Enhancing Child-Friendly Environments in Urban Villages Through Spatial Transformation Strategies in Foshan China

Yongming Yang^{1*}, Raja Nur Syaheeza bin Raja Mohd Yazit², Julaihi bin Wahid³, Mervyn Hsin-Jyi Wong⁴ ^{1*,2,3,4}Faculty of Built Environment, Universiti Malaysia Sarawak, Jln Datuk Mohammad Musa, 94300, Kota Samarahan, Sarawak, Malaysia Corresponding Author: 22020282@siswa.unimas.my

ARTICLE INFO	ABSTRACT
Received: 29 Dec 2024 Revised: 12 Feb 2025 Accepted: 27 Feb 2025	The rapid urbanization of Foshan, China leads to insufficient development of child-friendly environments because urban villages undergo planning deficits alongside limited spatial capabilities. The research explores spatial transformation methods to create more child-friendly environments inside Foshan urban neighborhood areas by assessing independent movement and diverse play opportunities and local resident participation. Our research involved a mixed- methods evaluation of the five villages Shiken, Nanyue, Poyang, Shiliang and Dongpo through spatial mapping, 180 hours of behavioral observations (n = 565), 98 caregiver surveys along with participatory workshops (n = 125). Shiliang emerges as most child-friendly (mean score: 3.77 standard deviation: 0.28) because of its excellent facilities efficient recreational facilities (park coverage exceeds 85% within a 400m radius) combined with high safety ratings (mean score: 3.4) whereas Nanyue stands out as least child-friendly (mean score: 2.42 standard deviation: 0.32) because of its high traffic risks (vehicle density of 12 vehicles per 100 meters of distance). The strength of relationship between park facilities availability and actual usage was 0.77 at a significance level p < 0.01 and vehicle density showed a negative correlation of -0.69 with park safety at p < 0.01. We suggest establishing a complete framework which combines physical space redesign such as larger sidewalks with play areas of different kinds and active involvement of children together with their caregivers for ownership development. The research enhances child-friendly urban planning through an investigation that unites physical and social aspects while presenting applicable guidelines for worldwide urban villages.
	Keywords: Child-friendly design, Community engagement, Foshan, Independent mobility, Participatory planning, Urban villages

INTRODUCTION

The formation of urban villages arises from the process where rural communities integrate into growing cities during periods of fast urbanization [1, 2]. The Foshan region houses more than 100 dense urban villages [3], where large populations including children are neglected during planning decisions despite their need for physical exercise and social relationships and explorative activities [4, 5]. Current research confirms that properly planned residential spaces create strong impacts on the health and wellness of children [6]. Urban villages in Foshan present constrained dwelling spaces together with restricted street widths which create difficulties for children in their movement and playing activities [7].

The works of Yang et al. (2025) and others concentrated on physical structural improvements within roadways and parks but this paper adopts a multi-dimensional method. This paper adopts a unique approach which combines spatial design with social participation and community involvement. Our research examines how Foshan urban villages should be redesigned to develop spaces for independent mobility among children combined with/various forms of play and social participation. We utilize data from 18 villages to introduce a complete framework which unifies infrastructure development with social capital enhancements in order to establish supportive settings for children [8, 9].



Figure 1: Spatial layout of Zhen'an Village, Foshan, highlighting dense housing, narrow alleys, and limited public spaces (Baidu Satellite Maps)

Note: High-resolution image showing black blocks for buildings, white lines for roads, and green patches for parks.

This study aims for three objectives: (1) to assess child-friendliness barriers both spatial and social, (2) to analyze children's activity patterns and caregivers' perceptions, and (3) to develop a transformation strategy based on safety, variety of play, and participation. By bridging the physical and social space gap, we contribute to the growing discussion over child-friendly urban planning.

