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A Study on the Assessment of Tour–Art–Learning Quality in Urban Parks from a Child-Friendly Perspective: A Case Study of Shaheyuan Park in Chengdu

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Abstract: Children are the future of society, and their well-being is vital for sustainable urban development. Chengdu, as the birthplace of the "Park City" concept, has actively integrated child-friendly principles into its urban model. In 2022, the "Implementation Plan for Building a Child-Friendly City in Chengdu" was launched, aiming to establish Chengdu as a leading national model. Since 2023, the city has leveraged its ecological strengths to promote "child-friendly happiness spaces", providing children with ample recreational and developmental opportunities within its "Park City" framework. Analyzing urban park construction in Chengdu from a child-friendly perspective is significant not only for promoting children's growth and urban development but also for providing valuable references for the development of child-friendly urban parks. Guided by the concept of "Tour–Art–Learning", which focuses on creating outdoor recreational spaces suitable for children, this study establishes a quality assessment framework for urban parks from a child-friendly perspective. Based on survey data collected from Chengdu's Shaheyuan Park using the Photo Elicitation Interview (PEI) method and Geographic Information Systems (GIS) technology, the analytic hierarchy process–fuzzy comprehensive assessment (AHP-FCE) model is applied to evaluate the park's Tour–Art–Learning quality. The results show that while the park demonstrates high overall quality, there are deficiencies in cultural aesthetics and learning activity carrying capacity and significant room for improvement in site accessibility. This study systematically evaluates the child friendliness of Shaheyuan Park and proposes strategies for improving its Tour–Art–Learning quality, offering new theoretical perspectives and practical pathways for urban park construction and the development of child-friendly cities.

Keywords: child friendliness; urban park; Tour–Art–Learning; assessment system; AHP-PCE model

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1. Introduction

To uphold children's rights and foster their development, the United Nations Children's Fund (UNICEF) and the United Nations Human Settlements Programme (UN-Habitat) jointly launched the "Child-Friendly Cities Initiative" (CFCI) in 1996 [1]. In August 2023, China's National Development and Reform Commission, Ministry of Housing and Urban-Rural Development, and the National Working Committee on Children and Women under the State Council issued the "Handbook for the Guidelines on the Construction of Urban Child-Friendly Spaces (Trial)". This handbook emphasized that "parks and green spaces serve as essential sites for children's outdoor leisure and recreational activities. These spaces should be adapted to suit children's physical and psychological needs,

with modifications particularly in urban fringe parks, comprehensive parks, specialized parks, community parks, pocket parks, and squares frequently utilized by children" [2]. In June 2022, 14 cities were selected in China's first national list of child-friendly cities, with Chengdu, Sichuan Province, included as a notable example. That same year, the "Implementation Plan for Building a Child-Friendly City in Chengdu" set forth a vision for Chengdu to emerge as a leading model of child-friendly urban development in China by 2035.

Currently, there is no clear definition of urban parks from a child-friendly perspective. Urban parks are spaces designed for recreation and leisure. Mary Tan (2021) outlined design principles for child-friendly urban parks, emphasizing good accessibility for children's daily outdoor activities, diverse terrains to accommodate various play types, opportunities for independent play, highly natural scenery, minimal artificial design to encourage interaction among children, and gender equity in spatial planning [3]. In this study, child-friendly urban parks are defined as parks capable of supporting children's travel activities, aesthetic appreciation, and knowledge acquisition and transfer.

Urban parks are essential in the development of child-friendly cities, playing a crucial role in satisfying the needs of children. Yuniastuti and others have noted that green open spaces offer health, environmental, economic, aesthetic, and socio-psychological benefits, while also fulfilling the needs of children's growth, development, and learning [4]. Numerous studies highlight that green-dominated environments have a comprehensive positive effect on children's physical and mental health, improving psychological well-being, fostering positive environmental attitudes, enhancing cognitive abilities, boosting learning desire, reducing illness, and speeding up recovery [5,6]. Additionally, Yu Bao and colleagues suggest that in green spaces, the landscape environment has a positive and significant relationship with the physical activity levels of children [7]. Consequently, assessing whether these parks meet children's requirements has become a central topic in discussions of landscape equity. In recent years, research on urban parks from a child-friendly perspective has steadily increased, focusing on the significance of these spaces for children's growth and development, optimizing park designs to maximize their utility for children, and establishing metrics for evaluating child friendliness in urban parks. Sallis et al. developed a socio-ecological model that underscores the importance of child-centered urban park design in promoting children's active engagement and utilization of these spaces [8]. Veitch et al., through qualitative walking interviews, examined children's perceptions of park features that might influence their visitation choices [9]. In the Chinese context, research on child-friendly spaces has expanded from a focus on "residential areas" to "community spaces" and subsequently to "urban parks", thereby extending from micro-environments in children's daily lives to broader public spaces in urban settings. Liu Guanlan et al. identified characteristics of "child-friendly" parks, proposing that such designs should adhere to principles of high accessibility, naturalness, and permeability [10]. Zeng Peng et al. reviewed the practices of child-friendly neighborhoods and pathways in the Netherlands, offering valuable insights [11]. Pei Yu et al. conducted an evidence-based study in Boston, assessing urban space from a child health and friendliness perspective [12].

The quality of urban parks from a child-friendly perspective encompasses various environmental dimensions, such as spatial design, safety, functional diversity, and facility accessibility, each of which plays a crucial role in influencing children's use of parks and the benefits derived from them. Loukaitou-Sideris et al. and McCormack et al. have asserted that park quality directly impacts utilization rates, with marked differences in appeal, particularly for children [13,14]. Baek et al. highlight that factors related to park quality, safety, and facilities significantly influence the manner and frequency of park usage as well as the characteristics of park visitors [15]. Additionally, Ming Gao et al.

explored the impact of urban park greening features and spatial quality on children's physical activity (PA). They found that designing high-quality play spaces and considering children's perceptions of the environment are crucial for promoting children's PA [16]. In terms of urban park quality assessment tools, this study provides a comprehensive review of research conducted from 2004 to 2020 in five Western countries that have pioneered explorations into the relationship between urban public open spaces and public health. Specifically, this study summarizes 14 quality assessment tools designed for urban parks or public open spaces containing parks, many of which are oriented toward children or make explicit reference to child users (Table 1). In China, most related research has either adapted or built upon these international assessment tools. For instance, Xing Zibo et al. analyzed the United Nations-recognized child-friendly city of Barcelona, Spain, as a case study. By employing the Child-Friendly Park Quality Index (QUINPY) and a spatial syntax accessibility model, they developed a comprehensive method for evaluating and analyzing child friendliness in urban parks by integrating assessments of park quality and accessibility [17]. Yu Bao et al., based on the theories of children's ability development and game value, employed the Woolley and Lowe assessment tool [18] to quantify the impact of these theories on urban neighborhood space environments and children's physical activities [19]. Ming Gao et al. used an assessment tool by Woolley and Lowe, designed around children's space design and activity values, to deeply analyze how features of outdoor play spaces in urban residential areas influence children's perceived safety. Their findings provide practical guidance for creating child-friendly urban environments [20]. In addition, Zhang, S., et al. evaluated the quality of urban parks in Chengdu, China, using multi-dimensional indicators. Although their study did not specifically focus on children, the results contribute to improving urban park assessment systems and guiding the sustainable planning and design of park landscapes [21].

