

Research Paper

Reprogramming Urban Communities

Enhancing Children's Well-being through a Value-Based Programming Approach in Inclusive Planning and Design

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Abstract

With the acceleration of urbanization, children's well-being in urban communities has become a growing concern. By conducting a semantic analysis of community street view data and administering surveys with multiple stakeholders, this study analyzes the key factors influencing children's well-being and constructs a value-based programming framework centered on cultural identity, safety, inclusivity, and multi-stakeholder collaboration. The findings indicate that environmental quality, interactivity, cultural identity, and social interaction have a direct impact on children's psychological health, sense of belonging, and feelings of safety. Additionally, multi-stakeholder collaboration plays a critical role in the sustainable improvement of children's well-being. The study concludes that through the integration of diverse values and the optimization of collaborative mechanisms, children's well-being in communities can be systematically enhanced. This study provides a new theoretical framework and practical approach for future urban community planning, with significant potential for broader application.

Keywords

Children's well-being, Architectural programming, Street View images, Semantic segmentation, Questionnaires, Linear regression

1. Background

Urbanization has led to higher building density in cities (Song and Zhu, 2011). This has reduced the size of community public spaces, which no longer support safe and independent activities for children (Bochaver et al., 2016). Areas once reserved for public use are now taken over by motor vehicles, commercial facilities, and other functions. This change has greatly limited the space available for children's activities in urban areas (Guo et al., 2023; De Visscher and Bouverne-de Bie, 2008).

In 2018, the United Nations urged communities to improve children's well-being in its report *Shaping Urbanization for Children: A Handbook on Child-Responsive Urban Planning* (UNICEF, 2018). This report emphasizes that communities are central to children's daily lives. The planning and design of public spaces in these communities are key to their healthy development. In China, urban planning often prioritizes functionality—such as transportation and commercial development—while neglecting spaces for children's activities (Wang et al., 2023). This can harm their quality of life and developmental potential (Shen et al., 2022).

A value-based architectural programming approach can help reprogram urban communities to better support children's well-being (Pyburn, 2017; Kalayci and Ozdemir, 2021). This approach uses sound, fair conflict-resolution strategies to ensure that the planning and design process considers the needs of all stakeholders (Jin et al., 2024; Xiang et al., 2021). By addressing gaps in urban research, this approach focuses on understanding and meeting children's needs, promoting more inclusive urban spaces. The study investigates the following questions:

1. How do different groups perceive children's well-being in urban public spaces?
2. What are the key factors in urban communities that influence children's growth and quality of life?
3. How can a value-based programming approach improve children's well-being in urban communities?

2. Literature review

2.1. Children's well-being in urban communities

In modern urban areas, children's well-being has become a key concern in urban planning (Collins et al., 2024). Research mainly focuses on three areas: green environments, urban infrastructure, and community services.

First, a well-maintained green environment offers children spaces for play and outdoor activities. These areas support cognitive development and emotional regulation (Bikomeye et al., 2021). Lyons et al. (2024) found that urban green spaces provide a peaceful retreat for young people. These spaces also strengthen family bonds and improve community cohesion.

Second, urban infrastructure, especially transportation, affects children's safety and quality of life (Fenton, 2012). De Macédo et al. (2022) showed that children's ability to move freely, without adult supervision, enhances their well-being. Access to open spaces like streets and parks supports this independent mobility.

Finally, community services such as education, healthcare, and recreation are essential for children's holistic development. These services help safeguard their mental health and socio-emotional growth (Poon et al., 2022). Sullu (2024) argued that urban planning should consider the needs of all community members, especially children, who have the right to participate in these decisions.

In conclusion, the quality of urban environments—including green spaces, infrastructure, and community services—plays a crucial role in supporting children's well-being.

2.2. Value-based architectural programming

As cities focus more on livability and quality of life, value-based architectural programming has gained attention (Jin, 2024). This approach not only addresses building design but also considers how social, cultural, and environmental values can improve urban communities and residents' well-being (Tu and Jin, 2024).

Recent studies on urban programming emphasize improving community environments by integrating different values, especially those that impact residents' well-being. Milovanovic et al. (2023) discussed how the EU's "Housing-Centered" framework can help redevelop large housing neighborhoods. This approach uses design guidelines to evaluate community programming. Other studies, like that of Kalayci and Ozdemir (2021), focus on creating inclusive, sustainable urban spaces by integrating historical, social, and cultural values. They presented a three-step model for urban programming, focusing on historical research, site analysis, and strategic planning.