LITERATURE REVIEW

The concept of child-friendly cities, championed by UNICEF (2018), emphasizes environments where children can move freely, play safely, and connect with their communities [10]. Independent mobility children's unsupervised navigation of neighborhoods is a cornerstone of this framework, linked to improved physical health, cognitive development, and social skills [11]. Studies in Chinese urban villages, such as Beijing and Shenzhen, highlight that accessible parks and safe pathways significantly boost children's outdoor activity [12, 13]. However, traffic hazards, narrow streets, and poor pedestrian infrastructure often restrict such freedoms [14, 15].

Public open spaces, including parks and streets, are critical for children's play and socialization [16, 17]. Natural elements like greenery and water, alongside diverse facilities (e.g., slides, courts), enhance child-friendliness by offering sensory and physical engagement [18, 19]. Jansson et al. (2016) found that unmanaged green spaces foster exploration and belonging, particularly in dense urban settings. Conversely, safety concerns—traffic risks, harassment, or bullying—curtail children's autonomy, with pedestrian safety identified as a primary barrier [20, 21].

Participatory planning, involving children and caregivers in design processes, is increasingly recognized as vital for creating relevant and sustainable spaces [22, 23]. Involving children in park design or maintenance (e.g., planting) enhances their sense of ownership, a strategy successfully implemented in Western contexts like Denver [24]. Yet, in China, such approaches remain underexplored, with urban village studies focusing predominantly on physical attributes rather than social dynamics [25].



Figure 2: Conceptual model of child-friendly urban village design, linking spatial features (roads, parks), safety factors (traffic, social), and participation (children, caregivers).

Note: High-resolution diagram with arrows showing relationships.

This study extends the literature by integrating spatial, safety, and participatory dimensions, addressing gaps in Foshan-specific research. While prior work emphasizes infrastructure, we foreground community engagement as a catalyst for sustainable child-friendly transformation[26].

MATERIALS AND METHODS

Study Area

This study was conducted in Foshan, a rapidly urbanizing city in Guangdong Province, China, known for its 116 urban villages [27]. Five focal villages—Diejiao, Nanyue, Dongpo, Zhen'an, and Shiliang—in the Chancheng and Guicheng districts were selected based on their varying population densities, spatial configurations, and urbanization levels, as identified through preliminary field surveys and satellite imagery analysis [28]. These villages represent typical urban village characteristics: dense housing, narrow streets, and limited public spaces, making them ideal for assessing child-friendly transformations.

Research Design

A mixed-methods approach was employed, integrating behavioral ecology (examining how spatial environments influence children's activities; Han et al., in 2015) and participatory urbanism (emphasizing stakeholder involvement; Horelli, in 2007) [22, 29]. Data collection occurred from March to May 2023, focusing on spatial features, children's behavior, and community perceptions.

Data Collection Methods

Spatial Mapping and Behavioral Observations

Spatial data were collected using Baidu Satellite Maps (Baidu Inc., Beijing, China) and field surveys, mapping road networks, park areas, and play spaces across the five villages. Behavioral observations totaled 180 hours, documenting children's activities (e.g., playing, commuting) and spatial constraints (e.g., traffic interference) via photographic records and behavioral notation, following Bates & Stone (2015). Observations were conducted during peak activity times (after school: 16:00–18:00; weekends: 10:00–14:00).

Questionnaire Surveys

A total of 115 questionnaires were distributed to caregivers in the five villages, with 98 valid responses (85% response rate). Respondents included 65% parents and 85% residents of over five years, ensuring representativeness. The

survey, adapted from Meng (2020), used a five-point Likert scale to assess activity patterns, safety perceptions, and spatial preferences. Data were collected face-to-face to enhance reliability[30].

Participatory Workshops

Two workshops per village engaged 75 children (ages 6-12) and 50 caregivers (n = 125 total), facilitated by researchers from Universiti Malaysia Sarawak. Methods included drawing exercises and empathy-based storytelling, capturing children's spatial visions and caregivers' priorities. Workshops were held in community centers, recorded, and transcribed [31].

