spatial Code	Pleasure	Relaxation	Excitement	Sense of Safety	Depression	Irritability	Loneliness
Marginalised Group	KD-T1	2.4	2.1	1.8	4.3	3.9	2.2	4.2
Marginalised Group	KD-C1	2.6	3.2	2.1	2.9	2.6	3.9	3.6
Marginalised Group	KD-R1	2.3	3.1	1.9	2.2	4.1	3.2	4.3
Marginalised Group	KD-H1	2	1.8	3	3.3	3.8	3.7	4.2
Marginalised Group	KD-G1	2.5	3.8	2.8	4.2	2.7	2.9	3.3
Marginalised Group	KD-L1	3.7	3.9	3	3.9	2.2	2.5	3.1
Marginalised Group	KD-G2	2.5	2.8	2.2	2.7	3.1	3.2	3.7
Marginalised Group	KD-G3	2	2.5	2.5	3.5	3	3	4
Indigenous Residents	KD-T1	4.3	4.2	3.8	4.6	1.8	1.6	2.3
Indigenous Residents	KD-C1	2.9	3.8	2.8	3.6	2.1	2.3	2.1
Indigenous Residents	KD-R1	3.4	4.3	3	3.9	2.4	2.2	2.8
Indigenous Residents	KD-H1	2.1	2	3	4	3.6	3.6	2.7

Indigenous Residents	KD-G 1	3.6	4.4	4	4.5	1.8	1.7	2.1
Indigenous Residents	KD-L 1	4.3	4.2	3.2	4.6	1.8	1.9	1.8
Indigenous Residents	KD-G 2	4.6	4.3	3.8	4.1	2	2.2	2.4
Indigenous Residents	KD-G 3	3.6	3.8	2.8	4.2	1.9	1.8	2

3.2.3 Mediating Variables: User Behaviour Patterns

Behavioural patterns serve as the mediating mechanism linking spatial attributes and social integration: POI density shapes functional support, while built environment quality affects users' willingness to linger. These two factors jointly govern users' behavioural choices, and disparities in behavioural patterns directly determine whether marginalised groups can realise the transition from mere subsistence to settled dwelling within the physical space.

Table 4 Classification of Activity Types

Activity Category	Definition and Characteristics	Specific Behaviour Examples
Necessary Activities(Code: N)	Directly associated with survival demands and less affected by the physical environment.	Commuting, shopping, medical consultation, parcel collection, working
Optional Activities(Code: O)	Dependent on favourable outdoor conditions; a core indicator for evaluating the quality of public spaces.	Strolling, dog walking, short resting, sunbathing, watching surroundings
Social Activities(Code: S)	Require the presence of other people, evolved from the above two types of activities, and reflect spatial vitality.	Conversing, chess/card games, square dancing, children's play, group fitness

Drawing on Jan Gehl's threefold classification of outdoor public activities illustrated in Table 4 (Gehl, 2013), this study operationalises user behaviours into three categories: Necessary Activities (N), Optional Activities (O) and Social Activities (S). Behavioural observation and questionnaire surveys were conducted across the eight hotspot spaces.

To eliminate bias caused by monotonous activities within individual spaces, brief questionnaires were randomly distributed to active occupants on site to verify their identity as either indigenous residents or migrant marginalised groups and record their ongoing activities. The statistical outcomes in Table 5 reveal that every surveyed space accommodates at least three dominant activity types (e.g., strolling, dog walking and social conversation in the park), which verifies the diversity of spatial activities. The frequency statistics of the three categories of behaviours grouped by population type in each hotspot zone are presented in Figure 2.

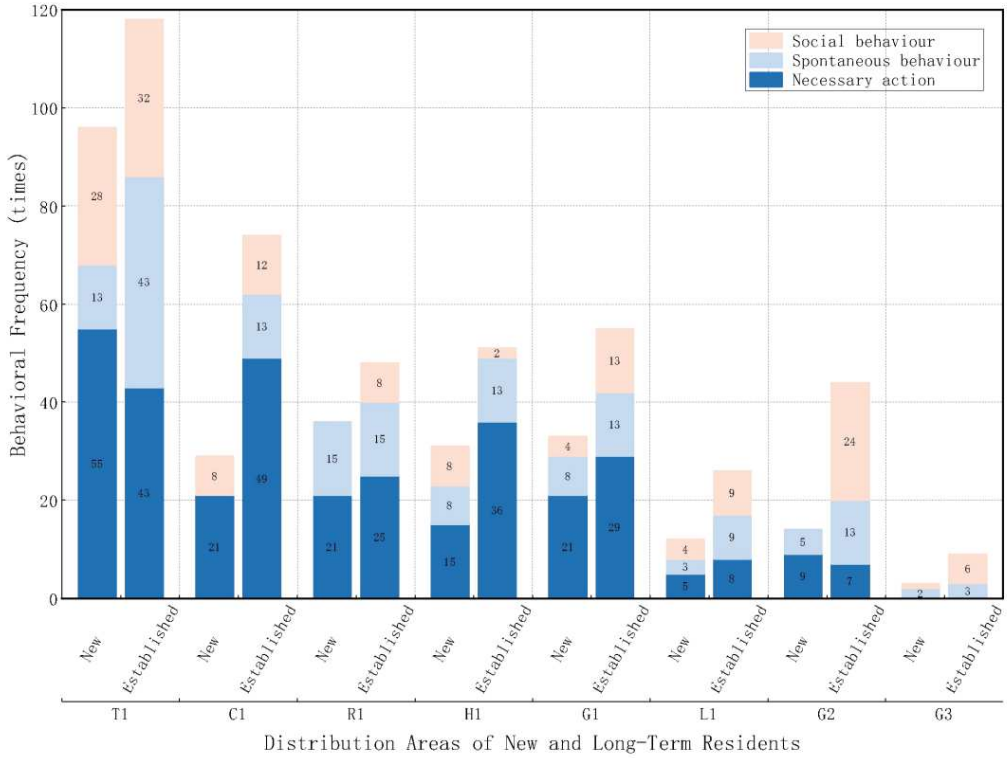


Figure 2 Statistical Chart of Behaviour Types of Indigenous residents in Hotspot Areas of Kuidong Village

3.3 Data Analysis Methods

This study employs a combination of POI density analysis, street-view semantic segmentation, behavioural cluster analysis, emotional difference analysis and comprehensive integrated analysis. Its objectives are to assess the spatial equity of resource provision, quantify therapeutic indicators of the built environment, reveal the coupling relationship between spatial configuration and behavioural patterns, compare disparities in perceived emotions between marginalised groups and indigenous residents, and ultimately verify the mediating effect of the causal pathway “Spatial Configuration - Behavioural Patterns - Emotional Stress”.