In summary, value-based architectural programming is a key tool for improving urban livability. Whether through preserving historical elements or incorporating stakeholder input, this approach helps meet the complex needs of modern urban environments.

3. Methodology

3.1. Case study

This study uses the Weifang New Village Subdistrict in Pudong New District, Shanghai, as a case study. The area covers 3.89 square kilometers and has a population of 122,000 people across 29 communities (Figure 1).

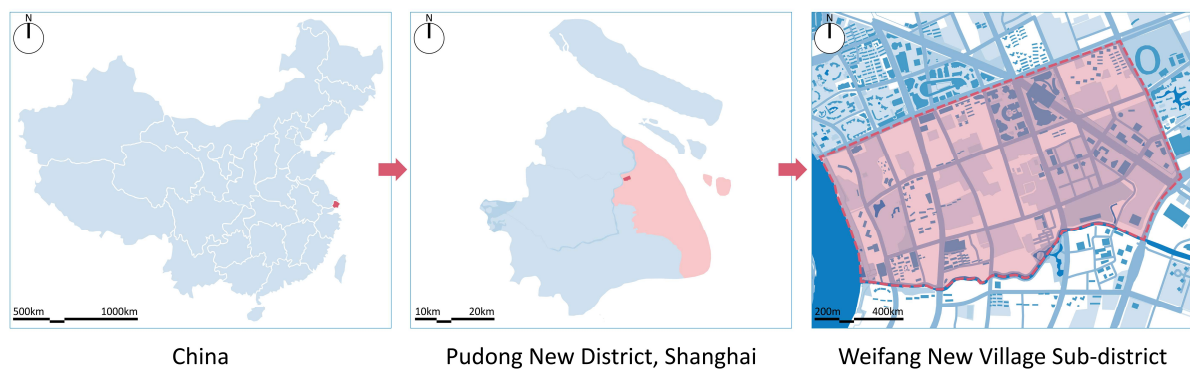


Figure 1. Location of the case study area. Source: Authors' own work.

The reasons for choosing this case are:

1. The site includes a mix of old urban areas and modern communities, representing different stages of urban development in Shanghai.
2. The area has a high population density, with people from diverse backgrounds in terms of age, income, and occupation.
3. The communities vary greatly in terms of green space and environmental quality.

3.2. Data collection

This study uses a mixed-methods approach, combining both quantitative and qualitative data to gain a comprehensive understanding of children's well-being in the community (Figure 2).