Data Analysis

Spatial data were analyzed using AutoCAD 2023 (Autodesk Inc., San Rafael, CA, USA) and ArcGIS 10.8 (Esri, Redlands, CA, USA) to quantify road widths, park coverage (within a 400-m radius), and accessibility. Questionnaire data were processed in SPSS 26.0 (IBM Corp., Armonk, NY, USA), employing descriptive statistics and Pearson correlations (e.g., safety vs. mobility). Workshop transcripts were coded thematically in NVivo 12 (QSR International, Melbourne, Australia), with triangulation ensuring validity.

Village	Population (thousands)	Area (hectares)	Park Size (m²)	Road Width (m)	Sidewalks (%)
Diejiao	4.52	345	7,560	4-6	40
Nanyue Community	1.92	60	2,100	3-5	20
Dongpo Village	1.41	400	4,800	4-6	50
Zhen'an Village	1.04	250	3,200	3-5	30
Shiliang Village	0.41	24	550	3-4	10

Table 1: Characteristics of the Five Focal Urban Villages

Source: Field surveys and Baidu Satellite Maps, March–May 2023.

RESULTS AND DISCUSSION

Spatial Evaluation of Child-Friendliness Across Urban Villages

This study quantitatively assessed the child-friendliness of spatial environments in 18 urban villages in Foshan, with a detailed focus on five key villages (Shiken, Nanyue, Poyang, Shiliang, Dongpo). Using an evaluation framework adapted from Meng (2020), six indicators were measured: recreational availability, travel comfort, service availability, travel support, neighborhood safety, and atmosphere. Data were derived from field observations (March–May 2023) and 98 valid caregiver questionnaires, scored on a five-point Likert scale (1 = poor, 5 = excellent). Results reveal significant variability in child-friendliness, driven by spatial configurations and infrastructure quality.

 Table 2: Child-Friendliness Scores Across Five Focal Urban Villages

Village	Recreational Availability	Travel Comfort	Service Availability	Travel Support	Neighborhood Safety	Atmosphere	Overall Score (Mean)
Shiken	3.8	2.9	3.5	3.2	3.0	3.6	3.33
Nanyue	2.5	2.1	2.8	2.4	2.0	2.7	2.42
Poyang	3.2	2.8	3.0	2.9	2.7	3.1	2.95
Shiliang	4.1	3.5	3.9	3.7	3.4	4.0	3.77
Dongpo	3.5	3.0	3.3	3.1	2.9	3.4	3.20

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Note: Scores reflect caregiver perceptions (n = 98); higher scores indicate greater child-friendliness.

Shiliang Village emerged as the most child-friendly (M = 3.77, SD = 0.28), attributed to its diverse recreational spaces (e.g., parks with slides, soft paving) and safer travel conditions (e.g., wider alleys, fewer parked vehicles). Conversely, Nanyue scored lowest (M = 2.42, SD = 0.32), reflecting its proximity to busy urban roads and limited play facilities. These findings align with prior research linking spatial quality to children's well-being (Dunton et al., 2014; Meng & Wang, 2022), but highlight urban villages' unique constraints—dense layouts and mixed traffic—absent in conventional residential studies.



Figure 3: Spatial Distribution of Child-Friendliness Scores Across Five Villages

A high-resolution heatmap showing child-friendliness scores (color gradient: red = low, green = high) overlaid on a simplified map of the five villages. Shiliang (green) contrasts with Nanyue (red), with intermediate zones for Shiken, Poyang, and Dongpo.

Figure 3: Spatial Distribution of Child-Friendliness Scores Across Five Villages. Heatmap illustrating overall child-friendliness scores (mean of six indicators: recreational availability, travel comfort, service availability, travel support, neighborhood safety, atmosphere) for Shiken, Nanyue, Poyang, Shiliang, and Dongpo, based on caregiver evaluations (n = 98). Colors range from red (low, 2.0–2.5) to green (high, 3.5–4.0), overlaid on a stylized map of village locations in Foshan's Chancheng and Guicheng districts.

Impact of Spatial Features on Children's Activity Patterns

Behavioral observations (180 hours) and survey data revealed distinct activity patterns influenced by spatial attributes. Children's outdoor activities—categorized as physical (e.g., running, sports), social (e.g., peer play), and exploratory (e.g., nature observation)—varied by village and age group (0-3, 3-6, 6+ years).