Coupled analysis of the aforementioned multi-source datasets identifies the core variables that determine the therapeutic outcomes for marginalised groups. The research outcomes deliver evidence-based support for the optimisation of therapeutic environments in urban villages underpinned by the orientation of spatial justice.

4. Results and Analysis

4.1 Measurement Results of Spatial Configuration Characteristics

4.1.1 POI Density and Facility Distribution: Peripherally Concentrated and Centrally Sparse Resource Allocation

As illustrated in Figure 3, a total of eight high-density activity zones were identified through thermal cluster analysis. These zones can be categorised into six functional types: transportation, commercial, gathering, landscape, residential and

medical, which broadly cover the primary daily activity contexts of residents.

The spatial distribution of POI densities presents a pronounced periphery-dense and core-sparse pattern. High-value clusters are concentrated on the village periphery and transitional zones connecting to urban road networks, including Huai Ta Metro Station (KD-T1), Kuiyuan Farmers' Market (KD-C1) and the East Campus of Tongshan Hospital of Traditional Chinese Medicine (KD-H1). By contrast, the central block registers markedly lower POI density, with a severe shortage of commercial and public service amenities within the cul-de-sac alleyways. Consequently, residents have to travel to the outer perimeter for routine shopping, medical treatment and commuting.

Such resource layout increases the living costs of marginalised groups and entrenches a passive behavioural pattern of inner-core residence versus outer-ring consumption in their daily spatial practices. This lays the primary foundation for the subsequent spatial decoupling analysis: the mismatch between facility provision and residents' spatial demands serves as the concrete manifestation of the periphery-concentrated and core-deficient resource allocation, whose spatial repercussions will be further elaborated in Section 4.5.

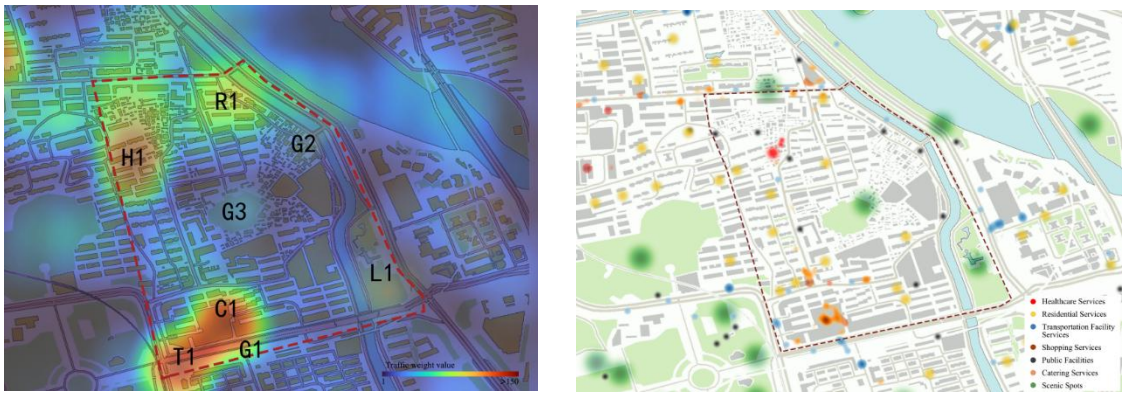


Figure 3 Distribution of Pedestrian Hotspots and POI Statistics in Kuidong Village

Table 5 POI Statistics and Functional Classification of Hotspot Zones in Kuidong Village

Code	Space Name	Function Type	Main POI Components	Spatial Characteristics
KD-T1	Huaita Metro Station	Transportation	Rail transit / bus stops	Connected to the urban transport network
KD-C1	Kuiyuan Farmers' Market	Commercial	Fresh produce retail, daily necessities retail	Core node for daily grocery shopping
KD-G1	Square in front of Youth Hostel	Gathering	Accommodation, small-scale businesses	Assembly and distribution space for floating population
KD-L1	Yingbin Garden	Landscape	Green space, resting facilities	Public leisure and social interaction space
KD-R1	Kuizhong Residential Compound	Residential	Dwellings, community supporting facilities	Public leisure and social interaction space
KD-H1	East Campus of Tongshan	Medical	General hospital, pharmacies	Service node for medical and healthcare provision

	Hospital of Traditional Chinese Medicine			
KD-G2	Entrance of Kuidong Village	Gathering	Village entrance shops, transport nodes	Transitional space linking the inner village and outer urban area
KD-G3	Surroundings of Kuishan Hill	Landscape / Gathering	Historical heritage remnants, small plazas	One of the limited public nodes within the central block

4.1.2 Typological Differentiation of Built Environment Quality

Table 6 Quantitative Analysis of Environmental Characteristics in Kuidong Village

Node Code	Photo	Green View Index (GVI)	Sky View Factor (SVF)	Building Line Coverage Ratio	Interface Permeability	Rest Facility Density (units per 100 metres)
KD-T1		28%	38%	65%	22%	4
KD-C1		0%	7%	98%	12%	1.2
KD-G1		8%	48%	92%	25%	4.5
KD-L1		68.5%	25%	5%	15%	12
KD-R1		25%	18%	85%	28%	15
KD-H1		28%	28%	78%	32%	6
KD-G2		20%	42%	75%	35%	22.5

Node Code	Photo	Green View Index (GVI)	Sky View Factor (SVF)	Building Line Coverage Ratio	Interface Permeability	Rest Facility Density (units per 100 metres)
KD-G3		35%	52%	0%	0%	2

According to the measurement results in Table 6, the built environment quality across the eight nodes can be divided into three divergent typologies:

(1) Landscape/gathering nodes (KD-L1, KD-G1, KD-G2, KD-G3): These nodes generally outperform other categories in terms of the Green View Index, rest facility density and interface permeability. KD-L1 (Yingbin Garden) achieves a Green View Index of 68.5% and a facility density of 12.0 units per 100 metres, making it the public space with the highest environmental quality in the whole village. KD-G2 (village entrance) boasts the maximum facility density at 22.5 units per 100 metres and an interface permeability of 35%, integrating gathering functions with satisfactory spatial openness.