Table 1. The quality assessment tools for urban parks and urban public open spaces.

Tool Name	Researchers	Year	Country	Target Group	Assessment Purpose
Public Open Space Tool (POST) [22]	Broomhall et al.	2004	Australia	All age groups (including children)	Assess features of public open spaces that promote or restrict physical activities
Recreation Facility Evaluation Tool (RFET) [23]	Cavnar et al.	2004	USA	All age groups (including children)	Evaluate the quality of park recreation facilities
Evaluate the quality of park recreation facilities [24]	Lee et al.	2005	USA	All age groups (including children)	Assess park physical activity resources, convenience, and undesirable behaviors
Built Environment Resource Assessment Tool (BRAT) [25]	Bedimo-Rung et al.	2006	USA	All age groups (including children)	Assess the impact of park environmental features on physical activities
Environmental Assessment of Public Recreation Spaces (EAPRS) [26]	Saelens et al.	2006	USA	All age groups (including children)	Comprehensive evaluation of physical environments in public recreation spaces like parks
Children's Public Open Space Tool (C-POST) [27]	Crawford et al.	2008	Australia	Children	Assess the impact of public open spaces on children's physical activities

Table 1. *Cont.*

Tool Name	Researchers	Year	Country	Target Group	Assessment Purpose
Community Park Audit Tool (CPAT) [28]	Kaczynski et al.	2010	USA	All age groups (including children)	Evaluate the level of support community parks provide for physical activities
Park Quality Assessment Tool (READI) [29]	Veitch et al.	2012	Australia	All age groups (including children)	Evaluate park characteristics related to physical activities of park users
Children's Recreation Space Assessment Tool [18]	Woolley et al.	2013	UK	Children	Assess the extent to which outdoor recreation spaces support children's play
Parks, Activity, and Recreation Evaluation Tool (PARK) [30]	Bird et al.	2015	Canada	5–18 years old children	Assess park features related to children's physical activities
Children's Recreation Space Quality Assessment Tool (PSQAT) [31]	Jenkins et al.	2015	USA	Children	Evaluate the quality of children's recreational spaces with a focus on play value
Adolescent Park Quality Index (QUINPY) [32]	Rigolon et al.	2016	USA	All age groups (including children)	Assess urban parks from the perspective of children's needs
Public Open Space Quality Assessment Tool (OCUS) [33]	Garau et al.	2019	Italy	All age groups (including children)	Evaluate children's experience in public open spaces
Children's Recreation Space Assessment Tool (PSAT) [34]	Gustat et al.	2020	USA	Children	Assess the playability of children's recreational spaces

In conclusion, there is a significant gap in localized research on the measurement and assessment methods for assessing child friendliness in urban parks. With the advancing policies and the ongoing initiatives to establish Chengdu as both a "park city" and a "child-friendly city", there is an urgent need to develop a localized quality assessment framework for urban parks that supports child-friendly modifications.

This study introduces an innovative assessment tool called the Tour–Art–Learning (TAL) framework, designed to comprehensively assess the child friendliness of urban parks. Centered on the TAL concept, the framework integrates three core dimensions: the Carrying Capacity of Children's Travel Behavior and Activities (Tour), the Carrying Capacity of Children's Art Appreciation Behavior and Activities (Art), and the Carrying Capacity of Children's Knowledge Acquisition and Transfer Behavior and Activities (Learning). Notably, the TAL concept was originally proposed by Wang Wei's research team in 2021 and has been validated through its application in designing cultural and recreational landscapes on university campuses [35].

This study represents the first application of the TAL framework to the assessment of child-friendly urban parks. Within the context of Chengdu's "park city" development, the study employs the PEI method and the AHP-FCE model to analyze the TAL quality and child friendliness of urban parks. Based on these findings, targeted improvement strategies are proposed, offering valuable insights and practical guidance for the child-friendly transformation of urban parks in the future.

In this work, we ask the following research questions:

Research question 1 (RQ1): Research Question 1 (RQ1): How can an assessment framework for assessing the Tour–Art–Learning (TAL) quality of urban parks from a child-friendly perspective be systematically developed?

Research question 2 (RQ2): What are the most critical indicators and their relative importance in evaluating the TAL quality of urban parks for children?

Research question 3 (RQ3): Based on the proposed assessment framework, how does the TAL quality of Shaheyuan Park in Chengdu perform, and what targeted strategies can enhance its child friendliness?

2. Research Methods and Data Sources

2.1. Research Methods

2.1.1. Indicator Selection

This study integrated a comprehensive literature review, field investigations, and participatory demand interviews with children to construct a framework for evaluating the Tour–Art–Learning (TAL) quality of urban parks from a child-friendly perspective. Based on the TAL concept proposed by Wang Wei's research team in 2021, the framework comprises three core dimensions. "Tour" represents the park's capacity to support children's mobility and activity needs, addressing their travel habits, preferences, and functional requirements. "Art" reflects the park's potential to inspire children's aesthetic experiences, offering sensory enjoyment and emotional satisfaction through immersive and well-designed environments. "Learning" refers to the park's ability to promote knowledge acquisition and social interaction, enabling children to build knowledge and social connections through engagement with natural and social settings, thereby fostering holistic and autonomous development.

We conducted a comprehensive and in-depth analysis of the extensive domestic and international literature as well as empirical case studies of child-friendly urban parks to identify and refine potential assessment dimensions (Figure 1). Building on this, we designed and implemented semi-structured participatory interviews with children aged 6 to 12 and their guardians, aiming to systematically collect qualitative data on children's specific needs and expectations for urban park spaces (Table 2). The interviews were conducted at the target park, Shaheyuan Park, and involved 50 children as participants. Children aged 9 to 12, with more advanced independent expression and logical thinking abilities, successfully completed face-to-face interviews on their own. For children aged 6 to 9, whose comprehension skills are still developing, interviews were completed with the assistance of their parents or guardians, ensuring their consent and understanding of the process. The results revealed a strong alignment between children's needs and the dimensions of the Tour–Art–Learning (TAL) framework, further validating its applicability and effectiveness in evaluating child-friendly urban parks.

Based on the literature review, field investigations, and semi-structured interviews, a universally applicable assessment framework for assessing the Tour–Art–Learning (TAL) quality of urban parks from a child-friendly perspective was constructed (Table 3). This framework identifies three primary categories: "Tour", "Art", and "Learning". Each category is further subdivided into nine secondary dimensions, such as "Site Accessibility", "Ecological Aesthetic", and "Nature Education Value". These dimensions are supported by 27 tertiary indicators, including "Site Location", "Plant Diversity", and "Health-Oriented Natural Educational Value". Collectively, these 27 TAL quality indicators were chosen for their significance to child friendliness in urban parks and served as the foundation for developing a universally applicable assessment framework. The framework was structured into four hierarchical levels: "Goal Level", "Criterion Level", "Sub-Criterion Level", and

"Indicator Level", providing a comprehensive and systematic tool for evaluating the child friendliness of urban parks.