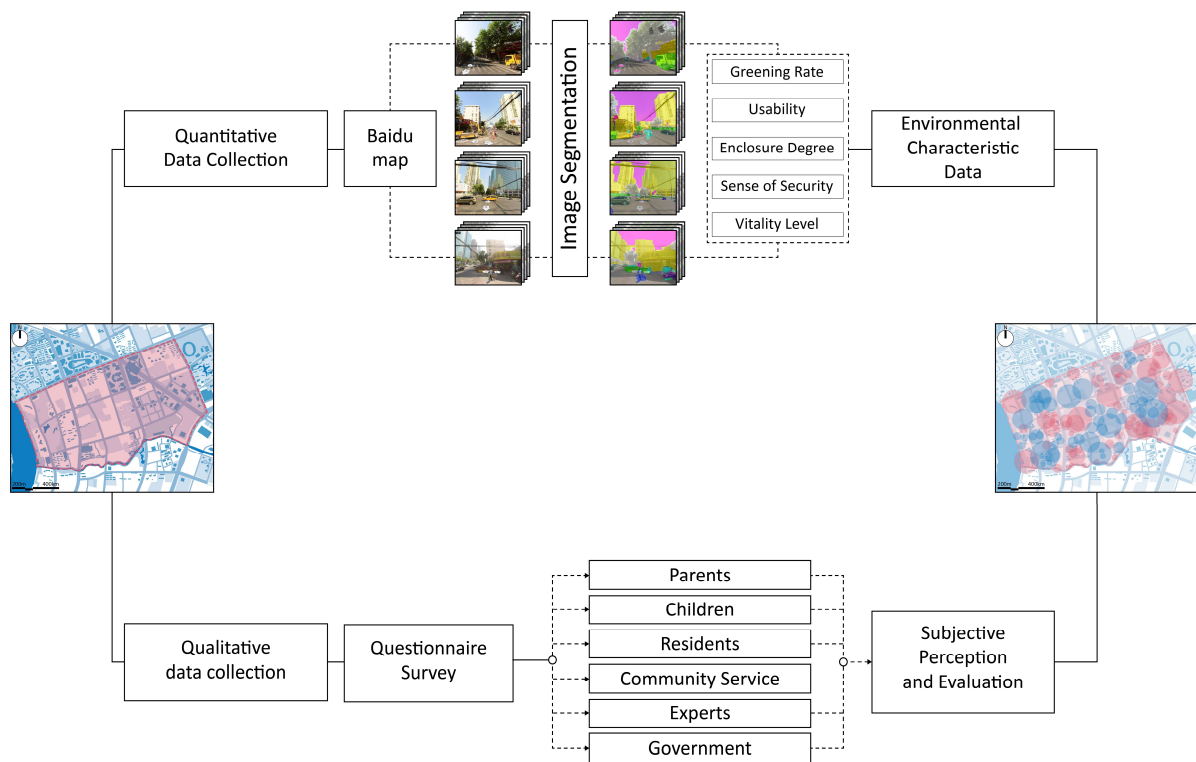


Figure 2. Data collection process of this study. Source: Authors' own work.

(1) Community environment data

The study collected community environment data using semantic segmentation techniques on street view images. Road network data was obtained from OpenStreetMap, and images were captured every 50 meters along roads using the Baidu Maps API. A sample point was set at each 50-meter interval, and street view images were taken in four directions (0°, 90°, 180°, 270°). The Segformer-B4 scene parsing and segmentation database was used to train a Fully Convolutional Network (FCN-8s) model, which performed semantic segmentation on the images.

The study calculated the proportion of pixels occupied by different objects in each image. The mean pixel ratio of each object was calculated across all four directions at each sample point (Wang et al., 2020). The study selected five indicators—greening rate, usability, enclosure, sense of security, and vitality—to examine how these factors relate to children's well-being (Table 1).

Table 1. Definitions and calculation methods of community public space indicators. Source: Authors' Own Work.

Indicator	Definition	Formula	Explanation
Greening rate	This factor reflects the distribution of natural elements and the ecological quality of the community environment.	$G_i = \frac{1}{n} \sum_{k=1}^n \frac{1}{m} \sum_{j=1}^m g_{jk} \times 100\%$	G_i represents the greenery coverage of community i , g_{jk} is the proportion of green vegetation pixels in the j^{th} street view image at the k^{th} sample point in community i , n is the number of sample

			points, and m is the number of images at each sample point.
Usability	This factor reflects the accessibility and potential usability of community spaces for residents, especially children.	$U_i = \frac{1}{n} \sum_{k=1}^n \frac{1}{m} \sum_{j=1}^m \frac{p_{jk}}{t_{jk} + r_{jk}} \times 100\%$	U_i represents the usability of community i , p_{jk} is the proportion of pixels for non-motorized lanes and sidewalks, t_{jk} is the proportion of pixels for motorized lanes, and r_{jk} is the proportion of pixels for other transportation facilities.
Enclosure degree	This factor reflects the sense of enclosure and visual privacy in the community, which directly impacts perceptions of safety and privacy.	$E_i = \frac{1}{n} \sum_{k=1}^n \frac{1}{m} \sum_{j=1}^m \frac{b_{jk} + t_{jk}}{r_{jk} + p_{jk}}$	E_i represents the enclosure of community i , b_{jk} is the proportion of pixels for buildings, t_{jk} is the proportion of pixels for trees, while r_{jk} and p_{jk} are the proportions of pixels for motorized lanes and sidewalks, respectively.
Sense of security	This factor reflects the perceived safety of the space, particularly for children.	$S_i = \frac{1}{n} \sum_{k=1}^n \frac{1}{m} \sum_{j=1}^m (f_{jk} + s_{ljk} + tl_{jk} + c_{jk} + w_{jk}) \times 100\%$	S_i represents the sense of security in community i , f_{jk} represents the proportion of pixels for fences, s_{ljk} for streetlights, tl_{jk} for traffic signals, c_{jk} for cameras, and w_{jk} for street-facing windows, reflecting the impact of these facilities on safety.
Vitality level	This factor reflects the level of activity in the community and the degree of engagement and social interaction opportunities for residents, especially children.	$V_i = \frac{1}{n} \sum_{k=1}^n \frac{1}{m} \sum_{j=1}^m (pd_{jk} + bc_{jk}) \times 100\%$	V_i represents the vitality of community i , pd_{jk} represents the proportion of pixels for pedestrians, and bc_{jk} represents the proportion of pixels for bicycles, indicating the vibrancy and social interaction potential of community public spaces. Higher values suggest a more vibrant and socially interactive community.