KD-G3 (surroundings of Kuishan Pagoda) serves as an exception. Although its Green View Index (35%) and Sky View Factor (SVF, 52%) are moderately acceptable, both the building alignment rate and interface permeability register zero, with merely 2.0 rest facilities per 100 metres. Visitors can only linger on hard structural elements such as the monument plinth and metal railings. It is therefore defined as a low-intensity leisure space with weak supporting capacity, where landscape resources are visually accessible yet practically unusable.

(2) Functional service nodes (KD-C1, KD-H1, KD-T1): Designed for specialised commercial, medical and transport services, these nodes exhibit generally poor environmental quality with highly enclosed and oppressive spatial forms. Their rest facility density ranges only from 1.2 to 6.0 units per 100 metres, failing to adequately accommodate residents' daily resting and socialising demands.

(3) Residential node (KD-R1): It has a low Sky View Factor (SVF = 18%) and a high building alignment rate of 85%, resulting in a strong sense of spatial enclosure. Nevertheless, its rest facility density reaches 15.0 units per 100 metres, and built structures such as covered corridors provide sufficient amenities for lingering activities, rendering it a relatively high-quality space within the residential cluster.

Overall, the built environment of Kuidong Village follows a pattern of robust peripheral support paired with inadequate central resources. High-quality public nodes are unevenly distributed, while central nodes suffer from the structural flaw of being visually accessible yet functionally unusable. Function-oriented nodes prioritise operational efficiency over human comfort, which restricts marginalised groups' access to therapeutic environmental resources.

This finding corroborates the analysis in Section 4.1.1: high-quality built environments are likewise concentrated on the village periphery, whereas the central block becomes functionally ineffective in environmental performance, creating

implicit spatial exclusion at the physical environment level. Together with resource allocation disparities, this environmental imbalance will be incorporated into the analytical framework of the decoupling mechanism in Section 4.5.

4.2 Group Differences in Perceived Emotional Stress

4.2.1 Overall Pattern of Group Disparities in Perceived Emotions

As presented in Table 9 and Figure 4, across a total of 56 emotional rating comparisons covering the eight hotspot nodes, marginalised groups did not score higher than indigenous residents on any single indicator. The mean values of four positive emotions, namely pleasure, relaxation, excitement and sense of safety, were systematically lower for marginalised groups, while the three negative emotions including depression, irritability and loneliness registered universally higher scores.

In terms of overall group averages, marginalised groups recorded notably lower scores in relaxation (2.90) and perceived safety (3.38) compared with indigenous residents (3.88 and 4.19 respectively), with their loneliness score approximately 1.6 points higher (3.80 versus 2.28). The residential node KD-R1 demonstrated the most striking emotional divergence: marginalised groups reached the peak values for both depression (4.1) and loneliness (4.3) at this site, whereas indigenous residents obtained a high relaxation score of 4.3 in the identical space. Within this single physical setting, the two population subgroups exhibited nearly mirror-image emotional structures.

Nevertheless, such discrepancies are not uniformly manifested across all dimensions. The gaps between the two groups narrowed substantially regarding the sense of safety at the transport node KD-T1 (4.3 for marginalised groups versus 4.6 for indigenous residents) and positive emotions at the medical node KD-H1 (pleasure score: 2.0 versus 2.1). The former result implies that spaces with high functional density deliver formal security benefits that transcend group boundaries, while the latter indicates that deficiencies in functional facilities exert indiscriminate impacts on both cohorts.

In other words, intergroup disparities are predominantly embedded in affective and social dimensions rather than the functional provision of amenities. This delineates the core focus for the node-by-node mechanistic analysis in the subsequent section.

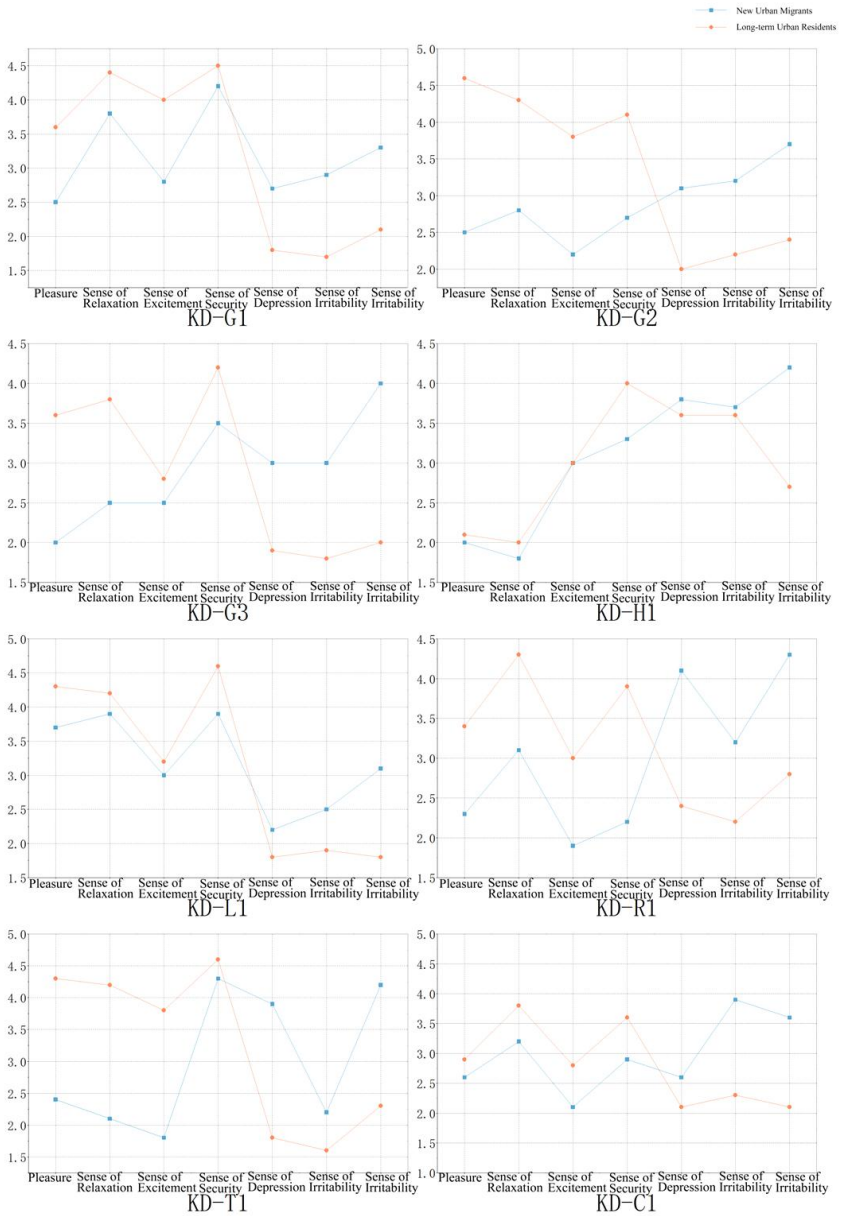


Figure 4 Comparison of Emotional Scores between Marginalised Groups and Indigenous Residents at Each Hotspot Node in Kuidong Village

4.2.2 Spatial Generation Mechanism of Intergroup Differences

Beneath the overall pattern, the divergent mechanisms across the eight types of nodes can be summarised into three core pathways, as detailed in Appendix Table A1:

First, spatial deprivation. The contradictory combination of formal physical safety alongside the absence of social networks at the transport node KD-T1, together with the transformation from physical segregation to psychological isolation within the residential node KD-R1, jointly exclude marginalised groups from inclusive spatial integration.