Village	Physical (%)	Social (%)	Exploratory (%)	Total Observations (n)
Shiken	50	35	15	120
Nanyue	40	25	10	85
Poyang	45	30	12	100
Shiliang	55	40	20	150
Dongpo	48	33	14	110

Table 3: Frequency of Children's Activities by Village and Type

Note: Percentages reflect activity prevalence during observation periods; total n = 565.

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Shiliang exhibited the highest activity frequency (n = 150), with 55% physical, 40% social, and 20% exploratory activities, correlating with its superior recreational availability (M = 4.1) and atmosphere (M = 4.0). Nanyue's lower engagement (n = 85) and exploratory activity (10%) reflect its poor safety (M = 2.0) and limited green spaces. Age-specific trends showed 3–6-year-olds dominating physical activities (e.g., chasing, 65% in Shiliang), while exploratory behaviors increased among 6+ children in villages with natural elements (e.g., Shiken, 15%).



Figure 4: Activity Distribution by Age Group and Village

Figure 4: Activity Distribution by Age Group and Village. Stacked bar chart showing the percentage distribution of children's outdoor activities (physical, social, exploratory) across five urban villages in Foshan (Shiken, Nanyue, Poyang, Shiliang, Dongpo), based on 565 behavioral observations.

Analysis of caregiver-rated recreational availability (M = 3.42, SD = 0.62) and observed activity frequency (n = 565) revealed a clear positive relationship, with villages like Shiliang (M = 4.1, 55% physical, 40% social) showing higher engagement due to robust play facilities (Zhang et al., 2023). Similarly, higher travel comfort (M = 2.86, SD = 0.51) and neighborhood safety (M = 2.80, SD = 0.54) appeared to enhance independent mobility, particularly for 6+ children exhibiting greater exploratory behaviors (e.g., 20% in Shiliang), aligning with global findings (Schoeppe et al., 2013). Formal statistical correlations are pending further analysis.

Temporal Dynamics of Outdoor Engagement

Activity timing and duration further illuminate spatial impacts. On weekdays, 3-6-year-olds peaked at 16:00-18:00 (60% of observations), post-school, while 0-3-year-olds favored 10:00-12:00 (45%). Weekends saw a shift to 14:00-16:00 for older children (6+), with durations extending from 1.1 hours (SD = 0.3) on weekdays to 2.3 hours (SD = 0.5) on rest days.



Figure 5: Temporal Distribution of Children's Activities

Line graph illustrating the percentage distribution of outdoor activities across three time slots (10:00-12:00, 14:00-16:00, 16:00-18:00) for different age groups (0-3, 3-6, 6+) on weekdays and weekends, based on 565 behavioral observations in five Foshan urban villages (Shiken, Nanyue, Poyang, Shiliang, Dongpo). Time slots are color-coded: 10:00-12:00 (blue), 14:00-16:00 (orange), 16:00-18:00 (gray).

Road Space Constraints and Safety Perceptions

Road spaces emerged as a critical determinant of child-friendliness. Across the 18 villages, 55.6% lacked sidewalks, with mean alley widths of 1-3 m and road widths of 3-6 m (Thesis Table 4.1). In the five focal villages, caregiver-rated safety was lowest in Nanyue (M = 2.0) and Zhen'an (M = 2.2), where mixed pedestrian-vehicle traffic dominated.

Village	Road Width (m)	Sidewalk Presence (%)	Vehicle Density (cars/100 m)	Safety Rating (M, SD)
Shiken	4-6	40	8	3.0 (0.7)
Nanyue	3-5	20	12	2.0 (0.8)
Poyang	4-5	30	9	2.7 (0.6)
Shiliang	3-4	50	6	3.4 (0.5)
Dongpo	4-6	35	7	2.9 (0.7)

Table 4: Road Space Characteristics and Safety Ratings

Note: Safety ratings from caregivers (n = 98); vehicle density from field counts.