(2) Questionnaire survey data

To collect qualitative data, the study used a multi-perspective questionnaire survey. This survey aimed to understand the needs and opinions of various stakeholders, including parents, children, residents, community service personnel, experts, and government officials.

The survey consisted of three sections:

The first section gathered basic information about the respondent, such as community, child's age, gender, and education level.

The second section assessed the perceived well-being of children in the community. Respondents rated their satisfaction with the state of children's well-being in eight areas: environment, humanity, society, systems, temporary needs, economy, aesthetics, and safety.

The third section asked for overall satisfaction with the community's ability to meet children's well-being needs.

A total of 800 questionnaires were distributed, with 691 valid responses after excluding incomplete ones.

3.3. Data analysis

This study uses a multi-level data analysis approach to analyze both quantitative and qualitative data. The goal is to develop a value-oriented programming framework to improve children's well-being in urban communities (Figure 3).

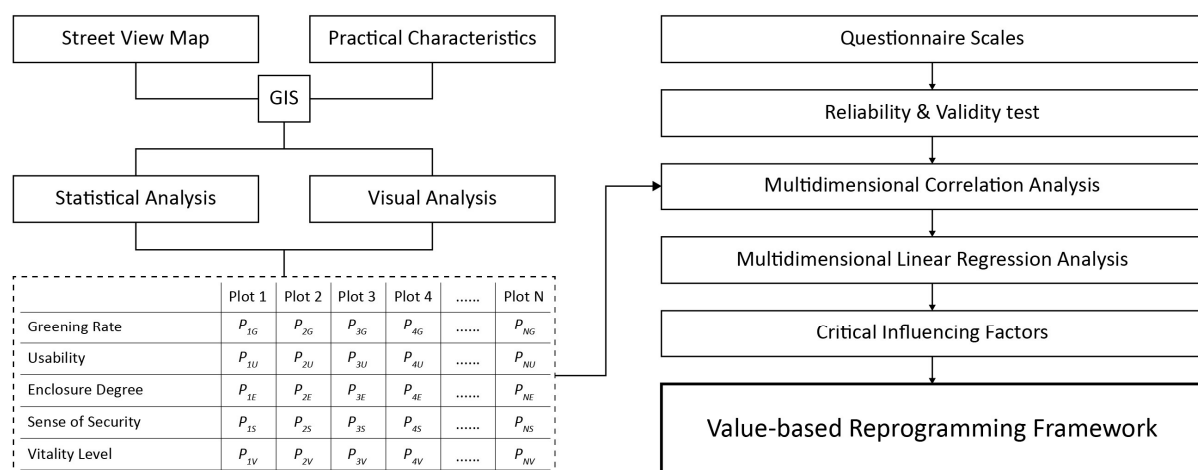


Figure 3. Data analysis process of this study. Source: Authors' own work.

First, ArcGIS software was used for spatial visualization analysis of the community environment data. This showed how different elements are distributed across the community. To ensure the reliability of the qualitative data, we tested the questionnaire data for reliability and validity using SPSS 26.0 software. This step helped confirm the accuracy of the analysis results.

Second, we performed descriptive statistical analysis on the community data and survey responses. This provided an overview of community environment features and residents' perceptions. We also used Pearson correlation analysis to explore relationships between the characteristics of community public spaces and factors influencing children's well-being. This analysis identified key areas for improvement in urban community programming.

Finally, to understand the relationship between community programming factors and children's well-being, we built a linear regression model. This model helped identify the most effective programming factors for improving children's well-being. The results led to the creation of a value-oriented programming framework through comparative analysis among different stakeholders.

4. Findings

4.1. Current status of the public spaces and perception in urban communities

The respondents in this study represented a wide range of ages and family backgrounds. Their demographic characteristics are shown in Table 2.

Table 2. Demographic characteristics of participants in the questionnaire. Source: Authors' own work.

