ASSESSING THE DISTRIBUTION OF GREEN SPACE AND PROPOSED SOLUTIONS TO ENHANCE PEOPLE'S ACCESS TO GREEN SPACE IN THANH KHE, CAM LE, HAI CHAU DISTRICTS, DA NANG CITY

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(Received: April 27, 2025; Revised: June 15, 2025; Accepted: June 21, 2025)

DOI: 10.31130/ud-jst.2025.23(10C).660E

Abstract - Urban green spaces (UGS) provide essential ecosystem services that enhance health, quality of life, and support the achievement of the United Nations' Sustainable Development Goals, particularly Goals 3 and 11. However, equitable access to UGS remains a challenge in many urban areas. This study analyzes the accessibility of UGS for residents in three districts of Da Nang - Thanh Khe, Cam Le and Hai Chau - based on factors such as geographic distribution, transportation infrastructure, demographic characteristics, and green space functionality. Through field surveys and public feedback, the study assesses usage needs and perceived benefits related to physical and mental health, as well as social interaction. Based on these findings, the authors propose technology-integrated solutions for designing and managing UGS to improve equitable access, enhance community engagement, and promote smart, sustainable urban development.

Key words - Urban green space; equitable access to green space; green space design; urban green infrastructure; technology; sustainable urban development

1. Introduction

In the context of rapid urbanization, ensuring equitable access to UGS has become an important factor in reducing social inequality and enhancing the connection between people and nature. Many international studies have affirmed the positive role of green spaces on physical health, mental well-being, and community cohesion. In Vietnam, especially in Da Nang, recent planning policies have contributed to the expansion of public green areas. However, significant limitations persist, including unreasonable allocation, inadequate community participation in design and management, and insufficient attention to the specific needs of vulnerable groups, which collectively hinder equitable access to UGS. Some new parks lack amenities and are not used effectively. Additionally, domestic studies on equitable access to UGS mostly remain at a general level, without in-depth analysis of factors affecting design, management, and usage behavior at the local level, especially in central districts like Thanh Khe, Hai Chau, and Cam Le - where the demand for UGS is very high. This constitutes a significant research gap, as local-level disparities and specific user needs often go unaddressed. Therefore, this study not only helps identify factors affecting equitable access to UGS but also uniquely contributes by providing an in-depth, local-level analysis and guiding design, planning, and management solutions for urban green space systems in a sustainable, effective manner that better meets practical needs, particularly through the integration of technology.

2. Research overview

2.1. International research

International studies have approached UGS from various perspectives, from equity in green space distribution to the relationship between UGS and community health. Kabisch & Haase compared equitable access to UGS in European cities, showing significant differences between population groups based on socio-economic factors [1]. Research synthesis provided evidence of health benefits from UGS, emphasizing that green spaces positively impact both physical and mental health [2]. Meanwhile, Wolch et al.'s study focused on environmental equity and social impacts of UGS, indicating that the distribution and management of UGS should be linked to social equity and community participation [3]. Wang & Lee used a quantitative approach to measure green space access, thereby analyzing differences between population groups in the enjoyment of UGS [4].

2.2. Domestic research

Some preliminary studies have approached the issue of equity in the distribution and access to UGS. Research analyzes the accessibility of green space in Hue City and points out the inequality in the distribution of greenery between areas with different population densities [5]. Particularly, vulnerable groups such as the elderly, children, and low-income individuals often face more difficulties in accessing UGS due to geographical location and lack of supporting facilities [6]. However, domestic studies still mainly stop at describing the current situation and have not delved into analyzing the factors affecting the design, management, and usage behavior of UGS at the local or district level – where the disparity in access is often more pronounced. This specific limitation in current domestic literature underscores the novelty and necessity of this study, which focuses on providing such granular analysis within the central districts of Da Nang.

2.3. Criteria for evaluating UGS

According to WHO and UN Habitat, UGS should be evaluated through the following groups of criteria:

- Accessibility: UGS should be within a radius of 300 – 400m from residences (equivalent to 5 – 10 minutes of

walking), with safe and diverse access (walking, cycling, public transport), and suitable for all groups.

- Functionality & Environment: UGS needs to have a minimum density of greenery of 9m²/person, support multifunctionality (recreation, sports, education...), accompanied by amenities (restrooms, lighting, benches...). Priority should be given to environmentally friendly materials, green infrastructure to prevent flooding, and ecological drainage.