Second, insufficient access to therapeutic environmental resources. Medical facilities (KD-H1) and cultural sites (KD-G3) are physically present yet functionally ineffective, failing to translate their basic functions and services into tangible therapeutic support. By contrast, the landscape node KD-L1 provides

counter-evidence that validates the intervention effectiveness of well-designed healing environments.

Third, social network exclusion. Indigenous residents' emotional monopolisation over the village entrance public space (KD-G2) and efficiency-driven exclusion within the commercial setting (KD-C1) form invisible barriers that hinder social cohesion.

It can be concluded that the negative emotional experiences of marginalised groups stem not from inherent psychological traits, but from the cumulative effect of the three intertwined mechanisms. When these three disadvantages converge at critical nodes such as residential areas, marginalised groups fall into a vicious cycle: physical segregation - restricted activities - social disembedding - emotional exhaustion. In this context, perceived emotional stress acts not only as a measurement of individual psychological wellbeing, but also as a sensitive indicator reflecting the degree of spatial justice and the depth of social integration.

4.3 Cluster Analysis of Users' Behavioural Patterns

K-Means clustering was adopted with the cluster number set as K=3 and a silhouette coefficient of 0.76. On the basis of the proportional composition of three behavioural categories, namely necessary activities, voluntary activities and social activities, three typical behavioural patterns of users in Kuidong Village were classified, as illustrated in Table 7.

Table 7 Cluster Analysis of Typical Behavioural Patterns in Hotspot Zones of Kuidong Village

Category	Classification Criteria	Representative Nodes	Spatial Mechanism
A1 Dominated by Necessary Activities (Survival-oriented)	Necessary activities ≥50%, social activities 30%, difference ≥20%	Marginalised groups at KD-C1, KD-H1, KD-R1, KD-T1, KD-G1, KD-G2; Indigenous residents at KD-C1, KD-R1, KD-H1	Low integration degree, single-function POIs and inadequate environmental support confine spatial usage to rigid daily affairs including commuting, shopping and medical visits. Marginalised groups stay out of compulsion rather than voluntary choice. For instance, the proportion of spontaneous activities of marginalised groups at KD-C1 equals zero. Such spaces merely fulfil basic survival demands and fail to accommodate therapeutic functions and social integration.
A2 Balanced Behavioural Pattern (Transitional Type)	Necessary activities: 30%–55%; spontaneous/social activities: 20%–37%; pairwise differences among the three types all ＜15%	Indigenous residents at KD-T1, marginalised groups at KD-H1, indigenous residents at KD-G1, mixed population at KD-L1	High POI complexity and fundamental resting facilities underpin diverse behavioural needs. Marginalised groups begin to engage in spontaneous and social activities such as strolling and chatting, yet have not embedded themselves into stable social networks. They are in an intermediate transitional stage from mere survival to settled inhabitation.
A3a Strongly Supported Social Interaction	Social activities ＞50%, highly organised, high frequency and long duration	Indigenous residents at KD-G2	High POI diversity and sufficient amenities render the space a core carrier for neighbourhood socialising. Nevertheless, marginalised groups are excluded from this sphere. The entrenched social networks of indigenous residents lead to monopolised space occupation, constructing invisible barriers against social inclusion.
A3b Weakly Supported Leisure Activities	Spontaneous + social activities ＞80%, with extremely small sample size and low absolute frequency	Marginalised groups at KD-G3	Poor environmental quality and scarce facilities only allow unorganised, low-intensity passive leisure behaviours such as Tai Chi practice and brief casual greetings. The statistically high proportion of social activities masks the actual ineffectiveness of environmental therapeutic functions.

The three behavioural patterns correspond to three distinct spatial predicaments experienced by marginalised groups: functional survival (A1), transitional inhabitation (A2), and excluded onlooking or token participation (A3). Low spatial integration and single-function POIs constrain spatial usage to repetitive necessary round trips in Category A1. Although high POI compound complexity and favourable environmental quality can stimulate spontaneous and social behaviours in Category A2, marginalised groups are still unable to access high-quality social engagement in Category A3 unless the spatial monopolisation formed by indigenous residents' social networks is dismantled.

Accordingly, human behaviour is not merely an outcome of spatial accessibility, but also a starting point for social integration and an intermediary variable through which environmental therapeutic effects take hold.

4.4 Correlation Analysis

Building upon the overall statistical regularities, a two-stage correlation test was conducted grouped by population cohorts, with a sample size of N=19 for both marginalised groups and indigenous residents respectively. The first stage examined the correlation between built environment and human behaviour, followed by the second stage testing the relationship between behavioural patterns and perceived emotions.

4.4.1 Correlation Analysis between Built Environment and Behaviour

The two groups exhibited highly consistent responses to natural environmental indicators (Green View Index) and spatial scale metrics (Sky View Factor), yet profound divergences emerged regarding spatial fabric (building alignment rate) and boundary attributes (interface permeability). The detailed results are presented in Table 8.

Table 8 Comparison of Correlations between Environmental Attributes and Behavioural Types: Marginalised Groups versus Indigenous Residents

Environmental Variable	Behavioural Type	Correlation Coefficient (r): Marginalised Group	Correlation Coefficient (r): Indigenous Resident Group	Difference Characteristics
Green View Index	Spontaneous behaviour (O)	0.505*	0.575**	Consistent trend, slightly stronger correlation for indigenous residents
Sky View Factor	Necessary behaviour (N)	-0.475*	-0.467*	Fully consistent
	Spontaneous behaviour (O)	0.528*	0.462*	Fully consistent
Building Alignment Rate	Necessary behaviour (N)	0.293(not significant)	0.603**	Significant divergence
	Spontaneous behaviour (O)	-0.380(not significant)	-0.618**	Significant divergence
Interface Permeability	Social behaviour (S)	-0.483*	-0.028(not significant)	Significant divergence

Note: ** denotes statistical significance at the 0.01 level; * denotes statistical significance at the 0.05 level.