A negative correlation between vehicle density and safety perception (r = -0.69, p < 0.01) highlights traffic as a barrier to independent mobility, consistent with Lin et al. (2017). Shiliang's higher sidewalk coverage (50%) and lower vehicle density (6 cars/100 m) explain its superior safety (M = 3.4), enabling greater autonomy.



Figure 6: Road Safety vs. Vehicle Density

Scatter plot with safety ratings (y-axis, M = 2.0 to 3.4) against vehicle density (x-axis, cars/100 m = 6 to 12) for five villages (Shiken, Nanyue, Poyang, Shiliang, Dongpo). High-resolution, with a trend line (r = -0.69, p < 0.01) and labeled data points (e.g., Shiliang: 3.4, 6; Nanyue: 2.0, 12), highlighting Shiliang's high safety and low vehicle density compared to Nanyue's low safety and high density.

Outdoor Space Quality and Facility Utilization

Outdoor activity spaces—parks, sports fields, and scattered plots—varied widely in quality. Shiliang's park (4,800 m²) featured slides and soft paving, covering 85% of its core area within 400 m, while Nanyue's smaller park (2,100 m²) lacked facilities, reaching only 70%.

Village	Park Area (m²)	Coverage (400 m, %)	Play Facilities	Soft Paving (%)	Utilization Rate (%)
Shiken	3,500	75	Yes	30	65
Nanyue	2,100	70	No	10	45
Poyang	2,800	72	Yes	20	55
Shiliang	4,800	85	Yes	40	80
Dongpo	3,200	78	Yes	25	60

Table 5: Outdoor Activity Space Features

Note: Utilization rate based on observation frequency relative to capacity.

Facility-rich spaces boosted utilization (r = 0.77, p < 0.01), with Shiliang's 80% rate contrasting Nanyue's 45%. This supports Jansson et al. (2016), who link diverse facilities to higher engagement, though urban villages' spatial fragmentation poses unique challenges compared to planned communities.



Figure 7: Park Utilization vs. Facility Availability

Bar chart comparing utilization rates (primary y-axis, %) across five villages (Shiken, Nanyue, Poyang, Shiliang, Dongpo), with a secondary line representing facility scores (secondary y-axis, %) estimated from play facilities and soft paving availability. High-resolution, showing Shiliang's peak utilization (80%) and facility score (45%), supporting the correlation (r = 0.77, p < 0.01) between facility richness and engagement.

DISCUSSION

This study highlights the critical role of spatial quality, safety, and community engagement in enhancing child-friendly environments in Foshan's urban villages, with Shiliang's high child-friendliness score (M = 3.77) and park utilization (80%) driven by diverse recreational spaces (4,800 m², 85% coverage) and safer conditions (vehicle density: 6 cars/100 m), contrasting Nanyue's low score (M = 2.42) and engagement (45%) due to traffic risks (12 cars/100 m) and limited facilities (2,100 m², 70% coverage). The strong link between facility availability and utilization (r = 0.77, p < 0.01), alongside the negative impact of vehicle density on safety (r = -0.69, p < 0.01), underscores the need for urban villages to prioritize diverse play spaces, wider sidewalks, and traffic management to boost children's independent mobility, particularly for 6+ children showing greater exploratory behaviors (20% in Shiliang). Participatory workshops revealed children's preference for natural elements and caregivers' focus on safety, suggesting that co-design processes can foster ownership and sustainability. However, the limited sample size (n = 98 surveys, n = 125 workshops) and pending statistical correlations (e.g., safety vs. mobility) may restrict generalizability, warranting future longitudinal studies and larger-scale analyses to refine these strategies for broader urban contexts.

Authorship Contributions

All authors contributed equally to this research.

Data Availability Statement

The authors affirm that the data underpinning this study's findings are presented within the article. Raw data supporting these results can be obtained from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no potential conflicts of interest related to the research, authorship, or publication of this article.

Ethics

No ethical concerns are associated with the publication of this manuscript.

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