- Aesthetics & Identity: Landscape design should be harmonious, reflecting local culture, heritage, and urban spirit.

- Social Inclusion: Create spaces for community interaction, suitable for diverse genders, ages, and needs; residents should be involved in the design and management process.

- Technology & Smart Management: Application of IoT, sensors, digital maps, QR apps... to enhance management efficiency and responsiveness. The system should be flexible and adaptable to environmental and social changes [7], [8].

3. Research methodology

3.1. Quantitative methodology

Surveys were conducted from December 15, 2024, to February 15, 2025, in three research districts. Data was collected directly in parks during various time frames (7:30 AM – 10:00 PM, Monday to Sunday) to ensure representativeness. The average survey duration was 10-15 minutes, with respondents randomly selected from various locations within the park. The questionnaire was designed with clear multiple-choice and Likert-scale options to facilitate efficient data collection within this timeframe, while allowing for more detailed input when participants wished.

The questionnaire was designed to include 5 parts covering factors affecting spatial distribution, the impact of UGS:

- Demographic information: Gender, age, education, income, living area, frequency, and duration of UGS usage.

- Activities at UGS: 12 common activities and an "other" option for additional input.

- Perceived benefits: Regarding physical health, mental well-being, and social interaction.

- Motivation for use & ESD awareness: Including factors of distance, convenience, and awareness of sustainable development (5-point Likert scale).

- Expectations and desired amenities: Suggestions for a UGS model suitable for the majority of users.

Data collected through surveys and field observations were categorized into the following factor groups (Table 2):

- Demographic characteristics: Personal information including age, gender, education level, monthly income, means of transportation to UGS, travel time to the nearest UGS, and frequency of green space usage per week.

- Cultural Ecosystem Services (CES): Activities such as dog walking, strolling, hiking, cycling, reading, sightseeing, engaging in activities with children, social gatherings, picnicking, boating, canoeing, dining, photography, and parking.

- Perceived disamenities: Unpleasant scenery, air pollution, water quality issues, soil erosion, allergic reactions, harmful insects, poor maintenance, frequent noisy events, solid waste pollution, lack of safety due to social disturbances, and flooding.

- Perceived benefits: Physical health, emotional well-being, and social interaction.

- Motivational factors: Accessibility (connection to major transportation networks), proximity to home or workplace, ease of access via public transportation, tranquility, scenic beauty and landscape diversity, presence of water elements, size and scale of the park, availability of sports facilities, and opportunities for social interaction.

The study was conducted through the distribution of questionnaires, with a total sample size of 234; 226 valid responses were collected and used for analysis.

Table 1. *Demographic data*

Criteria	Hai Chau	Thanh Khe	Cam Le
Age group			
Under 15	6	14	10
16–25	36	58	36
26–35	18	16	20
36–50	10	8	10
Over 50	4	4	4
Gender			
Male	20	24	22
Female	26	34	34
Education level			
Lower secondary	6	6	4
Upper secondary	18	18	20
College	14	20	12
University	14	14	20
Postgraduate	4	0	0
Monthly income (VND)			
Under 5 million	36	30	34
5–10 million	10	14	10
10–15 million	0	6	6
15–20 million	0	4	4
Over 20 million	0	4	2
Means of transportation to UGS			
Walking	6	14	10
Bicycle	2	8	4
Motorbike	36	32	40
Car	4	0	2
Public transportation	0	0	0
Travel time to nearest UGS			
Under 5 minutes	6	6	4
5–15 minutes	28	20	26
15–30 minutes	10	28	16
Over 30 minutes	2	4	10
UGS usage frequency per week			
1–2 times	12	10	14
2–3 times	14	16	12
3–4 times	12	14	10
More than 4 times	8	18	20