The essence of such divergences lies in two core mechanisms. First, indigenous residents' path dependence on the traditional alley fabric. The building alignment rate exerts a remarkably strong reshaping effect on the behavioural patterns of indigenous residents ($r = 0.603$ for necessary activities, $r = -0.618$ for spontaneous activities), whereas the correlation proves entirely non-significant for marginalised groups. This indicates that the daily movement trajectories of indigenous residents are deeply embedded within the village's traditional high-density alley network. In contrast, the activities of marginalised groups are decoupled from this spatial texture and exhibit the feature of spatial disembedding.

Second, the defensive psychological boundary of marginalised groups regarding

social privacy. Interface permeability shows a significant negative correlation with the social behaviours of marginalised groups ($r = -0.483^*$), yet imposes no statistically significant impact on indigenous residents. As incoming outsiders, marginalised groups harbour stronger privacy demands and territorial awareness. Excessively permeable spatial boundaries activate their psychological defence mechanisms and consequently inhibit the occurrence of social interactions.

4.4.2 Correlation Analysis between Behaviour and Emotion

Having verified the shaping effect of the built environment on human behaviour, this subsection examines how behavioural variations transmit to emotional outcomes, so as to validate the mediating pathway: spatial configuration - behavioural divergence - emotional exhaustion or therapeutic recovery. When grouped by population cohort, behaviours and emotions are deeply embedded for indigenous residents, while a systematic decoupling is observed among marginalised groups, as detailed in Table 9.

Table 9 Comparison of Correlations between Behavioural Types and Perceived Emotions: Marginalised Groups and Indigenous Residents

Group Type	Behavioural Variable	Emotional Variable	Correlation Coefficient (r)
Indigenous Residents(N=19)	Necessary behaviour (N)	Sense of depression	0.574*
		Sense of pleasure	-0.487*
	Spontaneous behaviour (O)	Sense of safety	0.461*
Marginalised Groups (N=19)	All behaviours (N/O/S)	Seven emotional indicators	-

Note: ** indicates significance at the level of $p < 0.01$; * indicates significance at the level of $p < 0.05$.

The “behaviour–emotion decoupling” serves as empirical evidence of spatial injustice manifested at the micro psychological level. For indigenous residents, behaviours and emotions are deeply embedded and mutually resonant: necessary activities intensify feelings of depression ($r = 0.574$) and reduce pleasure ($r = -0.487$), while spontaneous stationary stays enhance the sense of safety ($r = 0.461$). In this context, spatial engagement itself constitutes affective production.

In stark contrast, none of the three categories of behaviours show statistically significant correlations with the seven emotional indicators among marginalised groups. Their commuting, resting or social interactions fail to exert any regulatory effect on their emotional states. The village merely functions as a functional vessel that offers low-cost dwelling space for them, and their daily behaviours are reduced to undifferentiated physical movements with no emotional feedback.

Such decoupling does not stem from inherent flaws in individual psychological traits, but represents a structural consequence brought about by spatial syntactic deprivation and the failure of therapeutic environments. Confined to zones characterised by low integration, low POI density and inadequate environmental support (Category A1: survival-dominated necessary activities), marginalised groups are restricted to one-dimensional survival-driven movements, which cannot be translated into affective resources due to insufficient amenity provision. More

fundamentally, their emotional wellbeing is predominantly shaped by external urban systemic factors — including employment pressure, household income constraints and institutional identity discrimination — rather than micro-scale within-village behavioural practices. Any emotional benefits derived from activities inside the village are offset by external structural anxiety, leaving the process of social integration perpetually suspended in a transitional limbo.

Accordingly, the core requirement of spatial justice at the behaviour–emotion dimension extends far beyond merely supplying social interaction venues. It necessitates reconstructing the sensitivity of the behaviour–emotion linkage for marginalised groups through the upgrading of environmental quality, so that their stays and interpersonal engagements within the village can be genuinely converted into resources for psychological healing and capital for social inclusion.

4.5 Influence Mechanism of Environmental Characteristics and Corresponding Behavioural Response Rules

The preceding sections have separately verified two sequential pathways: the built environment shapes behavioural patterns, and behavioural patterns in turn modulate perceived emotions, as well as uncovered structural divergences in these mechanisms between the two population groups. In this section, a mediating effect test is adopted to validate the complete causal chain: spatial configuration - behavioural divergence - emotional exhaustion or therapeutic recovery. The aggregated results are presented in Table 10.

Mechanism 1: Spatial Constraints and Emotional Depletion

This part tests whether the enclosing attributes of the built environment (building alignment rate, Sky View Factor) deplete emotional resources by compelling necessary activities (N). At the overall sample level, the building alignment rate exerts a significant positive indirect effect on the sense of depression via necessary behaviours (ab=0.009, CI [0.003, 0.021]), while the direct effect is non-significant. In other words, spatial enclosure mainly drains emotional resources indirectly through forced through-movement.

When stratified by group, the mediating effect is statistically significant for indigenous residents: necessary behaviours markedly elevate depression and reduce pleasure, with the negative pathway of the Sky View Factor following the same logic. Spatial constraints therefore incur measurable emotional costs for this cohort. By contrast, the X-M path is non-significant for marginalised groups (β=0.052, p=0.205), indicating no valid mediation. Their traversals represent merely involuntary physical displacements and are not experienced as embedded within the traditional spatial fabric. Consequently, the behaviour–emotion linkage breaks down at the initial stage, resulting in spatial disembedding and decoupling.

Mechanism 2: Natural Support and Psychological Healing

This mechanism examines whether the Green View Index can boost spontaneous stationary stays (O) and translate into a sense of safety through the eyes-on-the-street effect.

At the aggregate level, the Green View Index generates a significant positive indirect effect on the sense of safety via spontaneous behaviours (ab=0.471, CI [0.033, 0.949]), with the therapeutic impact realised entirely through the indirect pathway of encouraging lingering and recreational activities.

Stratified by research group, the mediating effect is exceptionally strong among indigenous residents (ab=1.256, approximately 2.7 times the overall value). Natural spaces serve as the physical carrier for maintaining social networks and fostering place identity. For marginalised groups, however, neither the X-M path nor the M-Y path reaches statistical significance, leading to a complete breakdown of the mediation effect, namely therapeutic alienation. Although natural healing resources are visually accessible to them, they cannot be practically utilised, which constitutes direct evidence of inequitable distribution of environmental wellbeing.