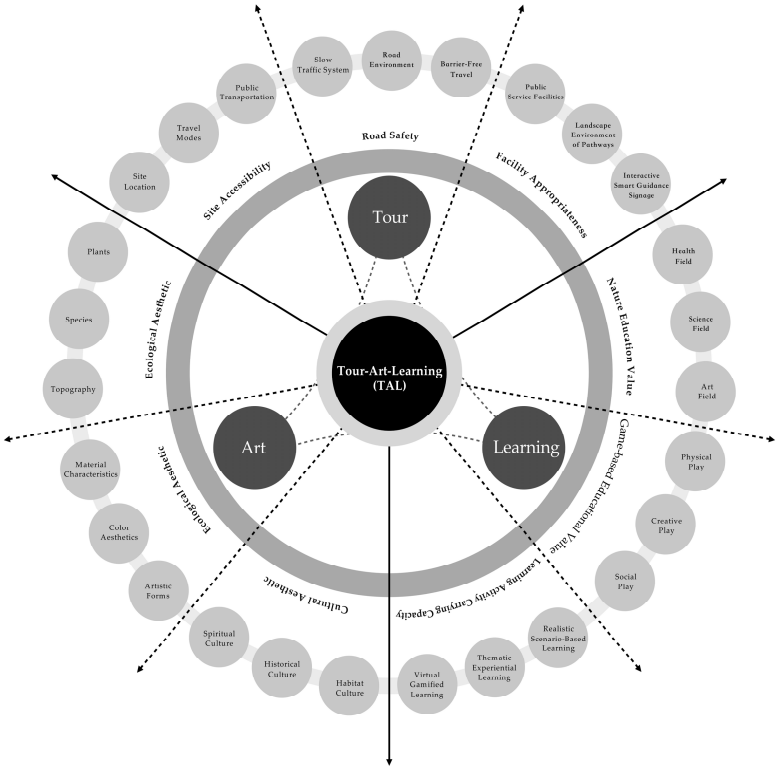


Figure 1. The Tour–Art–Learning (TAL) framework: a comprehensive assessment model for child-friendly urban parks.

Table 2. A summary of children's urban park activity needs and their connection to the Tour–Art–Learning framework: qualitative interview data.

Children's Activity Needs	Definition	"Tour" Activity	"Art" Activity	"Learning" Activity	Demand Ratio
Good Accessibility	Proximity of the park to children's residential areas	✔			72%
Availability of Multiple Transport Modes	Whether the park provides diverse transportation options	✔			48%
Good Road Safety	Whether road designs are child friendly and minimize potential dangers	✔			100%
Interaction with Facilities	Whether the park offers highly interactive facilities	✔		✔	90%
Viewing Animals and Plants	Whether natural scenery is attractive to children		✔	✔	94%
Diverse Terrain	Whether terrain designs are diverse and suitable for children's activities		✔	✔	76%
Landscapes with Multiple Colors, Shapes, and Forms	Whether landscape designs stimulate children's visual sensory experience		✔	✔	80%
Cultural Elements	Whether the park integrates local cultural and educational elements		✔	✔	56%

Table 2. *Cont.*

Children's Activity Needs	Definition	"Tour" Activity	"Art" Activity	"Learning" Activity	Demand Ratio
Sunbathing and Chatting	Whether the park provides open spaces suitable for relaxation and socialization			✔	60%
Ball Games	Whether the park provides dedicated sports fields			✔	40%
Playing Games with Friends	Whether the park supports children's social interactions			✔	84%
Interaction with Nature	Whether opportunities for interacting with nature are provided		✔	✔	64%
Play Facilities	Whether the park provides facilities suitable for children's play			✔	100%
Thematic Play Activities	Whether the park offers storytelling or scenario-based play projects			✔	36%

Table 3. The assessment index system for the quality of urban park Tour–Art–Learning from a child-friendly perspective.

Goal Level	Criterion Level	Sub-Criterion Level	Indicator Level
A: Assessment of Tour–Art–Learning Quality in Urban Parks	A1: Tour (Carrying Capacity of Children's Travel Behavior and Activities)	A4: Site Accessibility	A13: Location Characteristics of the Site
			A14: Diversity of Travel Modes
			A15: Convenience of Public Transportation
		A5: Road Safety	A16: Safe Pedestrian System
			A17: Stabilized Road Environment
			A18: Barrier-Free Travel Environment
		A6: Facility Appropriateness	A19: Completeness of Public Service Facilities
			A20: Quality of Scenic Pathway Environment
			A21: Intelligent Interactive Guidance Signs
	A2: Art (Carrying Capacity of Children's Art Appreciation Behavior and Activities)	A7: Ecological Aesthetic	A22: Plant Aesthetic Appeal
			A23: Species Richness
			A24: Topographic Diversity
		A8: Artistic Aesthetic	A25: Perception of Artistic Forms
			A26: Reflection of Color Aesthetics
			A27: Presentation of Material Characteristics
		A9: Cultural Aesthetic	A28: Construction of Human Habitat Culture
			A29: Heritage of Historical Culture
			A30: Continuity of Spiritual Culture

Table 3. *Cont.*

Goal Level	Criterion Level	Sub-Criterion Level	Indicator Level
	A3: Learning (Carrying Capacity of Children's Knowledge Acquisition and Transfer Behavior and Activities)	A10: Nature Education Value	A31: Health Education Value of Nature
			A32: Scientific Education Value of Nature
			A33: Artistic Education Value of Nature
		A11: Game-based Educational Value	A34: Physical Educational Play Value
			A35: Creative Educational Play Value
			A36: Social Educational Play Value
		A12: Learning Activity Carrying Capacity	A37: Real-Scene Learning Activities
			A38: Thematic Experiential Learning Activities
			A39: Virtual Gamified Learning Activities

2.1.2. AHP-FCE Assessment Model

The AHP-FCE assessment model is a comprehensive assessment approach that combines the analytic hierarchy process (AHP) with fuzzy comprehensive evaluation (FCE).

(1) Determining indicator weights through AHP, utilizing the TAL quality assessment framework for urban parks from a child-friendly perspective, we constructed a judgment matrix $A = (a_{ij})_{n \times n}$. Experts in child-friendly design, park management, environmental design, and urban planning were invited to rate each indicator a_i / a_j based on Saaty's 1–9 scale through a structured questionnaire. The relative weights of each factor at the same level, along with the maximum eigenvalue, were calculated. The detailed calculation steps are presented in Equations (1)–(4).

$$m_i = \prod_{j=1} a_{ij} \tag{1}$$

$$w_i^* = \sqrt[n]{m_i} \tag{2}$$

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* \tag{3}$$

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Aw)i}{w_i} \tag{4}$$

where: m_i denotes the product of the elements in each row of the judgment matrix A, while w_i^* represents the eigenvector. By normalizing this eigenvector, the relative weights of the factors at the same hierarchical level can be obtained w_i. The variable λ_{max} is the largest eigenvalue.

(2) For the consistency assessment of the judgment matrix, as detailed in Formulas (5) and (6), it is essential to evaluate the consistency of the judgment matrix to guarantee its reliability for subsequent analytical processes.

$$CI = \frac{\lambda_{\max - n}}{n - 1} \tag{5}$$

$$CR = CI / RI \tag{6}$$

where: *CI* represents the consistency index of the judgment matrix, *RI* represents the average random consistency index, and *CR* denotes the consistency ratio. If $CR < 0.1$, it indicates that the judgment matrix has passed the consistency test and can be used as a guide for evaluation.