Table 2. *Group of research factors and variables*

No. Factor Group	No.	Dynamic Factors
I Dynamic Factors	1	Accessibility (Connection to transport network)
	2	Proximity to home
	3	Proximity to workplace
	4	Ease of using public transportation
	5	Tranquility of space
	6	Aesthetic value and landscape diversity
	7	Presence of water elements in the space
	8	Regulations and size of green spaces
	9	Fitness equipment
	10	Opportunities for social interaction
	11	Lighting system
	12	Width of walkways
	13	Environmental sanitation
	14	Security and order
	15	Toilets
	16	Parking space
	17	Shade, shelter from sun/rain
	18	Seating availability
II Benefit Factors	1	Physical health
	2	Mental health
	3	Social interaction
III Cultural Ecosystem Services (CES)	1	Spaces for walking
	2	Jogging, running, long-distance walking
	3	Cycling
	4	Reading
	5	Sightseeing
	6	Participation in children's activities
	7	Meeting people
	8	Outdoor dining, barbecue
	9	Boating, rowing
	10	Eating and drinking
	11	Photography
	12	Playing games
IV Risk Factors	1	Unpleasant appearance or landscape
	2	Air pollution
	3	Water quality issues
	4	Soil erosion
	5	Harmful or allergy-inducing organisms (e.g., mosquitoes)
	6	Maintenance issues
	7	Noise, lifestyle disturbance
	8	Waste pollution
	9	Insecurity
	10	Flooding

3.2. Data collection methods

The study was conducted in three central districts of Da Nang City - Thanh Khe, Hai Chau, and Cam Le - areas characterized by high urbanization rates and rapidly developing population density and infrastructure. The selected urban green spaces (UGS) included 29/3 Park, APEC Park, Hoa Xuan Park, and several other community green spaces, varying in scale, location, and design. Their areas ranged from 2 to 20 hectares, with many located along rivers, enhancing both ecological potential and spatial connectivity. The research employed the following methods:

- Spatial analysis: ArcMap and GIS data were used to identify the distribution of UGS, calculate green space density per capita, and measure access distances from residential areas.

- Community surveys: Questionnaires were administered at selected UGS. Data were processed using SPSS to assess usage levels, motivating factors, and barriers to access.

- Prototypical modeling: A UGS design model was developed to meet various levels of equitable access.

The sample size was determined based on exploratory factor analysis (EFA) guidelines, with a minimum of 50 observations and preferably over 100. Common sample ratios include 5:1 or 10:1 (number of observations per measured variable). Using the formula $N = 5 \times$ *number of measured variables*, with 52 variables involved in the EFA, a sample size of 260 was required ($N = 5 \times 52$). To ensure this target, 325 questionnaires were distributed, and 234 were returned. Of these, 226 valid responses were used for EFA. SPSS software and the median method were used to evaluate green space allocation and equitable access. The analytical results serve as a scientific basis for proposing solutions to optimize the distribution and improve access to urban green spaces.

3.3. Analytical processing

Based on the overview and consultation, the variables affecting the accessibility and use of green space. In the study, the variables were measured on a 5-level Likert scale: 1 - Strongly disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly agree. The groups of variables were built around the motivations for using UGS and sustainable development awareness. Data processing using SPSS with the following steps: (1) Testing the reliability of the scale using Cronbach's Alpha, (2) Exploratory factor analysis (EFA), (3) Descriptive analysis and comparison between groups of variables, shown in chart 10-13, shows that there are 5 potential groups (with a total of 52 observed variables - Table 1) affecting the level of satisfaction in using public green space.

3.3.1. Geographic data analysis

The spatial distribution of parks is based on this road network. The accessibility of green spaces in Da Nang's districts exhibits significant inequity. City center areas, exemplified by large parks like 29/3 Park, achieve 100% accessibility due to their scale and service area. However, district-level analysis reveals disparities: Thanh Khe District predominantly features city-level park coverage (88%) with minimal residential (4%) and district-level (8%) green space, indicating better access for larger parks but overall inequity between residential and city-level areas. Similarly, Hai Chau District shows higher district-level coverage (56%) compared to residential (10%) and city-level (34%), highlighting a deficit in green space accessibility for residents. Cam Le District further exemplifies this, with district-level green space dominating

(92%) and very little residential coverage (8%) and almost no city-level parks, leading to very low and challenging green space access for its residents (Figure 1).