Mechanism 3: Boundary Defence and Emotional Decoupling

This part tests whether interface permeability reduces the sense of relaxation by constraining social behaviours (S). At the overall sample level, interface permeability indirectly diminishes relaxation by discouraging social interactions (ab = −0.466, CI [−0.941, −0.065]), presenting a shielding pattern.

When grouped by population cohort, the X-M pathways are consistent for both groups (permeability inhibits social activities in both cases), yet the M-Y pathways diverge sharply. Marginalised groups exhibit a precise dual breakdown: the X-M path is statistically significant (β = −0.491*, verifying territorial defence psychology among outsiders), while the M-Y path is non-significant (β = 0.697). Even when they overcome defensive mentality to engage in socialising, no emotional benefits are obtained, resulting in total decoupling between social behaviours and emotional responses. In contrast, the mediating effect is significant for indigenous residents (ab = −0.396). Once social activities take place, they are strongly converted into a sense of relaxation (β = 1.140*), forming an unobstructed emotional transmission chain.

Table 10 Group Divergence of Mediating Mechanisms and Implications for Spatial Justice

Mechanism	Indigenous Residents	Marginalised Groups	Implications for Spatial Justice
Spatial Constraint	Embedded in traditional fabric, emotional resonance	Spatial disembedding and decoupling, broken mechanism	Spatial deprivation erodes the meaning of human behaviour
Natural Healing	Rooted response, potent transformation	Suspended resources, therapeutic alienation	Barriers exist between groups in the distribution of environmental wellbeing
Boundary Social Interaction	Boundary adaptation, unobstructed emotional transmission	Dual breakdown, complete decoupling	Spatial design takes indigenous residents as the default dominant users

Note: * p < 0.05, ** p < 0.01. *A BootCI that does not contain zero indicates a statistically significant mediating effect. The term "shielding pattern" refers to the scenario where the indirect effect is significant while the direct effect is non-significant, namely that X influences Y primarily through the mediating variable M.*

The three sets of mediating models have verified the inter-group asymmetry of

the causal chain “Environment - Behaviour - Emotion” from distinct dimensions. The mediating pathways operate unimpeded throughout for indigenous residents, whereas varying degrees of breakdown and ineffectiveness are observed among marginalised groups. Such divergence is not coincidental; instead, it constitutes a structural manifestation of spatial injustice at the micro psychological level. Marginalised groups are not merely recipients of insufficient resources, but also victims of dysfunctional operational mechanisms. Even if equal access to green spaces, amenities and public realms is provided, therapeutic environments will merely replicate privileged spaces exclusive to indigenous residents without reconstructing their capacity for behaviour-to-emotion conversion.

From the temporal perspective, short-term rental expectations hinder the formation of place identity. From the social perspective, the spatial monopoly of indigenous residents’ social networks subjects all social activities of marginalised groups to constant scrutiny. Accordingly, the reconstruction of spatial justice for marginalised groups requires targeted interventions responding to three dimensions at the micro-mechanism level:

First, accessibility restoration at the physical dimension. It is necessary to increase the POI density in residential areas inhabited by marginalised groups, break the behavioural lock-in dominated by necessary activities, and grant them spatial freedom to shift from forced through-movement to voluntary lingering.

Second, adaptive design at the psychological dimension. Semi-public spaces with controllable boundaries shall be arranged at the high-frequency activity nodes of marginalised groups, balancing visual permeability and territorial shielding. Such design lowers the threshold of social defensive psychology, transforming visible yet inaccessible greenery and facilities into accumulable emotional capital.

Third, integrative activation at the social dimension. By embedding resting and socialising scenarios, the complete pathway of spontaneous lingering - social interaction - emotional rehabilitation can be gradually reconstructed. This is the most fundamental and long-cycle component among the three interventions. A progressive micro-renewal model is required, which not only remodels spatial form but also adjusts the structure of social relations in the long run.

The ultimate question of spatial justice within the context of therapeutic environments lies not in what physical elements a space contains, but in which adjustable variables can endow the space with intrinsic meaning. Only when spatial configurations are capable of repairing the mediating transmission mechanisms for marginalised groups — enabling behaviours to generate affective transformation — can therapeutic environmental design truly transcend the instrumental rationality of physical renewal and embrace the value rationality inherent in reconstructing spatial justice.

5. Discussion

The empirical analysis in this paper systematically validates the transmission chain of objective spatial morphology – daily behavioural responses – outcomes of emotional perception. Spatial morphology exerts dual effects on residents’ behaviours,

namely coercive constraints and motivational support. More crucially, when exposed to identical physical surroundings, indigenous residents and marginalised groups demonstrate fundamentally divergent space-affect feedback mechanisms owing to disparities in social identity, residential tenure expectations and psychological demands. Statistical significance merely represents a superficial phenomenon; beneath it lie the deep-seated psychological mechanisms governing how the two cohorts interact with their built environments. The findings reveal that the existing spatial configuration of urban villages imposes systematic erosion on residents' mental health.

5.1 Marginalised Groups: Psychological Defence and Spatial Alienation

One of the core findings of this study is the comprehensive emotional decoupling observed among marginalised groups. Although spatial morphology exerts a significant influence on their behaviours, behavioural changes fail to translate into emotional benefits.

The evidence derived from Mechanism Three is particularly conclusive. Excessively permeable physical boundaries disrupt privacy limits and markedly discourage social willingness; even when social interactions take place, they cannot generate a sense of relaxation. When the environment fails to meet their expected standards, individuals reconstruct psychological boundaries by shutting down channels of social engagement. The extremely high building density and abrupt, unbuffered public interfaces within urban villages continuously diminish their sense of private territory. The breakdown of the behaviour–emotion linkage constitutes a defensive psychological coping strategy adopted by individuals in response to environmental stimuli exceeding their tolerance threshold.

To withstand persistent environmental stress, marginalised groups carry out a passive stripping of meaning towards village space: they sever the connection between micro physical settings and core emotional systems, reducing the urban villages to a mere physical container that only delivers affordable dwelling functions, rather than constructing it as a community endowed with a sense of emotional belonging.

This represents a concrete manifestation of spatial alienation in Henri Lefebvre's theoretical framework — space degenerates from an inhabited place into a compulsory shelter for survival. This mechanism also accounts for why a certain level of green view ratio and open space can barely arouse their in-depth emotional resonance. It is not that natural elements lose their therapeutic efficacy, but that the psychological pathway for healing is voluntarily blocked under the state of psychological defence.