(3) The fuzzy comprehensive evaluation (FCE) to derive assessment outcomes was implemented. It was initiated by identifying a subset of factors relevant to the evaluation subject, specifically, the TAL quality assessment indicators for urban parks, denoted as $A = \{A_1, A_2, A_3, \ldots, A_n\}$. A novel grading scheme $V = \{ExcellentV_1, GoodV_2, AverageV_3, PassV_4, FailV_5\}$ was constructed based on these indicators. The Photo Elicitation Interview (PEI) technique and Geographic Information Systems (GIS) were employed to gather data via a Likert 5-point scale, evaluating user satisfaction with TAL quality in urban parks. Correspondingly, the fuzzy comprehensive evaluation matrix was denoted as $R_A = \{R_{A1}, R_{A2}, R_{A3}, \ldots, R_{An}\}$. Subsequently, fuzzy operations were executed to ascertain the evaluation scores for the uppermost objective levels, as elucidated in Formula (7).

$$B_i = W_i \times R_i \tag{7}$$

where: W_i corresponds to the distribution of weights across the factors of each indicator layer within subset A, while R_i represents the fuzzy comprehensive evaluation matrix for each respective indicator layer.

(4) Regarding score conversion, mathematical methodologies were utilized to transform the assessment grades into a five-point rating scale, resulting in the score set $k = \{k_1, k_2, k_3, k_4, k_5\}$, where $k_1 = 5$, $k_2 = 4$, $k_3 = 3$, $k_4 = 2$, and $k_5 = 1$. Following this conversion, a weighted summation technique was employed to compute the specific scores for the influencing factors of the TAL quality in urban parks and the corresponding layers of criteria, as depicted in Formula (8).

$$F_i = \sum_{j=1}^{n} m_{ij} k \tag{8}$$

where: F_i signifies the specific score assigned to each influencing factor, m_{ij} represents the membership degree of each influencing factor within subset A relative to the designated evaluation level, and k indicates the score attributed to each evaluation level.

If $F(F_i) \geq 4$, the rating should be "excellent". If $3.7 \leq F(F_i) < 4$, the rating should be "good". If $3.3 \leq F(F_i) < 3.7$, the rating should be "average". If $F(F_i) < 3.3$, the rating should be "poor".

2.1.3. Questionnaire Design

This study entailed the creation of two distinct questionnaires to facilitate different phases of quantitative analysis. The initial questionnaire, designated as the Children-Friendly Urban Park TAL Quality Assessment Indicator Weight Expert Scoring Sheet, was disseminated in 20 copies to gather expert evaluations on the significance of TAL quality components within urban parks. The participating experts were selected from diverse fields, including child-friendly studies, park management, environmental design, and urban planning, ensuring a comprehensive and interdisciplinary assessment of the TAL framework. This expert questionnaire was structured into three segments: the first segment provided detailed instructions and scoring criteria to confirm experts' comprehension of the Saaty 1–9 scaling method and its implementation; the second segment collected essential demographic and professional details of the experts, including their academic qualifications, field of research, and experience, ensuring that all participants had pertinent expertise; the third and pivotal segment required experts to employ the Saaty scale to

determine the importance levels of each TAL quality factor. These evaluations were pivotal, as they formed the foundational weight data for the analytic hierarchy process, facilitating subsequent multi-criteria decision analysis.

The secondary questionnaire, the Children-Friendly Urban Park TAL Quality Satisfaction Survey, targeted actual park users, particularly families with children and their guardians. Specifically, the survey focused on children aged 6–12 as the primary respondents. To ensure accurate understanding of the questionnaire content, all surveys were conducted with the assistance of their parents or guardians, who provided clarification or support as needed. This approach aimed to holistically gauge the perceptions and satisfaction levels across different age demographics regarding TAL quality in urban parks. The purpose of this survey was to measure the genuine satisfaction of park users concerning the TAL quality attributes. It was bifurcated into two parts: the first gathered fundamental social characteristics of the participant families; the second part evaluated their actual satisfaction with the TAL quality attributes using a five-point Likert Scale described as "excellent, good, average, pass, fail", with respective scores of 5, 4, 3, 2, and 1, subsequently followed by a thorough statistical analysis of the collected data.

2.2. Data Sources

2.2.1. Park Selection

Chengdu, the capital of Sichuan Province, is recognized as the birthplace of the "Park City" concept, which emphasizes environmental sustainability, ecological security, urban-rural integration, green development, and institutional robustness to enhance urban livability and overall well-being. Anchored by the vision of "City within Parks, Parks within the City", Chengdu has developed a diverse and comprehensive park system. As of mid-2023, the city boasts over 1600 parks, categorized into ecological parks, comprehensive parks, community parks, specialized parks, and pocket parks, forming an interconnected city-wide green network (Figure 2). To further enhance the living environment for children, Chengdu has integrated child-friendly principles into its park city initiative. Under the theme "Parks for Children, Happier Children in Parks", the city has pioneered a unique model of child-friendly parks, aiming to foster healthier and more fulfilling growth experiences for children within urban spaces.

Based on Chengdu's park classification system and extensive field research, five representative parks were selected for this study: Beihu Ecological Park, Jiaozi Park, Shaheyuan Park, Huo Shui Park, and New Jinniu Park. Among these, four parks were officially designated as Chengdu's first child-friendly demonstration parks in 2023. Shaheyuan Park, however, was not selected, presenting a distinctive case for evaluation. Its exclusion offers a valuable opportunity to identify existing deficiencies and propose tailored improvement strategies. Ultimately, Shaheyuan Park was chosen as the pilot site for this study (Figure 3).

Shaheyuan Park was selected as the pilot site for several strategic reasons. Located in the northern part of Jinniu District near the upper reaches of the Fu River and the source of the Shahe River, the park is a key transportation hub with convenient access, serving as a critical node linking multiple administrative districts. Covering an area of approximately 10 hectares, the park possesses significant cultural and historical heritage, as it was previously a major construction material hub. Remnants of historical railway tracks and timber storage facilities have been preserved, adding educational and cultural value to the site. Furthermore, the park is situated within a densely populated area, with 55,000 registered residents and 132,500 permanent residents. The surrounding community boasts abundant educational resources, including a significant number of children, adolescents, and faculty and students from Xihua University, creating a vibrant and highly educated demographic (Figure 4). The park's design incorporates the "Forest-Wood-People" concept, highlight-

ing the lifecycle of wood and providing children with a distinctive "Tour–Art–Learning" (TAL) experience. However, field investigations revealed notable shortcomings, such as insufficient traffic-calming measures and a lack of clarity in communicating the park's thematic design to visitors. These findings underscore the park's representativeness as a case study, offering critical insights into the challenges faced by child-friendly parks. This study leveraged Shaheyuan Park to identify systemic issues and propose actionable strategies for enhancing the design and functionality of urban parks from a child-friendly perspective.