	Basic information	Quantity	Proportion
Age	8 to 14 years old	154	22.3%
	15 to 35 years old	229	33.2%
	36 to 45 years old	212	30.7%
	Over 46 years old	95	13.8%
Sex	Male	332	48%
	Female	359	52%
Educational background	Primary school and below	254	36.8%
	Middle school and high school	65	9.44%
	Bachelor degree or above	372	53.8%
Annual household income	Less than 100,000 yuan	123	17.8%
	100,000 to 200,000 yuan	390	56.5%
	More than 200,000 yuan	178	25.7%
Groups	Children	154	22.3%
	Parents	198	28.6%
	Residents	127	18.4%
	Community service	122	17.6%
	Experts	81	11.7%
	Government	10	1.4%

Next, we used semantic recognition technology based on street view maps to analyze the public spaces in the study area (Figure 4). The data revealed that residential areas had the highest greenery coverage, averaging 45.5%. In terms of usability, parks had good walkability, with well-covered pedestrian paths and bicycle lanes, meeting the activity needs of children and parents. Regarding enclosure, residential areas had higher enclosure, with more vertical space occupied by buildings and vegetation than parks or streets. This provided children with a more enclosed and safer environment for activities. The security analysis showed that residential areas scored highest in safety, followed by streets, while parks had a moderate score.

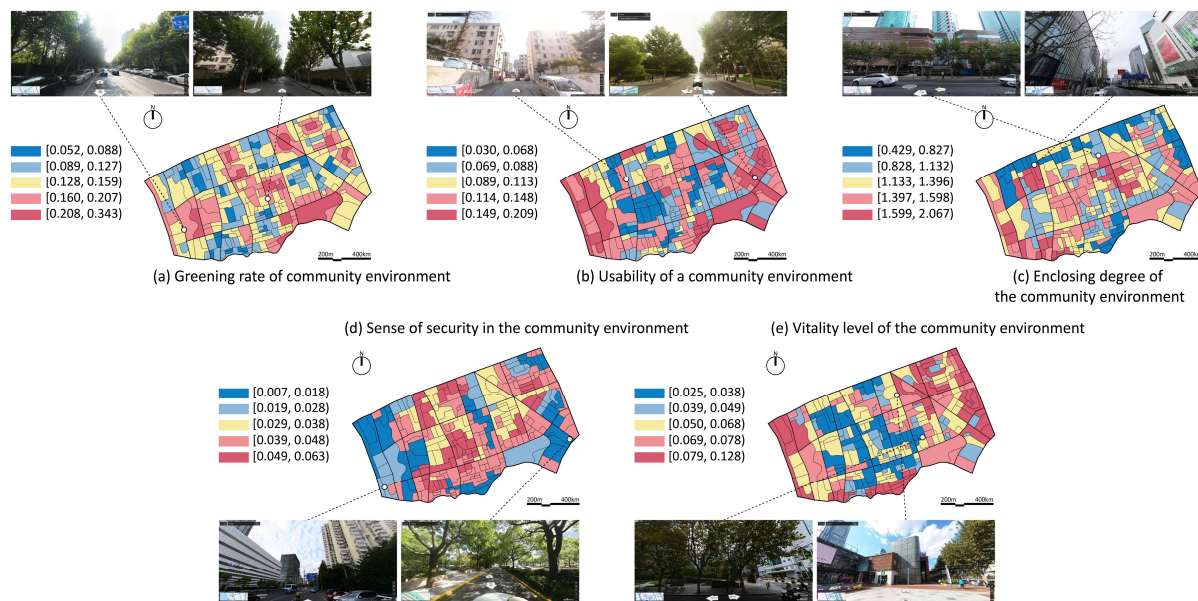


Figure 4. Spatial characteristics of community public space indicators. Source: Authors' own work.

Lastly, the survey assessed respondents' satisfaction with children's well-being in the community, focusing on eight aspects: environment, humanity, society, systems, temporary needs, economy, aesthetics, and safety. Descriptive statistical analysis results are shown in Table 3.

Table 3. Survey results on the current status of satisfaction perception of children's well-being in the community. Source: Authors' own work.

Dimension	Min	Max	Mean	SD	Variance
Environment	1	5	4.1481	0.77763	0.605
Human	1	5	3.1622	0.76984	0.593
Society	1.25	5	3.6272	0.78237	0.612
System	1.06	5	3.8481	0.72872	0.531
Temporary	1.33	5	3.5426	0.72944	0.532
Economy	1	5	3.0813	0.78604	0.618
Aesthetics	1	5	3.9813	0.90534	0.823
Safety	1	5	4.2292	0.80393	0.646

4.2. Children's well-being in the community from a multi-stakeholder perspective

Respondents were grouped into six categories: parents, children, other residents, community service personnel, experts, and government officials. This allowed us to compare satisfaction levels regarding children's well-being in the community (Figure 5).