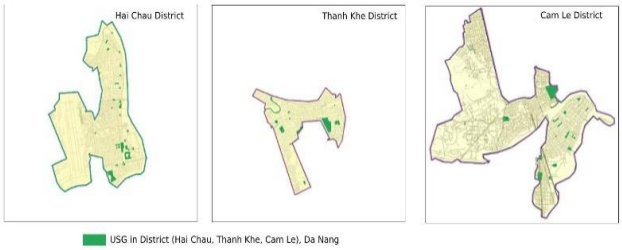

Figure 1. *Green Space Distribution Data in Da Nang Districts from ArcGIS Map*

3.3.2. Exploratory factor analysis (EFA)

Four variable groups achieved a Cronbach's Alpha coefficient greater than 0.6, indicating acceptable internal consistency, as recommended by Hair et al. (2010). These groups include: service utility, environment and perception, and infrastructure–connectivity. The group labeled "Perceived Benefits" had an Alpha coefficient of 0.576, which did not meet the minimum reliability threshold and was therefore excluded from further analysis. After eliminating non-compliant variables, 41 observed variables across four factor groups remained and were used in the EFA (Table 3).

Table 3. *Cronbach's Alpha Coefficients for Variable Groups*

No.	Variable Group	No. of Items	Cronbach's Alpha
1	Risk Factors	10	0.869
2	Dynamic Factors	18	0.892
3	Benefit Factors	3	0.576
4	CES (Cultural Ecosystem Services)	12	0.744
5	Desired Factors	4	0.657

Table 4. *KMO and Bartlett's Test Results*

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		.836
Bartlett's Test of Sphericity	Approx. Chi-Square	1033.323
	df	153
	Sig.	.000

The Kaiser–Meyer–Olkin (KMO) measure was 0.836 (> 0.5), and Bartlett's Test of Sphericity yielded a significance value of 0.000 (< 0.05), indicating that the data were suitable for factor analysis (Table 4). An eigenvalue > 1 criterion was used to extract the main components. Four key factors were extracted, explaining a total variance of 69.096% (Table 5).

This result demonstrates that the extracted components appropriately reflect the latent structure of the 41 observed variables and offer high generalizability. The four factor groups are described as follows:

- Service utility: Includes elements related to the availability and adequacy of services and amenities in green spaces, such as public restrooms, seating, phone charging stations, lighting systems, and security.

- Environment and perception: Covers aspects such as openness, air quality, tree canopy density, landscape color scheme, feelings of relaxation, harmony, and closeness to nature.

- Infrastructure and connectivity: Focuses on the quality of pedestrian pathways, accessibility via public transportation, connections between functional zones, and overall ease of reaching UGS.

- Safety and social factors: Encompasses variables such as security, nighttime lighting, space for community activities, and the perceived sense of safety when using green spaces.

Table 5. *Total Variance Explained*

No.	Initial Eigenvalues (Total)	Initial Eigenvalues (% of Variance)	Initial Eigenvalues (Cumulative %)	Extraction Sums of Squared Loadings (Total)	Extraction Sums of Squared Loadings (% of Variance)	Extraction Sums of Squared Loadings (Cumulative %)	Rotation Sums of Squared Loadings (Total)	Rotation Sums of Squared Loadings (% of Variance)
1	6.451	35.839	35.839	6.451	35.839	35.839	3.855	21.414
2	3.32	18.442	54.281	3.32	18.442	54.281	2.913	16.184
3	1.497	8.315	62.597	1.497	8.315	62.597	2.858	15.877
4	1.17	6.499	69.096	1.17	6.499	69.096	2.812	15.621
5	0.882	4.898	73.994					
6	0.784	4.356	78.35					
7	0.634	3.521	81.871					
8	0.561	3.117	84.988					
9	0.429	2.386	87.374					
10	0.369	2.045	89.419					
11	0.331	1.838	91.257					
12	0.296	1.645	92.902					
13	0.267	1.481	94.383					
14	0.255	1.417	95.8					
15	0.217	1.204	97.004					
16	0.205	1.137	98.141					
17	0.182	1.013	99.154					
18	0.152	0.846	100					

Extraction Method: Principal Component Analysis.

