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Article

A Study on Sustainable Development through Inclusive and Friendly Urban Park Design: A Case Study of Wenxin Forest Park Taichung City

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Abstract: This study examines Wenxin Forest Park in Taichung City as a case study to evaluate the availability and effectiveness of barrier-free facilities, age-friendly environments, and pet-friendly spaces within an urban park. The research further assesses how inclusive design principles are implemented in alignment with Sustainable Development Goal (SDG) 11.7, which advocates equitable access to safe, inclusive, and accessible green spaces. A mixed qualitative–quantitative approach was adopted, incorporating on-site observations, facility measurements, and systematic classification and comparison with relevant regulatory standards to examine facility configuration, usability, and compliance. The results indicate that while the park demonstrates a basic level of inclusive design, several limitations persist. Parking space arrangements do not fully meet current regulations, only two of the four main entrances are equipped with tactile paving (50% compliance), the proportion of accessible restroom stalls (4:14) is below recommended standards, and age-friendly seating accounts for only 5% of total resting facilities. In addition, although designated pet areas are provided, the large-dog zone (384 m²) does not reach the suggested minimum size. Overall, the findings suggest that further improvements are needed in facility proportionality, spatial organization, and responsiveness to diverse user groups. The study concludes by emphasizing the importance of strengthening barrier-free guidance continuity, expanding elder-friendly facilities, and refining the scale and management of pet-friendly spaces to support more inclusive and sustainable urban public environments.

Keywords: Urban parks, Inclusive design, Barrier-free facilities, Age-friendly environment, Pet-friendly spaces, SDG 11.7

1. Introduction

Urban parks play a critical role in promoting sustainable and inclusive urban environments. Increasing attention has been given to barrier-free facilities, elder-friendly environments, and pet-friendly spaces to ensure equitable access for diverse user groups. In this study, "elder-friendly" refers to environments designed to support the physical and psychological needs of older adults, consistent with the principles of age-friendly cities proposed by the World Health Organization.

Wenxin Forest Park, located in Nantun District of Taichung City, Taiwan, covers approximately 8.88 hectares and is situated near the Seventh Redevelopment Zone, one of the most economically developed areas in the city. The surrounding area is characterized by high-density residential developments, commercial facilities, and convenient public transportation, including the Taichung MRT Green Line. Due to its strategic location, the park serves as an important recreational space for a wide range of users, including older adults, families, and pet owners. This study aims to evaluate the availability and effectiveness of barrier-free facilities, elder-friendly environments, and pet-friendly spaces, and to assess their alignment with Sustainable Development Goal (SDG) 11.7, which emphasizes equitable access to safe, inclusive, and accessible green spaces.

2. Literature Review

2.1 Barrier-Free Design and Spatial Equity

Barrier-free design is regarded as a core foundation of inclusive urban spaces, aiming to eliminate environmental constraints imposed on users with diverse abilities and to ensure equal accessibility to public spaces. Imrie [**Error! Reference source not**

found.] argues that disability should not be understood as stemming from individual physical or mental conditions, but rather as the outcome of spatial designs that fail to respond to diverse user needs. This perspective highlights the necessity of addressing accessibility through systematic environmental adjustments. Design elements such as ramp gradients, circulation widths, handrail configurations, and tactile guidance systems are critical factors influencing both accessibility and safety in public spaces.

From a theoretical perspective, Imrie and Hall [**Error! Reference source not found.**] introduce the concept of urban inclusivity, emphasizing that public spaces should avoid exclusionary effects caused by designs favoring specific groups. The seven principles of universal design proposed by Mace [**Error! Reference source not found.**] further provide practical guidance for implementing barrier-free and inclusive environments, and these principles continue to be widely applied in public facilities and urban planning. Existing studies generally agree that the adoption of universal design contributes to enhanced spatial equity and greater flexibility in public space use.