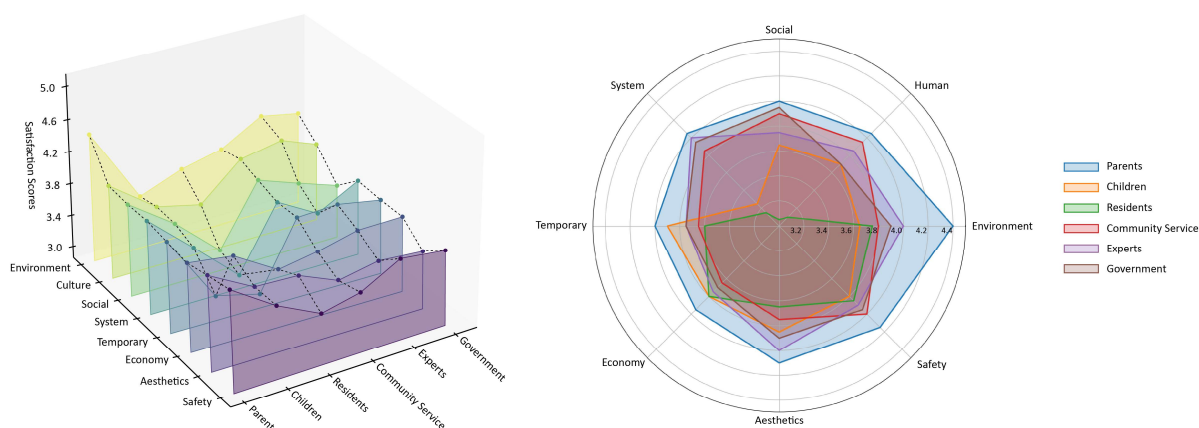


Figure 5. Satisfaction perception results of community public space indicators from a Multi-Stakeholder Perspective. Source: Authors' own work.

In the environmental dimension, parents and experts gave the highest satisfaction scores, 4.4 and 4.0, respectively. They particularly appreciated the community's greenery and air quality. In the human dimension, parents and community service personnel gave higher satisfaction scores of 4.05 and 3.95. They praised the community's support for children's social and cultural activities. In the social dimension, parents and community service personnel also gave high scores of 4.0 and 3.9. They valued the community's platforms for social interaction and its support for family structures. In the systems dimension, parents and experts gave the highest scores of 4.05 and 4.0, believing that the community's education and healthcare systems meet children's needs. In the temporal dimension, both parents and children gave relatively high scores, 4.0 and 3.9, showing appreciation for the scheduling of community activities. In the economic dimension, parents and other residents gave relatively high scores of 3.95 and 3.8, indicating satisfaction with the affordability of children's activities and services in the community. In the aesthetics dimension, satisfaction levels were similar across all groups. Parents, experts, and children gave scores of 4.1, 4.0, and 3.85, respectively. They particularly appreciated the community's architectural and landscape design. In the safety dimension, satisfaction scores were generally high across all groups. Parents gave the highest score of 4.15, emphasizing community security and safety facilities.

4.3. Correlation analysis between community environment and children's well-being

We used Pearson correlation analysis to explore how community environmental characteristics relate to children's well-being perceptions.

First, we calculated a composite score for five environmental characteristics: greening rate, usability, enclosure, sense of safety, and vibrancy. These scores were averaged and weighted to derive an overall environmental score for each area (ranging from 1 to 5). The survey data was then checked for reliability and validity using SPSS (Table 4).

Table 4. Cronbach's alpha, KMO, and Bartlett's test. Source: Authors' own work.

Cronbach's alpha		0.941
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.715
Bartlett's Test of Sphericity	Chi-Square	161.362
	Degrees of freedom	78
	p-value	0.000

The analysis results, shown in Figure 6, reveal a significant positive correlation between the greening rate and the environmental dimension of children's well-being ($r = 0.77$, $p < 0.01$). This suggests that greening in the community plays a crucial role in improving perceptions of children's well-being. Usability showed a significant positive correlation with the social ($r = 0.59$, $p < 0.05$) and systems ($r = 0.69$, $p < 0.05$) dimensions, highlighting the importance of accessible community facilities for improving children's well-being. Enclosure also showed a strong correlation with the safety dimension ($r = 0.73$, $p < 0.01$), indicating that spatial layout affects residents' sense of security.