3.3.3. Chart analysis

The chart analysis of survey data from the three districts - Hai Chau, Thanh Khe, and Cam Le - revealed notable differences in green space usage behaviors, perceptions, encountered limitations, and design expectations for urban green spaces (UGS)

- Usage activities:

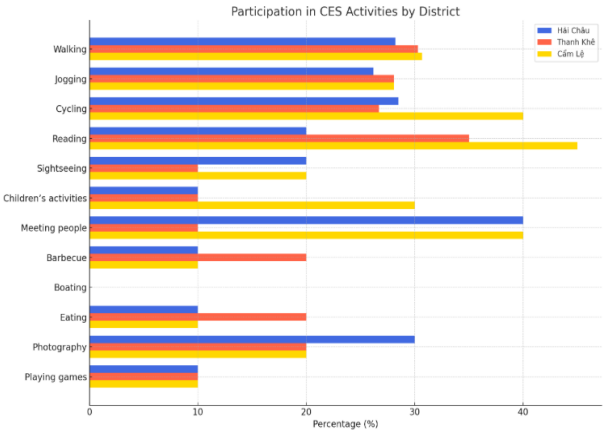

Figure 2. *Participation in CES Activities by District (Hai Chau, Thanh Khe, Cam Le), Da Nang*

Residents of Hai Chau tended to engage in light physical activities such as cycling (40%) and socializing with friends. This reflects the availability of open spaces and infrastructure that support group activities in the area. In Thanh Khe, a high proportion (30%) reported

participating in activities with children, indicating a strong demand for child-friendly and family-oriented green spaces. In contrast, Cam Le stood out with a high rate (45%) of outdoor reading activities, suggesting a preference for quiet, low-noise environments suitable for rest and personal relaxation (Figure 2).

- Motivational factors:

Thanh Khe received the highest rating for accessibility, with a median score of 5/5, particularly due to its wide pathways, proximity to residential areas, and relatively good sanitation conditions. Cam Le ranked highest in aesthetic perception and landscape quality, including greenery diversity and natural beauty. Hai Chau was recognized for its tranquil atmosphere, making it especially suitable for the elderly or individuals seeking peaceful environments (Figure 3).

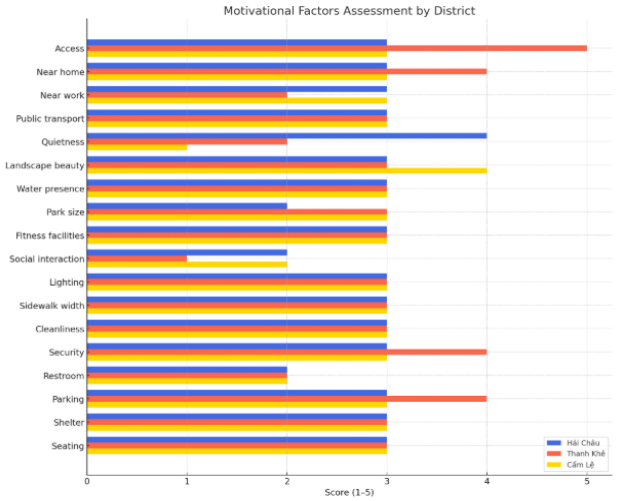

Figure 3. *Median Motivational Factors Assessment by District (Hai Chau, Thanh Khe, Cam Le), Da Nang*

- Perceived limitations and disamenities:

The level of disadvantages was relatively similar across districts in terms of issues such as solid waste pollution, noise, and lack of security. However, Thanh Khe was rated higher for flooding risks and allergic reactions caused by vegetation. In Cam Le, maintenance and sanitation were reported as insufficient, particularly in small parks located in newly developed residential areas.

Regarding design expectations, residents across all three districts expressed a preference for soft, organic layouts (e.g., curved pathways, tiered spaces) and natural color schemes (green, brown, gray), reflecting a desire to harmonize with nature. The most highly prioritized amenities included public restrooms, Wi-Fi, refreshment kiosks, phone charging stations, and seating - demonstrating a clear need for convenience and practical functionality in UGS use (Figure 4).

Overall, the chart analysis shows that green space usage behaviors and expectations vary significantly among districts, depending on demographic characteristics, infrastructure conditions, and local living needs. These findings provide a practical foundation for guiding the design of flexible, equitable, and context-sensitive green space models.