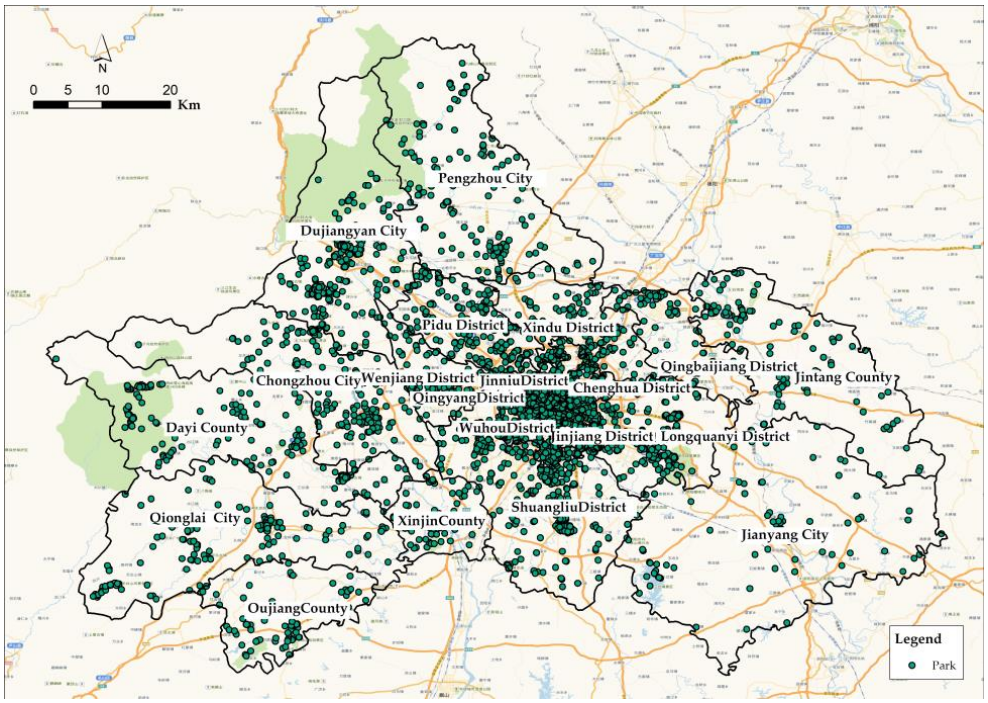


Figure 2. Distribution map of parks across Chengdu.



Figure 3. Locations of Shaheyuan Park in Chengdu, Sichuan, China.

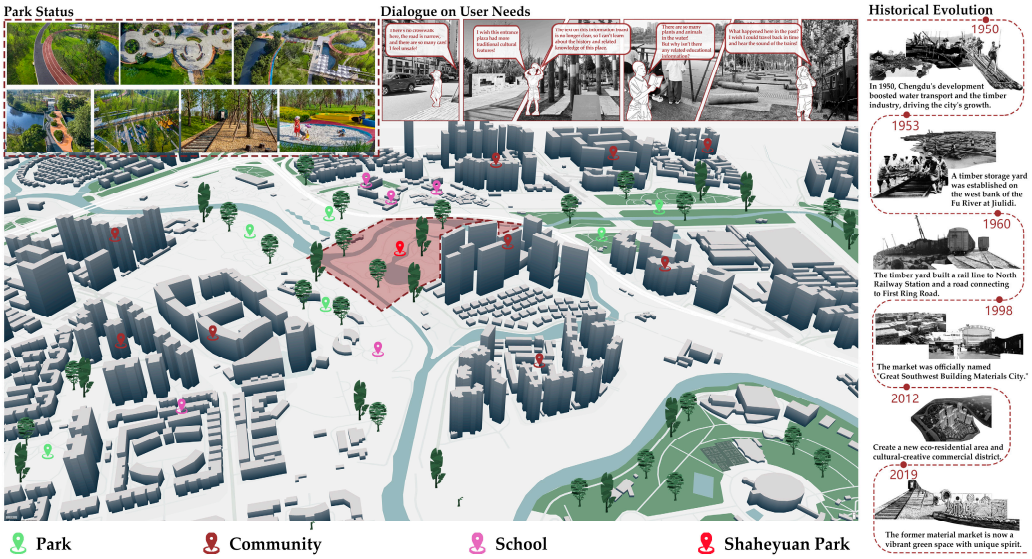


Figure 4. Current situation survey of Shaheyuan Park.

2.2.2. Survey Details

This study integrated the Photo Elicitation Interview (PEI) technique with Geographic Information Systems (GIS) technology. PEI is an established qualitative research method that leverages photographs as stimuli to elicit deep insights from respondents during interviews. The study involved disseminating questionnaires that were designed from a child-friendly perspective to assess the TAL quality in urban parks. These questionnaires were accompanied by photographs depicting various TAL quality elements, enabling the public to provide evaluations of their satisfaction with the depicted park qualities, thus facilitating the collection of emotional and cognitive feedback. A preliminary survey was executed in May 2023 to capture initial perceptions of the sites. Comprehensive data gathering occurred from July to September 2023, with interviews conducted based on scenarios or images that could visually represent the TAL quality from a child-friendly viewpoint at Shaheyuan Park. Participants were queried about their satisfaction with the park's TAL quality using scoring questionnaires. In total, 60 questionnaires were distributed and completed, achieving a 100% response rate. To enhance the objectivity and scientific rigor of the results, alongside landscape spatiotemporal big data research techniques, the "site accessibility" aspect of TAL quality, traditionally challenging to intuitively present, was visualized for participants. This approach translated the complex concept of site accessibility into clear, easily understandable visual information. Accessibility analysis utilized color gradients and regional segmentation to delineate the expansion trends and precise boundaries of the park's service areas, thereby facilitating a quick comprehension of the spatial distribution characteristics of park accessibility.

In ArcGIS, a new geodatabase and feature dataset were established, into which urban road vector data were integrated. Based on existing research and standards, walking speeds were set at 90 m/min; non-motorized vehicle speeds at 375 m/min; and motor vehicle speeds on expressways and freeways at 2000 m/min, on main roads at 1000 m/min, on secondary roads at 833.33 m/min, and on access roads at 500 m/min. Urban park Points of Interest (POI) data were incorporated, and thresholds for walking, non-motorized, and motorized vehicle times were set at 5, 10, and 15 min, respectively, under the framework of a "15-min convenience living circle". This methodology generated maps illustrating the service areas of the parks under various travel modes and time thresholds. The study employed the ratio of park green space service area to assess park accessibility (Table 4).

Table 4. Relevant indicators for Shahe Park.

Park Name	Administrative District	Park Area (ha)	District Area (ha)	Park-to-District Area Ratio (%)
Shaheyuan Park	Jinniu District	10	10,800	0.10

Park Green Space Service Area Ratio = (Park Green Space Accessibility Area/Total Administrative Area of the Park) × 100%

3. Results

3.1. Calculation of Indicator Weights

The AHP was utilized to establish the weights of the indicators, with the square root method applied to compute the coefficients of the judgment matrix (Table 5). Twenty experts were engaged to evaluate and rate the significance of each indicator, assigning specific weight coefficients accordingly. The arithmetic mean of these coefficients was then calculated to determine the average weight coefficients for all indicators. Consistency tests were conducted to validate the relative weights derived from the indicator system. These relative weights were subsequently transformed into absolute weights, enhancing the clarity with which each factor's contribution to the overall objective is portrayed. The absolute weight of each indicator at the lowest hierarchical level is calculated as the product of its corresponding relative weights.

Table 5. Summary of weight calculation results for the indicator system.