2.2 Elder-Friendly Facilities

With the acceleration of population aging, the safety and comfort of older adults in public spaces have become increasingly important issues in urban design. Loukaitou-Sideris [**Error! Reference source not found.**] shows that seat height and spacing, shading facilities, and walkway evenness play a crucial role in enabling older adults' participation in outdoor activities. Similarly, Chan et al. [**Error! Reference source not found.**] found that adequate lighting and visual legibility significantly enhance older adults' willingness to use park spaces and their perceived sense of safety.

In the Taiwanese context, Lin [**Error! Reference source not found.**] showa that older adults commonly experience inconvenience related to wayfinding systems and restroom design in public spaces. Although relevant regulations addressing elder-friendly facilities have been established in Taiwan, their implementation in park environments remains inconsistent. In particular, aspects such as seating design, the distribution of resting points, and the continuity of pedestrian routes require further verification through on-site investigations and user-based evaluations.

2.3 Pet-Friendly Spaces

As pet ownership continues to increase, conflicts and management issues arising from shared use of public spaces by pet owners and non-pet users have attracted growing attention. Degeling and Rock [**Error! Reference source not found.**] note that differences in behavior, hygiene, and safety concerns may generate conflicts between these groups, underscoring the importance of circulation separation, designated zones, and effective maintenance and management systems in spatial design. An ideal pet-friendly space should integrate safety-oriented design with clear regulations to maintain order in public environments.

Table 1. Summary of Relevant Literature.

Author / Year	Title / Topic	Research Focus	Methodology	Main Findings and Contributions
Imrie (2012) [**Error! Reference source not found.**]	Universal Design and Equitable Access	The social implications and spatial equity of barrier-free design	The social implications and spatial equity of barrier-free design	Identifies that barriers stem from exclusionary spatial design; emphasizes the inclusion of diverse abilities as a foundation for social justice.
Lin (2019) [**Error! Reference source not found.**]	A Study on the Use of Barrier-Free Spaces by the Elderly	Usage experience and perceptions of elderly users in public facilities	Field interviews and questionnaire survey	Finds that elderly users often face obstacles related to wayfinding systems and accessible toilets; recommends strengthening spatial legibility and user-friendliness.
Taichung City Construction Bureau (2021) [**Error! Reference source not found.**]	Report on the Current Status of Pet-Friendly Park Facilities in Taichung City	Conditions and public responses regarding pet activity spaces in Taichung	Policy document review and user feedback analysis	Points out that insufficient zoning and signage lead to spatial overlap; recommends strengthening designated areas and facility management mechanisms.

In Taiwan, although many municipalities have begun to establish designated pet activity areas, design standards and management mechanisms remain inconsistent. In Taichung City, for example, some parks have introduced pet zones, yet deficiencies persist in circulation separation and regulatory signage, potentially affecting the experience of other user groups [**Error!**

Reference source not found.]. Moreover, Koohsari et al. [**Error! Reference source not found.**] show that well-designed pet-friendly green spaces can encourage dog walking and promote neighborhood interaction. Recent studies further emphasize that the planning of pet-friendly parks should be aligned with sustainable development goals, such as SDG 1, to balance inclusivity with effective urban governance.

3. Method

This study adopts a structured case study research design. Data were collected through multiple field investigations conducted between June and July 2025, including on-site observations, dimensional measurements, and photographic documentation.

The evaluation framework consists of three dimensions: barrier-free accessibility, elder-friendly facilities, and pet-friendly spaces. Each dimension was assessed using predefined indicators, including pathway width, ramp slope, seating design, spatial distribution, safety features, and facility provision.

All observations and measurements were compared with relevant national regulations and planning guidelines to ensure objectivity and consistency. This approach provides a systematic and replicable framework for evaluating inclusive design in urban parks.

4. Issues of Barrier-Free Design and Spatial Equity

4.1 Concepts of Barrier-Free Design and Spatial Equity

Barrier-free design constitutes a fundamental principle for achieving inclusivity and human-centered values in public space planning. Its primary objective is to eliminate environmental barriers through spatial interventions, enabling people with disabilities, older adults, and individuals with mobility limitations to access and use public facilities safely, conveniently, and with dignity [**Error! Reference source not found.**]. The seven principles of universal design further provide operational guidelines that emphasize equitable use, low physical effort, and tolerance for error as essential criteria in public facility planning and design [**Error! Reference source not found.**].