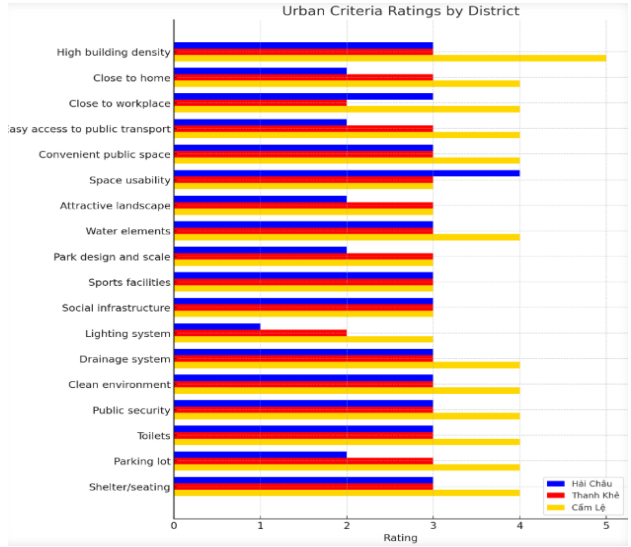

Figure 4. *Median Perceived Disamenities by District (Hai Chau, Thanh Khe, Cam Le), Da Nang*

4. Results

This study analyzed the level of access to urban green spaces in the three districts of Hai Chau, Thanh Khe, and Cam Le in Da Nang City, identifying influencing factors and proposing a prototypical green space model to ensure equitable and effective use

4.1. Assessment of current status and accessibility of green space

The study analyzed urban green space (UGS) accessibility in the three districts of Hai Chau, Thanh Khe, and Cam Le in Da Nang City, identifying key influencing factors and proposing a prototype model to ensure equity and efficiency in green space use. Survey results revealed significant disparities in the spatial distribution of green spaces among the districts. Hai Chau had a higher park density, providing residents with more convenient access. In contrast, Thanh Khe and Cam Le had more limited green space areas, especially at the neighborhood level. Based on GIS data analysis and field surveys, the research team identified several critical issues:

- Green space density falls short of planning standards: The per capita green space area in all three districts is below the minimum threshold recommended by the World Health Organization (WHO) of 9m²/person.

- Uneven access to green spaces: Central urban areas have significantly better access compared to suburban or peripheral zones. This disparity is influenced by historical urban planning decisions, rapid urban development pressures, and current land policies in Da Nang.

- Insufficient public infrastructure and amenities: Some parks lack essential facilities such as playgrounds, walking paths, and public restrooms, which limits their usability and attractiveness to residents. Furthermore, a lack of community participation in design and management contributes to the ineffective utilization of some newly developed parks.

- Diverse awareness and usage needs: Younger individuals tend to use green spaces for physical activities

such as walking or cycling, whereas the elderly and children face more challenges in accessing these areas due to mobility limitations and facility shortages.

4.2. Technological approaches to UGS design and management

Based on the results of factor analysis, the study proposes a number of technological solutions in the design and management of urban green space systems, including:

- Application of technology in analysis and planning:

+ Use ArcGIS combined with OpenStreetMap data to analyze real-world access networks. This approach is highly feasible as such geospatial data is readily available or can be efficiently collected [11].

+ Applying the UGS service zoning model according to the travel radius of different population groups (children, elderly people...).

+ Integrate sensor data (IoT) to measure air quality, humidity, light, and noise in the park. The integration of IoT sensors and the development of digital mapping applications are prevalent trends in smart cities globally and can be implemented in phases.

- Innovation in green space design integrated with traffic:

+ Design green bicycle lanes connecting to parks, with rest stops and shade trees.

+ Build green corridors connecting small UGSs together instead of focusing on large parks [12].

+ Incorporate smart bus stops at park gates to increase accessibility.

- Smart operation and management solutions:

+ Build an interactive digital map system, integrating real-time data on user density, community events, and park sanitation status.

+ Create a digital UGS management platform that allows urban authorities, citizens and designers to jointly monitor, reflect and propose improvements.

4.3. Proposed model of exemplary green space:

Based Based on the factor analysis results, the study proposes several technology-driven solutions for the design and management of urban green space (UGS) systems, including:

- Technology applications in analysis and planning:

+ Utilize ArcGIS in combination with OpenStreetMap data to analyze actual access networks [11].

+ Apply UGS service area zoning models based on the mobility ranges of different population groups (e.g., children, the elderly).

+ Integrate sensor (IoT) data to monitor environmental conditions such as air quality, humidity, lighting, and noise levels within parks.