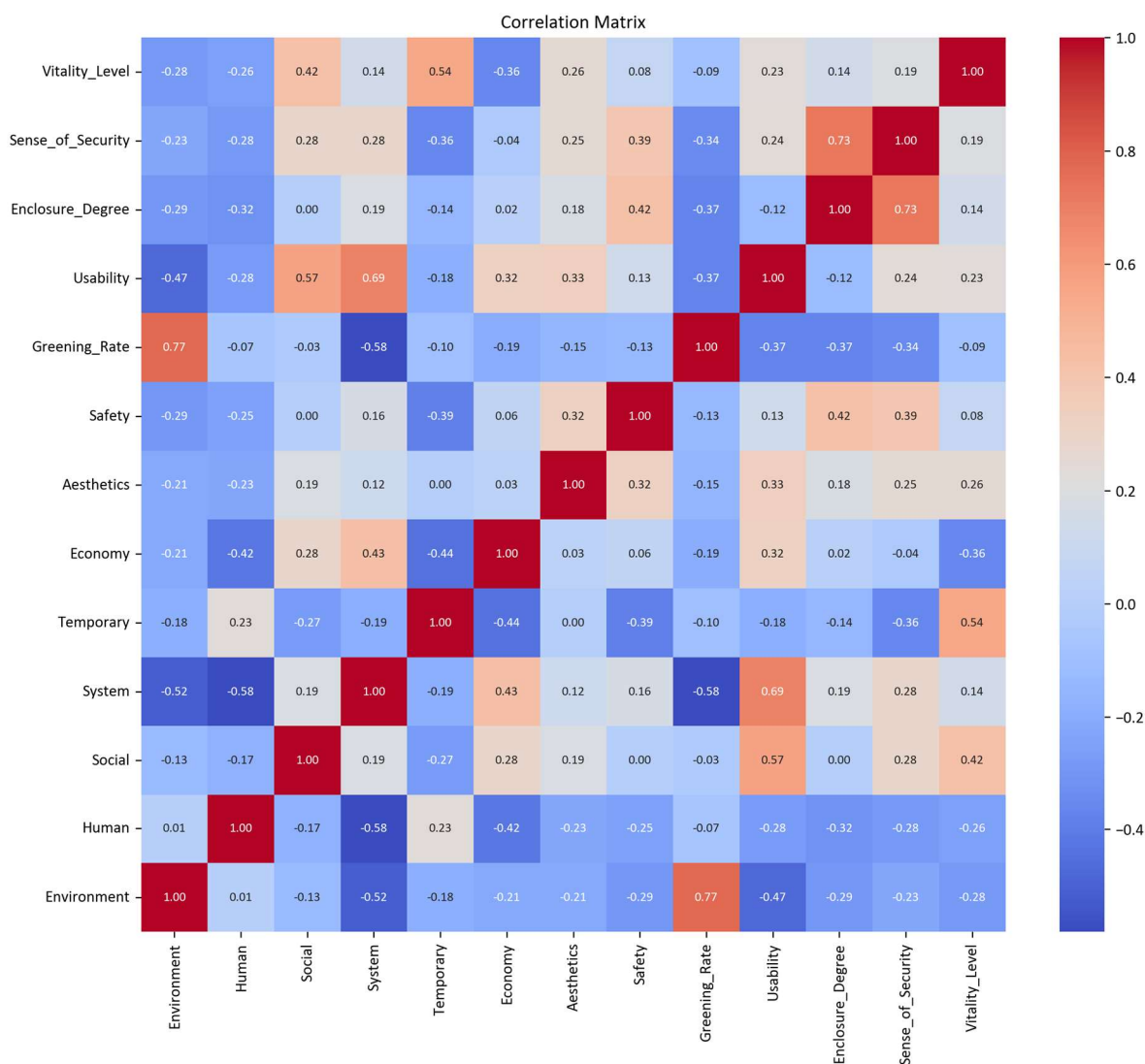


Figure 6. Correlation matrix between community environment and programming perception factors. Source: Authors' own work.

4.4. Key environmental factors affecting children's well-being in the community

This study uses a multiple linear regression model to identify key programming factors that influence children's well-being in urban communities. The model evaluates eight programming factors based on their effect on overall children's well-being. To account for demographic influences, we tested variables like gender, community, household income, and education level. These tests showed no significant effects from these demographic factors.