Spatial equity, rooted in urban planning and social geography, focuses on the fairness of resource distribution and access opportunities within urban spaces. It emphasizes the prevention of structural spatial exclusion arising from differences in age, ability, or social status [**Error! Reference source not found.**, **Error! Reference source not found.**]. Within public green spaces, barrier-free design serves not only as a technical requirement but also as a practical mechanism for realizing spatial equity, reflecting the extent to which urban governance responds to diverse user needs.

4.2 Applications of Barrier-Free Design and Spatial Equity

Table 2. Observation and Measurement Record of Barrier-Free Design and Spatial Equity.

Item / Attribute	Entrance Accessibility	Accessible Toilets	Parking Facilities	Visual and Assistive Information
Category / Facility				
Current Condition / Field Measurement Results	The park has four main entrances; only two are equipped with tactile paving for the visually impaired. / Net width ≈ 92 cm; slope slightly steeper in some sections.	Two accessible toilet units (one under maintenance). Male (Urinals 8, Seate 2, Squat 2) Female (Seate 9, Squat 5) All gender (Urinals 1, Seate 2) Family (Seate 1) Accessible (Seate 1) Gender ratio 4:14 Squat-to-seated ratio 7:11	**Car spaces**:117 (Accessible 5,Family 3, EV 4) size 550 × 250 cm, unloading zone 150 cm. **Motorcycle spaces** 240 (Accessible 4, EV 2) size 200 × 220 cm, markings clear.	Tactile paving provided only at two entrances; limited visual guidance within the park.
Regulatory Requirements	Minimum clear width ≥ 90 cm; ramp slope ≤ 1:12.	Female squat-to-male squat ratio = 1:4; seated toilets ≥ 40% of total.	Car: 600 × 200 cm with 150 cm unloading zone; Motorcycle: 220 × 225 cm with signage required.	Tactile paving, signage, and audio guidance required.
Compliance Status	Partially compliant (slope slightly exceeds standard).	Partially non-compliant (gender and seated ratio slightly off standard).	Not fully compliant (car length below standard).	Non-compliant.

In universally shared spaces such as urban parks, the implementation of barrier-free design and spatial equity directly reflects the human-centered orientation and inclusiveness of urban public policies. Field investigations of Wenxin Forest Park in Taichung City indicate that most major entrances are equipped with barrier-free ramps, wide pathways, and accessible restrooms, largely complying with current accessibility regulations. These findings suggest a relatively mature level of infrastructure provision.

Nevertheless, a closer examination of user experience and actual accessibility reveals remaining challenges, including level differences at pathway intersections and insufficient continuity of wayfinding systems to accessible facilities. These issues demonstrate that regulatory compliance at the facility level alone is insufficient to ensure spatial equity. Future public space planning should therefore shift from isolated facility provision toward an integrated, process-oriented design approach that addresses the complete user journey across diverse population groups.

4.3 Summary: Policy and Planning Implications

Overall, Wenxin Forest Park demonstrates a solid foundation for promoting barrier-free and inclusive design. However, further improvements are needed in areas such as accessible parking dimensions, pathway continuity, and guidance systems for visually impaired users. Future park planning should prioritize clear signage, standardized parking layouts, and continuous high-contrast wayfinding systems to ensure independent and safe use by diverse user groups.

From a policy perspective, barrier-free design should extend beyond regulatory compliance and be embedded within broader frameworks of spatial equity and social inclusion. Institutionalized evaluation mechanisms and user-centered feedback processes can facilitate a transition from formal accessibility toward substantive equity, thereby advancing the goal of "Design for All" in sustainable urban development.

5. Elder-Friendly Facilities for Older Adults

5.1 Evaluation Framework of Elder-Friendly Facilities

In response to the rapid global aging trend, creating age-friendly living and recreational environments has become a critical agenda in urban governance and public space design. According to the World Health Organization's Age-Friendly Cities framework, an age-friendly environment should enable older adults to actively participate in public life, maintain social connections, and delay physical and cognitive decline [**Error! Reference source not found.**]. Urban parks, as key everyday spaces for walking, leisure, and social interaction, play a vital role in supporting healthy and active aging when age-friendly design principles are effectively integrated.