- Innovative UGS design integrating transportation:

+ Design green bike lanes connecting parks, with shaded rest stops.

+ Develop green corridors linking smaller UGS units rather than focusing solely on large parks [12].

+ Integrate smart bus stops at park entrances to enhance accessibility.

- Smart operation and management solutions:

+ Develop an interactive digital mapping system that integrates real-time data on user density, community events, and park sanitation status.

+ Create a digital UGS management platform enabling collaboration among urban authorities, residents, and designers for monitoring, feedback, and improvement suggestions.

4.4. Proposed prototype for neighborhood green space

Based on the analytical findings, the research team proposed a prototype model for neighborhood-scale UGS with the following key criteria:

- Equitable access: Ensure that every resident has access to green spaces within a reasonable distance (300–500m for neighborhood parks, 500–1000m for district-level parks) [13].

- Multifunctional integration: Green spaces should not only serve aesthetic purposes but also meet demands for recreation, physical activity, and community interaction.

- Optimized design and amenities: Elements such as shaded trees, pedestrian pathways, rest areas, phone charging stations, public Wi-Fi, and clean restrooms should be considered to enhance user experience.

- Technology and GIS-based integration:

+ Apply digital technology for planning, monitoring, and real-time evaluation of green space usage.

+ Develop smart-integrated green mobility: the park core should include recreational and community areas, equipped with environmental IoT sensors that display live data via digital boards.

+ Augmented/virtual reality (VR) applications can also be implemented to enrich user engagement.

The research team utilized architectural software such as 3DMax, SketchUp, and Enscape to develop a 3D prototype of neighborhood green space, identifying key typologies tailored to specific usage needs. The model is designed to ensure equitable access for all residents while facilitating easy, enjoyable, and practical use of green infrastructure (Figure 5). The model includes the following functional zones:

- A1 – Basic amenities and public services: Refreshment kiosks, phone charging stations, electric vehicle chargers, automated public restrooms, pet-friendly zones.

- B1 – Natural landscapes and relaxation areas: Gardens, ponds, and outdoor seating spaces.

- C1 – Public and outdoor activity spaces: Sports areas, playgrounds, and pedestrian streets.

- D1 – Mobility and spatial orientation: Safe walking paths, bus stops, and bicycle parking areas.

- E1 – Lighting and architectural/technological highlights: Lighting systems, light/sound sensors, water features, and ornamental structures.

The development of green spaces should follow this

priority structure to optimize accessibility and usability, contributing to improved living environments and promoting smart, sustainable urban development.

Location A1, B1, C1, D1, E1 in USG KDC

E1 View to the fountain (Focus pattern, water surface)

C1 View of outdoor play space (activity space model)

B1 View to the relaxing seating space (Outdoor seating model)

A1 View to service counter + Environmental IoT Sensor (model of Drink and Snack Counter + technology equipment)

B1 View to the relaxing seating space combined with a canopy with a Solar panel model outdoor seating)

B1 View to relaxing seating space + Technology parking lot (outdoor seating model + bicycle/electric vehicle parking lot)

E1 View to the landscape (path shape model)

B1 View to the seating space by the lake (low wall model for sitting)

B1 View to the relaxing seating space (ceiling walkway model with gaps, water permeability)

Figure 5. *3D prototype of neighborhood green space*

5. Conclusion

The study of green space distribution and public accessibility in the districts of Hai Chau, Thanh Khe, and Cam Lein Da Nang City is essential for assessing the current situation, identifying influencing factors, and proposing effective improvement solutions. Through field surveys, quantitative data collection, and statistical analysis, the research provides a comprehensive understanding of public access to and usage of urban green spaces. The findings indicate an uneven distribution of green spaces, which negatively affects residents' satisfaction. Key factors such as environmental quality, transportation infrastructure, and the availability of public amenities play a vital role in enhancing the effective use of green spaces. In addition, the study offers valuable reference data for urban planners and designers to propose optimized solutions aimed at developing a sustainable urban green space system that meets the actual needs of residents. The results consistently show that disparities in green space distribution impact user satisfaction, and that factors such as environmental quality, transport infrastructure, technological integration, and public amenities are crucial for improving the effectiveness and inclusiveness of green space utilization.

Acknowledgements: This work was supported by The University of Danang - University of Science and Technology, code number of Project: T2024-02-43.

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