5.2 Indigenous Residents: Place Attachment and Burdened Rootedness

In stark contrast to marginalised groups, indigenous residents yielded significant effects across most mediating pathways, which confirms their deep rootedness and place attachment to the physical environment of the village. For indigenous residents, the urban villages is not a transitional lodging space but an integrated living landscape.

Their daily behaviours are deeply embedded within the traditional street network, and intergenerational memories together with the acquaintance society mutually anchor physical space and self-identity.

Mechanism Two demonstrates that natural landscapes deliver an exceptionally high behaviour-to-healing conversion rate for this cohort. Furthermore, social interactions have become a normalised underpinning of their acquaintance-based community, bringing steady and predictable emotional benefits.

Nevertheless, Mechanism One uncovers the pains embedded within indigenous residents' rootedness. A higher building alignment rate forces an increase in the frequency of necessary through-movements, which significantly intensifies feelings of depression and deprives them of pleasure. The high building alignment ratio and low openness derived from the spontaneous sprawling development of urban villages drastically curtail public spaces available for lingering and social communication. Although indigenous residents maintain strong emotional attachment to this locality, they cannot offset the persistent erosion imposed by the extreme spatial form on their mental wellbeing.

5.3 Seeking the Public Comfort Zone: Reconstructing the Threshold of Therapeutic Space

A synthesis of the mechanistic disparities between the two groups confirms that the root cause of the dysfunction of public spaces in current urban villages lies in the extreme physical form breaching the distinct psychological comfort thresholds of both cohorts. Marginalised groups withdraw inward and sever the linkage between behaviours and emotions once their requirements for privacy and a sense of security are violated. By contrast, indigenous residents are pushed into overcrowded external surroundings due to the compression of public domains, suffering continuous emotional exhaustion from persistent spatial friction.

The former represents decoupling characterised by enacted behaviours devoid of affective feedback, while the latter embodies burdened rootedness accompanied by emotional depletion despite profound place attachment. Collectively, the two scenarios constitute the micro psychological manifestation of spatial injustice.

Accordingly, the core logic of spatial optimisation is to identify a public comfort zone that accommodates the demands of both groups through targeted quantitative interventions. The definition of this zone entails the simultaneous fulfilment of three quantitative targets.

First, the privacy indicator (interface permeability) shall be adjusted back above the privacy regulation threshold of marginalised groups to alleviate their defensive decoupling.

Second, openness indicators (Green View Index, Sky View Factor, and density of resting facilities) shall be elevated to the effective range triggering therapeutic responses among indigenous residents, so as to activate their rooted healing mechanism.

Third, the restrictive indicator (building alignment rate) shall be reduced below

the level where depressive feelings are markedly mitigated for both cohorts, whilst relieving the burdened rootedness experienced by indigenous residents.

Taking the dataset of this study as a benchmark, the above thresholds can be further operationalised into quantifiable design guidelines.

Interface permeability ought to strike a balance between retaining essential visual buffering to prevent triggering territorial defence among marginalised groups and sustaining the eyes-on-the-street mutual surveillance required for the indigenous residents' acquaintance society. The building alignment rate should be regulated within a range that avoids oppressive enclosure while preserving the continuity of street corridors. The Green View Index and the density of resting facilities need to reach a supply level sufficient to elicit robust therapeutic responses from indigenous residents, alongside guaranteeing accessibility to natural landscapes and rest amenities for marginalised groups.

Only when the physical indicators of all environmental elements are calibrated within the psychologically tolerable thresholds for human healing villages can we simultaneously dismantle the defensive decoupling of marginalised groups and ease the burdened rootedness of indigenous residents. In this way, urban can be regenerated from mere survival containers into therapeutic places.

6. Conclusion

6.1 Main Research Findings

From the theoretical perspective of spatial justice, this paper takes urban villages as the research object and adopts multi-group mediating models as the integrated analytical method to systematically examine the transmission pathway of objective spatial morphology – daily behaviours – emotional perception, as well as its divergent mechanisms across different groups. The main conclusions are summarised as follows:

(1) Mediating Transmission: Healing Is Mediated by Behaviours

The impacts of spatial morphology on residents' psychology are primarily realised through the mediating transmission of daily behaviours. Specifically, the building alignment rate aggravates depressive emotions by forcing frequent necessary through-movements (Mechanism 1); the Green View Index delivers therapeutic effects by stimulating spontaneous activities (Mechanism 2); and interface permeability curbs social interactions by eroding privacy boundaries (Mechanism 3). Physical settings do not exert direct influences on mental states; instead, they indirectly shape emotional outcomes by reshaping social behaviours such as lingering and interpersonal communication. Accordingly, the ultimate goal of therapeutic intervention lies not in physical renovation, but in the restoration of social behaviours and social relations.

(2) Group Differentiation: Emotional Decoupling versus Burdened Rootedness

Marginalised groups exhibit comprehensive emotional decoupling across all three mechanistic pathways. They adopt psychological defence and meaning stripping

as coping strategies against environmental stimuli exceeding their tolerance thresholds, reducing the urban villages to nothing more than a dwelling container. Despite their profound place attachment, indigenous residents suffer emotional depletion stemming from burdened rootedness amid spatial friction caused by the high building alignment rate.

The spatial demands of marginalised groups follow a hierarchical structure. Prioritising low-cost living convenience and ensuring undisturbed necessary behaviours constitutes their fundamental foundation for settling in the city. On this basis, reconstructing emotional bonds by restoring privacy boundaries and providing accessible natural landscapes and social spaces represents the core of therapeutic intervention and the starting point for their urban integration.

(3) Intervention phasing: prioritise network connectivity before qualitative enhancement.

The low integration of internal road networks within urban villages and their weak linkage with the urban hinterland constitute the deep structural root of group segregation; spatial segregation at the macro scale precedes environmental perception at the micro scale.

Accordingly, therapeutic regeneration must first eliminate structural exclusion by removing dead-end roads, densifying the branch road network, and strengthening spatial stitching with surrounding urban functional zones. Only after establishing such a skeletal framework can refined interventions targeting the Green View Index, openness, building alignment rate, interface permeability and the density of rest facilities be implemented, allowing micro-scale therapeutic design to be underpinned by macro-scale accessibility.