The planning and design of elder-friendly facilities should be grounded in an understanding of age-related functional changes and user behavior. Core principles include safety, accessibility, comfort, information clarity, and social participation. Measures such as non-slip surfaces, continuous barrier-free routes, adequate seating and shading, clear wayfinding systems, and diversified activity spaces can significantly reduce usage risks and enhance older adults' willingness to use public spaces. In Taiwan, these principles have gradually been incorporated into urban design regulations and policy guidelines, positioning urban parks as important testing grounds for implementing age-friendly spatial strategies.

5.2 Application of Elder-Friendly Facilities

With the arrival of an aging society, the implementation of elder-friendly facilities in urban public spaces has become an essential concern in urban planning and design. Elder-friendly facilities refer to spatial and physical provisions designed to improve older adults' quality of life, activity participation, and safety. Under the WHO Age-Friendly Cities framework, public environments should be inclusive and responsive, enabling older adults to remain socially engaged and physically active [**Error! Reference source not found.**].

Wenxin Forest Park in Taichung City serves as an illustrative case due to its convenient location near the MRT Green Line and major arterial roads, making it a popular destination for daily walking and recreation among older residents. Field observations indicate that the park provides relatively dense seating, non-slip pedestrian paths, and low-impact fitness equipment suitable for older users. However, several limitations remain, including the absence of armrests and backrests on some benches, localized uneven pavement conditions, and insufficient wayfinding and information systems. Compared with national design standards and age-friendly assessment criteria, these deficiencies suggest further opportunities for improvement in spatial safety and usability.

Table 3. Observation Record of Elder-Friendly Facilities.

Item / Attribute	Seating Facilities	Shading Facilities	Age-Appropriate Fitness Equipment	Guidance and Signage System
Current Condition				
Field Observation and Measurement	The field survey indicates that a total of 152 seating facilities are installed in Wenxin Forest Park, including 20 wooden benches without backrests, 43 stone landscape benches, 22 wooden benches with backrests, 8 age-friendly benches equipped with armrests, 1 accessible bench, 34 decorative marble benches, and 24 semi-circular stone benches.	Primarily natural tree shade	High-intensity equipment: 1 unit / Low-intensity equipment: 7 units. Facilities are stable; most are low-impact and suitable for older adults.	Text is clear; contrast is moderate and legibility acceptable.
Regulatory Requirements	Benches should be installed every 50–100 m and provide shading. At least 30% of benches should be age-friendly (with backrests and armrests).	Shading should be provided by structures or trees.	Equipment should be age-appropriate with safety design features.	High-contrast and legible fonts required.
Compliance Evaluation	Non-compliant–only 5% of benches meet age-friendly standards.	Compliant.	Partially deficient.	Compliant.

5.3 Summary: Implications for Age-Friendly Design

Overall, Wenxin Forest Park demonstrates a basic level of age-friendliness and possesses the foundational conditions of an age-friendly urban park. Nevertheless, the predominance of benches without backrests or armrests reduces physical support for users with limited mobility, potentially affecting safety and comfort. This highlights the need for more supportive seating designs tailored to older adults' physical needs.

In addition, although fitness equipment encourages low-intensity physical activity among older adults, unclear or deteriorated instruction signage may increase usage risks. Future improvements should prioritize the provision of age-friendly seating, clearer instructional and wayfinding systems, and the integration of emergency assistance facilities. Such enhancements would strengthen the park's overall environmental supportiveness and better align it with the principles of age-friendly urban design.

6. Pet-Friendly Spaces in Urban Parks

6.1 Evaluation Framework of Pet-Friendly Spaces

With declining birth rates and changing household structures, companion animals have become an integral part of urban residents' emotional lives. In Taiwan, the population of dogs and cats has surpassed that of children, underscoring the growing relevance of pet-related considerations in public space planning. Incorporating pet-friendly design into urban parks can facilitate human–animal interaction while enhancing users' sense of place attachment and overall satisfaction with public spaces [1].