Criterion Level	Relative Weights	Sub-Criterion Level	Relative Weights	Indicator Level	Relative Weights	Absolute Weights
A1: Tour (Carrying Capacity of Children's Travel Behavior and Activities)	0.6667	A4: Site Accessibility	0.6370	A13: Location Characteristics of the Site	0.1429	0.0607
				A14: Diversity of Travel Modes	0.2857	0.1213
				A15: Convenience of Public Transportation	0.5714	0.2427
		A5: Road Safety	0.2583	A16: Safe Pedestrian System	0.6370	0.1097
				A17: Stabilized Road Environment	0.2583	0.0445
				A18: Barrier-Free Travel Environment	0.1047	0.0180
		A6: Facility Appropriateness	0.1047	A19: Completeness of Public Service Facilities	0.3331	0.0233
				A20: Quality of Scenic Pathway Environment	0.5695	0.0398
				A21: Intelligent Interactive Guidance Signs	0.0974	0.0068
A2: Art (Carrying Capacity of Children's Art Appreciation Behavior and Activities)	0.1667	A7: Ecological Aesthetic	0.5396	A22: Plant Aesthetic Appeal	0.5396	0.0485
				A23: Species Richness	0.1634	0.0147
				A24: Topographic Diversity	0.2970	0.0267
		A8: Artistic Aesthetic	0.1634	A25: Perception of Artistic Forms	0.2385	0.0065
				A26: Reflection of Color Aesthetics	0.6250	0.0170
				A27: Presentation of Material Characteristics	0.1365	0.0037

Table 5. *Cont.*

Criterion Level	Relative Weights	Sub-Criterion Level	Relative Weights	Indicator Level	Relative Weights	Absolute Weights
		A9: Cultural Aesthetic	0.2970	A28: Construction of Human Habitat Culture	0.1634	0.0081
				A29: Heritage of Historical Culture	0.5396	0.0267
				A30: Continuity of Spiritual Culture	0.2970	0.0147
A3: Learning (Carrying Capacity of Children's Knowledge Acquisition and Transfer Behavior and Activities)	0.1667	A10: Nature Education Value	0.6370	A31: Health Education Value of Nature	0.6833	0.0725
				A32: Scientific Education Value of Nature	0.1168	0.0124
				A33: Artistic Education Value of Nature	0.1998	0.0212
		A11: Game-based Educational Value	0.2583	A34: Physical Educational Play Value	0.6370	0.0274
				A35: Creative Educational Play Value	0.1047	0.0045
				A36: Social Educational Play Value	0.2583	0.0111
		A12: Learning Activity Carrying Capacity	0.1047	A37: Real-Scene Learning Activities	0.6370	0.0111
				A38: Thematic Experiential Learning Activities	0.2583	0.0045
				A39: Virtual Gamified Learning Activities	0.1047	0.0018

3.2. Fuzzy Comprehensive Evaluation Results

3.2.1. Accessibility Analysis Results for Shaheyuan Park

The GIS network analysis tool was utilized to generate the service areas for Shaheyuan Park under walking conditions for 5, 10, and 15 min (Table 6), with an overlay of surrounding parks', schools', residential areas', and public transport stations' POI data (Figure 5). The results indicate that the service range of Shaheyuan Park and travel time have an overall linear increasing relationship; as travel time increases, so does its service range (any decreasing trends would be due to administrative boundaries not extending far enough for accessibility expansion). Under walking conditions, accessibility is influenced by the distribution of POI locations, with high accessibility areas significantly concentrated around community parks, schools, public green spaces, and greenway routes near the park. Due to substantial objective limitations within its administrative area, the total service area ratio within 15 min is only 1.8%; however, as a community park serving nearby communities, its actual service radius preliminarily calculated without considering specific conditions like terrain and road status already meets the expectations of national standards. Within the "15-min convenience living circle" under walking conditions, the park covers 40 communities, including Mingyue Residence, Shahe·Yuan Shangjin Residence, and Xingyuan Oasis, along with five educational institutions ranging from kindergartens to higher education, six community and pocket parks, 13 bus stops, and only one subway station. Under non-motorized conditions, the total service area ratio is 41.12%, showing a significant improvement over walking, with broader accessibility, especially in areas with rich greenway resources or superior cycling conditions, meeting nearly half of the recreational needs of the district's residents. Under motorized conditions, the total service area ratio reaches 89.50%, essentially covering the entire administrative area, representing the strongest accessibility.

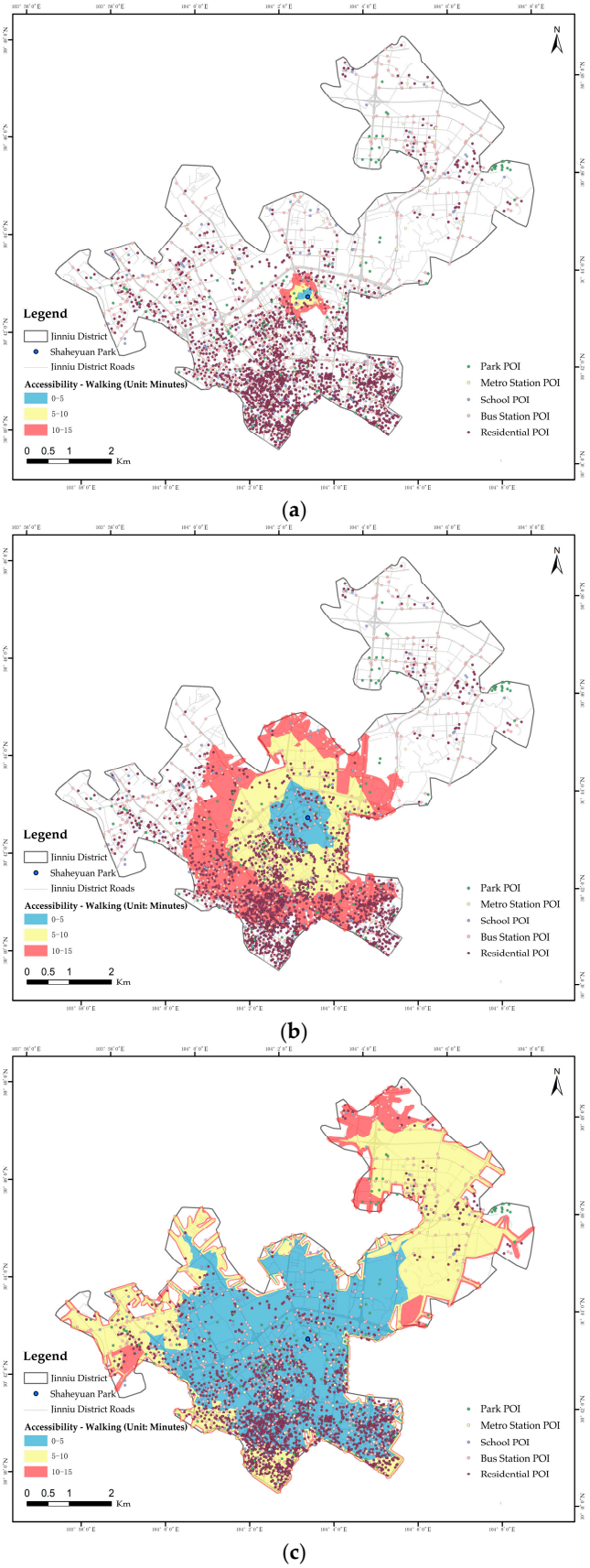


Figure 5. Accessibility analysis map for three modes of transportation. (**a**) Accessibility analysis map for walking; (**b**) accessibility analysis map for non-motorized vehicles; (**c**) accessibility analysis map for motorized vehicles.