As shown in Table 5, the environment ($\beta = 0.42$, $p < 0.01$), social ($\beta = 0.38$, $p < 0.05$), safety ($\beta = 0.35$, $p < 0.05$), and aesthetics ($\beta = 0.31$, $p < 0.05$) all have a significant positive impact on overall satisfaction with children's well-being. The environmental factor, in particular, showed the highest regression coefficient, highlighting its strong role in improving children's well-being. The model also had a good fit, with an R^2 value of 0.605, meaning these factors explain 60.5% of the variation in children's well-being needs.

Table 5. Linear regression results between community programming factors and children's well-being requirements. Source: Authors' own work.

Variable	B	Standard error	Beta	T-value	Significance
(constants)	1.635	0.779		1.987	0.081
Environment	0.419	0.151	0.420	4.505	0.004***
Social	0.380	0.177	0.378	4.620	0.006***
Safety	0.348	0.125	0.316	1.907	0.058**
Aesthetics	0.312	0.187	0.272	0.851	0.071**
R=0.690	R ² =0.679	Adjusted R ² =0.605			
Dependent variable: Overall children's well-being requirements					

5. Discussion

Based on the findings, we propose a value-based programming framework to improve children's well-being in urban communities.

5.1. Enhancing environmental quality and interactive experiences

Improving environmental quality and interactive experiences is essential for promoting children's well-being. Community spaces should be multifunctional and adaptable to meet the needs of children at different stages of development.

The design should include natural elements like plants, water features, and varied terrain to create a lively ecological environment. These elements offer sensory stimulation and help children feel more engaged and connected to their environment. Communities should also have multifunctional spaces, such as flexible activity areas and exploratory playgrounds. These spaces should encourage children to explore independently and interact with others. They should be adaptable to different seasons and activities to keep children interested over time.

5.2. Integration of cultural and social values

Cultural identity and social interaction are vital for children's mental health. Community programming should integrate cultural and social values through design and activities that strengthen children's cultural identity and social connections.

This can be done by creating cultural education spaces and hosting community events. The design should include culturally significant places, such as museums or craft workshops. These places provide valuable learning opportunities for children and act as hubs for social interaction. Organizing festivals, cultural exhibitions, and cross-cultural exchanges will further support children's cultural identity and increase their sense of belonging in the community.

5.3. Optimization of safety and inclusive design

Safety and inclusivity are key considerations in community design, especially in diverse urban environments. It is essential that all children can safely and equally participate in community activities.

To improve safety, community designs should incorporate smart technologies like surveillance systems and real-time alert features. These measures will make children's activity areas safer. The design should also include accessibility features to ensure that children with different abilities can easily use public spaces. Additionally, inclusive design should account for different cultural backgrounds and family structures. Multifunctional spaces and flexible designs will create a more diverse and inclusive environment.

5.4. Sustainable implementation through multi-stakeholder collaboration

Sustainable implementation of the programming framework requires collaboration among multiple stakeholders. Successful community planning depends not only on advanced design but also on active involvement from government bodies, experts, community service personnel, and residents.

Government agencies should lead by providing policy support and allocating resources. They should promote child-friendly policies and encourage new or renovated projects to follow the programming framework's principles. Experts and community service personnel should provide technical support and ensure that planning is both scientific and practical. They should also train residents and help them understand new planning concepts. Finally, the involvement of parents, children, and other residents is crucial for making the framework effective.

6. Conclusion

This study explores the current state and key factors affecting children's well-being in urban communities through semantic analysis of community street view data and multi-stakeholder surveys. Based on these insights, a value-based programming framework was constructed, offering a new perspective and practical approach to enhancing children's well-being in urban communities.

Specifically, the study concludes the following: (1) The quality of the environment and its interactivity are core factors influencing children's well-being, with elements such as greening rates, space usability, and enclosure directly linked to children's physical and mental health and sense of security. (2) Cultural identity and social interaction are crucial for children's mental health, and community design must actively incorporate local cultural elements and social activities to strengthen children's sense of belonging. (3) Safety and inclusivity are foundational to ensuring children's well-being; community planning should employ smart technologies and accessible design to create public spaces that are both safe and inclusive. (4) Multi-stakeholder collaboration is proven to be a key pathway for the sustainable implementation of children's well-being, with the active involvement of governments, experts, community service personnel, and residents effectively integrating diverse needs and resources to ensure comprehensive and flexible community planning.

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