6.2 Theoretical and Practical Implications

Theoretically, this study advances the examination of spatial justice from the macro level of resource allocation down to the micro dimension of psychological perception. The defensive decoupling of marginalised groups characterised by enacted behaviours disassociated from affective feedback, together with the burdened existence of indigenous residents marked by profound place attachment accompanied by continuous emotional depletion, collectively embody the micro manifestation of spatial injustice embedded in everyday emotional experiences. It adds an empirical annotation derived from environmental psychology to the theoretical framework of spatial justice.

Practically, the differentiated therapeutic strategies proposed in this research can furnish quantitative evidence for refined design governance and policy formulation in the regeneration of urban villages.

6.3 Limitations and Future Research Prospects

This study has several inherent limitations. Due to the complexity of street view data collection and processing for environmental attribute quantification, only eight representative nodes were selected. Although these nodes cover the dominant spatial

typologies, the relatively small sample size may restrict the statistical power and generalisability of the findings when extrapolated to a larger scale (Liu et al., 2015). Second, emotional perception was measured solely via self-reported questionnaires. Follow-up research could incorporate physiological indicators such as heart rate variability and galvanic skin response to improve measurement validity (Ulrich, 1984；Scannell & Gifford, 2010). Third, the sample coverage and geographical scope are limited, and further empirical tests are required before the conclusions can be generalised to urban villages in other cities.

For future research, the sampling frame could be expanded — either by increasing the number of sampling nodes or adopting full-coverage street view big data analysis — to verify the robustness of the results. In addition, variables related to community governance and social capital can be incorporated to explore the synergistic effects of spatial interventions and social interventions, thereby advancing the regeneration of urban villages from spatial healing towards comprehensive social healing.

Data availability

The datasets generated during and/or analysed during the current study are available in the Mendeley Data repository, at https://doi.org/10.17632hmtkfd83zs.1. The dataset preview link is available at

https://data.mendeley.com/preview/hmtkfd83zs?a=ae96a009-1428-43f6-a547-b8364f367645

Appendix

Appendix Table A1 Interactive Mechanism between Spatial Typology and Emotional Perception

	Node Code	Connotation	Core Mechanism	Logical Attribution
Spatial Deprivation Category	KD-T1 (Transport)	Disconnection between accessibility and social integration	Marginalised groups show a contradictory state of high sense of safety and severe loneliness (Sense of Safety = 4.3 / Loneliness = 4.2).	Deprivation interpreted via Space Syntax theory. Spaces with high integration provide formal physical safety, yet the absence of social networks results in psychological isolation — accessibility does not equal social integration.
	KD-R1 (Resid	Conversion of spatial	Marginalised groups reach the sample's peak	A concentrated outbreak point of spatial injustice. The

	ence)	segregation into psychological isolation	scores of depression and loneliness (4.1 / 4.3), while indigenous residents score 4.3 in relaxation.	superimposition of three factors: low spatial integration, low POI density and insufficient environmental support, converts spatial segregation into deep-rooted psychological isolation.
Category of Inadequate Therapeutic Environmental Resources	KD-G3 (Culture)	Cultural resources are visible but inaccessible in practice	Substandard environmental quality leads to overall negative emotions among marginalised groups (Pleasure = 2.0 / Loneliness = 4.0); indigenous residents maintain positive perceptions through historical and cultural identity.	Therapeutic failure. Cultural facilities are physically present yet fail to deliver their therapeutic functions.
	KD-H1 (Medical Care)	On-site service provision with broken social support	Both groups demonstrate low positive emotions, but marginalised groups score significantly higher in loneliness (4.2) than indigenous residents (2.7).	Disconnection between therapeutic resources and social support. Functional POIs cannot offset the deficiency of social support.
	KD-L1 (Landscape)	Counter-evidence of positive intervention effects	Marginalised groups obtain remarkably higher positive emotions than at other nodes (Pleasure = 3.7 / Relaxation = 3.9).	Positive intervention pathway of therapeutic environments. High environmental quality verifies the existence of environmental healing effects and logically validates the mechanism of the resource-inadequate category from both positive and negative dimensions.
Social Network Exclusion Category	KD-G2 (Village Entrance)	Indigenous residents' emotional monopoly over space	)Indigenous residents' pleasure score (4.6) is far higher than that of marginalised groups (2.5).	Spatial exclusion derived from social networks. The indigenous community's social networks form an emotional monopoly over physical space, creating an invisible barrier to social integration.
	KD-C1 (Com	Situational pressure	Marginalised groups display prominent	Efficiency-driven exclusion in POI allocation. High-density

merce)	brought by competitive consumption	irritability (3.9).	POI-intensive competitive consumption scenarios impose situational pressure on migrant tenants with insufficient social capital.

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Figure legends

Figure number	Figure title
Figure 1	Crowd Density Heatmap of Kuidong Village
Figure 2	Statistical Chart of Behaviour Types of Indigenous residents in Hotspot Areas of Kuidong Village
Figure 3	Distribution of Pedestrian Hotspots and POI Statistics in Kuidong Village
Figure 4	Comparison of Emotional Scores between Marginalised Groups and Indigenous Residents at Each Hotspot Node in Kuidong Village

Table legends

Table number	Table title
Table 1	Elements of Spatial Configuration
Table 2	Environmental Characteristic Indicators
Table 3	Summary of Mean Emotional Perception Scores of Marginalised Groups and Indigenous Residents at Different Nodes in Kuidong Village
Table 4	Classification of Activity Types
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Table 6	Quantitative Analysis of Environmental Characteristics in Kuidong Village
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Table 10	Group Divergence of Mediating Mechanisms and Implications for Spatial Justice

Ethics Statement

Ethical Approval: This study involves human participants using non-sensitive methods such as questionnaires. As the research poses minimal risk and does not involve sensitive data, it has been reviewed and approved by the CUMT Ethics Review Committee (Approval Date: 2025-05-01). Since this institution adopts a simplified review process for low-risk studies, no formal official approval number is issued; the project identifier for this review is CUMT-Arch-IRB-2025-0501. All procedures were conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. A written confirmation of this ethical approval has been uploaded alongside the cover letter.

Informed Consent: Informed consent was obtained in written form from all participants prior to the study (Consent Collection Period: May-June 2025). Participants were fully informed of the study purpose, data usage scope (for academic research only), and their right to withdraw from the study at any time without adverse consequences. All participants were adults, and no minors took part in this study. The anonymity of participants was strictly protected during the study, and personal information was only stored by number. Participants also consented to the publication of the de-identified data from this study. A copy of the informed consent form has been uploaded in the cover letter.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Dataavailability.zip