Table 6. Accessibility statistics for three modes of transportation.

Mode of Transportation	Mode of Transportation	Area (ha)	Service Area Ratio (%)
Walking	0–5	16.18	0.15
	5–10	53.15	0.50
	10–15	125.52	1.16
Total	15	194.84	1.80
Non-motorized Vehicle	0–5	462.50	4.28
	5–10	1643.37	15.22
	10–15	2335.21	21.62
Total	15	4441.08	41.12
Motor Vehicle	0–5	4838.56	44.80
	5–10	3633.36	33.64
	10–15	1193.18	11.05
Total	15	9665.10	89.50

3.2.2. TAL Quality Assessment Results for Shaheyuan Park

The PEI method was utilized to engage 60 respondents, who rated their actual satisfaction with 27 TAL quality indicators at Shaheyuan Park (Figure 6). The results indicate that respondents expressed lower satisfaction with aspects such as the "Convenience of Public Transportation", "Stabilized Road Environment", "Intelligent Interactive Guidance Signs", "Construction of Human Habitat Culture", "Continuity of Spiritual Culture", "Scientific Education Value of Nature", and "Virtual Gamified Learning Activities". Conversely, higher satisfaction levels were reported for the "Safe Pedestrian System", "Completeness of Public Service Facilities", "Plant Aesthetic Appeal", "Perception of Artistic Forms", and "Presentation of Material Characteristics".



Figure 6. Heatmap of amusement quality evaluation results for Shaheyuan Park.

3.2.3. Fuzzy Comprehensive Evaluation Matrix Results

The FCE method was applied to quantitatively analyze the TAL quality assessment results of Shaheyuan Park, constructing a fuzzy comprehensive evaluation matrix. By overlaying the weight vectors of each indicator factor, w_i, the comprehensive evaluation results and the final scores were obtained (Table 7). The results indicate that from a child-friendly

perspective, the Tour–Art–Learning quality of Shaheyuan Park is close to excellent, demonstrating that the park substantially fulfills the requirements for children's mobility, artistic aesthetic activities, and the acquisition and transmission of knowledge. Specifically, the "Tour" quality was good, "Art" quality was excellent, and "Learning" quality was excellent, suggesting slight deficiencies in carrying capacity for children's mobility activities. At the sub-criterion level, "Site Accessibility" was rated as average, "Road Safety" as excellent, "Facility Appropriateness" as excellent, "Ecological Aesthetics" as excellent, "Artistic Aesthetics" as excellent, "Cultural Aesthetics" as good, "Nature Education Value" as excellent, "Game-based Educational Value" as excellent, and "Learning Activity Carrying Capacity" as good. This indicates slight shortcomings in "Cultural Aesthetics" and "Learning Activity Carrying Capacity" and considerable room for improvement in "Site Accessibility". At the indicator level, 20 elements such as "Presentation of Material Characteristics" achieved high quality, fulfilling the design objectives with little room for enhancement well. Conversely, seven elements, like "Virtual Gamified Learning Activities", were rated lower, not meeting the design objectives, indicating significant room for improvement.

Table 7. Summary of fuzzy comprehensive evaluation results.

Criterion Level	Score	Rating	Sub-Criterion Level	Score	Rating	Indicator Level	Score	Rating
A1: Tour (Carrying Capacity of Children's Travel Behavior and Activities)	3.8367	Good	A4: Site Accessibility	3.6429	Average	A13: Location Characteristics of the Site	4.3000	Excellent
						A14: Diversity of Travel Modes	4.2000	Excellent
						A15: Convenience of Public Transportation	3.2000	Poor
			A5: Road Safety	4.1598	Excellent	A16: Safe Pedestrian System	4.5500	Excellent
						A17: Stabilized Road Environment	3.1000	Poor
						A18: Barrier-Free Travel Environment	4.4000	Excellent
			A6: Facility Appropriateness	4.2185	Excellent	A19: Completeness of Public Service Facilities	4.4500	Excellent
						A20: Quality of Scenic Pathway Environment	4.3000	Excellent
						A21: Intelligent Interactive Guidance Signs	2.9500	Excellent
A2: Art (Carrying Capacity of Children's Art Appreciation Behavior and Activities)	4.1784	Excellent	A7: Ecological Aesthetic	4.3361	Excellent	A22: Plant Aesthetic Appeal	4.5500	Excellent
						A23: Species Richness	4.1500	Excellent
						A24: Topographic Diversity	4.0500	Excellent
			A8: Artistic Aesthetic	4.3279	Excellent	A25: Perception of Artistic Forms	4.4500	Excellent
						A26: Reflection of Color Aesthetics	4.2000	Excellent
						A27: Presentation of Material Characteristics	4.7000	Excellent
			A9: Cultural Aesthetic	3.8094	Good	A28: Construction of Human Habitat Culture	2.9500	Poor
						A29: Heritage of Historical Culture	4.3500	Excellent
						A30: Continuity of Spiritual Culture	3.3000	Poor
A3: Learning (Carrying Capacity of Children's Knowledge Acquisition and Transfer Behavior and Activities)	4.1660	Excellent	A10: Nature Education Value	4.1681	Excellent	A31: Health Education Value of Nature	4.3000	Excellent
						A32: Scientific Education Value of Nature	3.0000	Poor
						A33: Artistic Education Value of Nature	4.4000	Excellent
			A11: Game-based Educational Value	4.2557	Excellent	A34: Physical Educational Play Value	4.3000	Excellent
						A35: Creative Educational Play Value	4.0000	Excellent
						A36: Social Educational Play Value	4.2500	Excellent
			A12: Learning Activity Carrying Capacity	3.9324	Good	A37: Real-Scene Learning Activities	4.1000	Excellent
						A38: Thematic Experiential Learning Activities	4.1000	Excellent
						A39: Virtual Gamified Learning Activities	2.5000	Poor

In summary, the evaluation results derived from the AHP-FCE model demonstrate a high degree of coupling and consistency with the TAL quality assessment outcomes. This indicates that the indicator system can coherently unify the internal logic with practical performance in reflecting respondents' satisfaction with various indicators. It is capable of accurately and objectively reflecting the level of TAL quality and child friendliness of the park.

4. Discussion

4.1. Strategies for Enhancing TAL Quality at Shaheyuan Park

This study originates from the concept of Tour–Art–Learning, aimed at creating suitable outdoor recreational spaces for children. By establishing an evaluation system for urban park TAL quality from a child-friendly perspective and employing the PEI method combined with GIS technologies to gather survey data from Shaheyuan Park in Chengdu, the AHP-FCE model was used to assess the park's TAL quality. The research indicates that the overall TAL quality of Shaheyuan Park is high, yet significant variances exist among specific evaluation indicators, highlighting areas within the park that require improvement. Based on the park's specific assessment results and existing issues, this paper proposes enhancement strategies from the following three aspects:

(1) Carrying capacity for children's mobility activities: First and foremost, the accessibility of public transportation around the park should be enhanced by encouraging multimodal transport integration, such as establishing shared bicycle/electric scooter rental stations at the park and public transport stops and promoting the use of various modes of transport to improve travel efficiency. The efficiency of public transport information delivery should be enhanced through apps or electronic displays that provide real-time public transport updates. Additionally, the road environment around the park should be improved by installing speed bumps and speed limit signs near the park to reduce potential traffic safety hazards; children's safety signs should be set up around the park, zero-height differences should be designed at park entrances, and efforts should be made to ensure that sidewalks and steps are slip-resistant. Lastly, the intelligence of guidance signs within the park should be enhanced using touchscreen and sound-sensing technologies, enabling children to interactively obtain information and knowledge; apps or other digital technologies should be integrated to provide more detailed guide information, allowing children and parents to better understand the facilities and activities in the park. Multilingual support should be introduced to meet the needs of children and families from various ethnic backgrounds (Figure 7).