Pet-friendly spaces should not be understood merely as areas where pets are permitted, but rather as environments intentionally designed through spatial zoning, safety provisions, sanitation facilities, and management mechanisms to support harmonious human–pet coexistence. Core principles include clear functional zoning, secure and comfortable facilities, adequate cleaning infrastructure, explicit behavioral guidelines, and the integration of social interaction opportunities for pet owners, thereby reducing conflicts and improving spatial order.

6.2 Application of Pet-Friendly Spaces

Wenxin Forest Park in Taichung City serves as a representative case due to its central location and frequent use by local residents for dog walking. Field observations indicate that the park's spacious open areas and extensive lawns provide a natural setting conducive to leash-based dog walking. Most interactions between pet owners and other users remain amicable, suggesting a baseline level of informal pet-friendliness.

However, the absence of designated pet activity zones, insufficient sanitation facilities, and limited informational signage reveal notable shortcomings. The lack of clear spatial differentiation and management guidelines may lead to ambiguity in user behavior, particularly during peak hours, thereby increasing the potential for conflicts or hygiene concerns. These findings indicate that the park's pet-friendly attributes remain largely informal rather than systematically planned.

Table 4. Observation Record of Pet-Friendly Spaces.

Item / Attribute	Zoning of Pet Areas	Safety Fences and Entrances	Usage Regulations and Signage	Observation of Owner Behavior
Current Condition				
Field Observation and Measurement	Separate zones for large and small dogs with clear boundaries. Large-dog area: 384 m² Small-dog area: 256 m²	Double-gate entry system with fences approximately 125 cm in height.	Signage includes illustrations and bilingual (Chinese–English) text outlining park rules.	Most owners keep pets leashed and clean up after them; overall responsible behavior observed.
Regulatory Requirements	Large-dog areas: 400–800 m²; Small-dog areas: 200–400 m².	Fence height ≥ 120 cm, with double-gate safety buffer.	Clear visual and textual signage required, stating behavioral rules.	Owners must keep pets leashed and clean up pet waste.
Compliance Evaluation	Non-compliant – large-dog area below minimum size standard.	Compliant	Partially compliant – signage font size too small.	Compliant

6.3 Summary and Planning Implications

Overall, Wenxin Forest Park can be characterized as an "open-access" pet-friendly space, where permissive use is enabled by spatial openness rather than institutionalized design and management. While this condition supports everyday pet-related activities, it also constrains the park's capacity to ensure safety, cleanliness, and equitable use for diverse user groups.

To enhance human–pet coexistence in urban parks, future planning efforts should move toward a more structured approach by introducing designated pet-use areas, strengthening sanitation infrastructure, and clarifying management rules through visible and consistent signage. Such measures would allow pet-friendly spaces to better align with inclusive urban design principles while balancing the needs of pet owners and non-pet users.

7. Discussion

The findings suggest that inclusive design in urban parks should not be understood solely as compliance with regulatory standards, but as a dynamic process shaped by spatial configuration, user interaction, and environmental context. This perspective aligns with previous studies emphasizing that accessibility and inclusiveness are influenced not only by physical infrastructure but also by continuity, legibility, and perceived safety.

Compared with existing research, this study highlights the importance of integrating barrier-free design, elder-friendly environments, and pet-friendly spaces into a unified framework. This integration enhances usability and inclusiveness.

The results indicate that improving facility distribution and spatial organization can significantly enhance user experience. Therefore, urban park planning should adopt a more user-centered approach.

8. Conclusion

This study evaluated the inclusive design of Wenxin Forest Park from the perspectives of barrier-free facilities, elder-friendly environments, and pet-friendly spaces. The results indicate that while the park partially meets regulatory standards, improvements are needed in facility distribution, spatial continuity, and user-oriented design.

The findings suggest that inclusive design should extend beyond compliance with standards and focus on actual usability. This study contributes to the development of inclusive public spaces and supports the implementation of SDG 11.7.

Future research is recommended to incorporate user perception surveys and longitudinal observations.

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