(2) Carrying capacity for children's art appreciation behavior and activities: At Shaheyuan Park, while there is an emphasis on the refinement of wood culture, there remains room for improvement in deeply exploring and presenting local Chengdu culture. Efforts should focus on enhancing the construction of human and spiritual cultures, deeply integrating local cultural elements through creative sculptures, cultural scenic walls, and interactive art installations to embody the regional culture within the park. Additionally, immersive cultural experiences and science education areas should be established using virtual reality (VR) and augmented reality (AR) technologies, along with interactive educational panels, to enhance participation and interactivity (Figure 8).

(3) Carrying capacity for children's knowledge acquisition and transfer behavior and activities: First, the focus should be on enhancing the nature education aspect of the park's science field by adding educational panels or landscape features themed around popular science, establishing outdoor classrooms for children's science camps and using games and experiences to guide children in acquiring knowledge. Second, efforts should be made to enhance the carrying capacity for virtual gamified research learning activities by innovatively introducing "immersive scripted" research learning paths that combine real-scene and digital elements to break physical and temporal boundaries of the space, offering more possibilities for study (Figure 9).



Figure 7. Strategies for enhancing the carrying capacity for children's mobility activities.



Figure 8. Strategies for enhancing the carrying capacity for children's art appreciation activities.

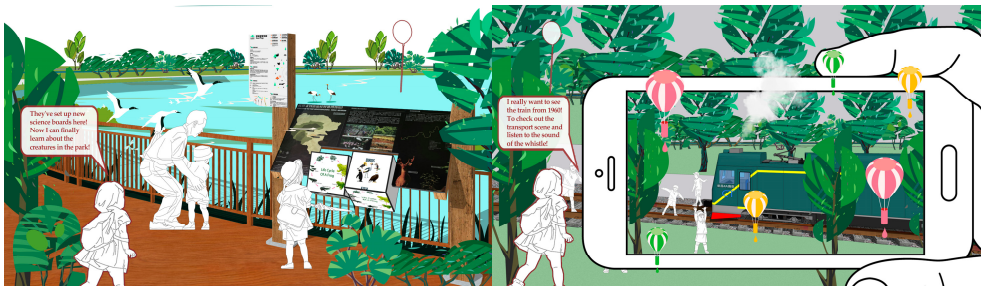


Figure 9. Strategies for enhancing the carrying capacity for children's knowledge acquisition and transfer activities.

4.2. Research Innovation

Previous studies have highlighted the broad application of the Tour–Art–Learning (TAL) model within the field of environmental design, addressing various contexts, such as the design of university campus recreational landscapes [35], child-friendly recreational spaces in park cities [36], innovative designs of children's outdoor play spaces in park cities [37], fostering intergenerational shared communities [38], and the creation of greenway landscape bridges [39]. These investigations collectively affirm the feasibility and necessity of incorporating the TAL model into environmental design practices. This study builds on existing foundations by systematically organizing and refining the conceptual framework of the 'Tour–Art–Learning' (TAL) model. The primary innovation lies in integrating the TAL framework into modern child-friendly design principles and human habitat sciences, offering a novel perspective on urban park development.

In constructing tools to evaluate the quality of children's outdoor recreational spaces, previous research typically involved in-depth analyses of multidisciplinary literature to create systems that align with specific research needs and included pilot studies at selected sites or adapted existing tools validated in practice, tailored to meet new research demands. Rooted in the TAL model, this study methodically synthesized and refined core elements from extensive theoretical research to develop a robust set of evaluation indicators. This process follows the rigorous logic and scientific methods characteristic of prior tool development, ensuring the objectivity and scientific integrity of the evaluation

system. It thoroughly covers traditional dimensions such as "diversity of play facilities", "integration with natural environments", "safety measures", "aesthetic experiences", and "learning opportunities". It also advances "site accessibility" beyond the limitations of some conventional tools, yet the dimension of "park maintenance and management level" has not been incorporated into the assessment tool, setting a direction for further expansion and refinement in future research.

4.3. Research Limitations

This study faces certain constraints and shortcomings due to limitations in manpower, time, and data acquisition channels:

(1) Limitation of data samples: The data collection and empirical analysis of this study are focused exclusively on Shaheyuan Park, which may limit the universality and broad applicability of its conclusions. Due to regional characteristics and variations in park design and management styles, it is difficult to generalize the findings to other regions or types of parks.

(2) Completeness of the evaluation system: Although the selection of indicators and allocation of weights were carried out with scientific rigor, a degree of subjective judgment is inevitably present. To enhance the objectivity and accuracy of the evaluation system, further refinements are necessary through multiple field pilot tests to continuously iterate and improve the evaluation tools.

5. Conclusions

Child-friendly design is not merely an endpoint but a fundamental baseline, above which lies a diverse spectrum of spatial needs. Urban parks, as vital urban public spaces that cater to the everyday recreational needs of children, play a crucial role in fostering child-friendly cities and significantly impact children's physical and mental health. Given this context, assessing the child friendliness of urban parks and implementing targeted adaptations to enhance their suitability for children holds profound significance for individuals, society, the development of Chengdu as a park city, and the broader construction of child-friendly urban environments. This study employs a combination of methods for comprehensive application and empirical analysis, offering valuable insights for evaluating the TAL quality of Shaheyuan Park and other urban parks. However, future research must strive to expand the scope of data collection, deepen the application of technologies, and refine the evaluation systems to ensure comprehensive coverage.

Moreover, integrating child-friendly urban park design aligns with sustainable development goals by promoting healthier lifestyles and fostering inclusive, safe, and sustainable urban environments. The enhancement of urban parks as child-friendly spaces directly supports several United Nations Sustainable Development Goals, such as ensuring healthy lives and promoting well-being for all ages (SDG 3); making cities inclusive, safe, resilient, and sustainable (SDG 11); and supporting the provision of accessible and sustainable green spaces (SDG 15). By focusing on these aspects, urban park development not only responds to immediate community needs but also contributes to long-term environmental sustainability and social cohesion, thereby enriching the quality of life and ensuring the continuity of urban green spaces for future generations. This comprehensive approach underscores the necessity of integrating child-friendly principles into urban planning and park design, which are essential for achieving broader sustainability objectives and enhancing the livability of urban areas, thus playing a pivotal role in the sustainable development of cities worldwide.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the IRB of the School of Design, Southwest Jiaotong University.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study, ensuring voluntary participation and safeguarding participants' rights and privacy.

Data Availability Statement: If requested, the corresponding author can make the data presented in this study available.

Conflicts of Interest: The authors have no conflicts of interest to declare.

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