Jordan Journal of Civil Engineering, Volume **20**, No. **4**, **2026**
DOI: https://doi.org/10.14525/JJCE.v20i4.06

Jordan Journal of Civil Engineering

Journal homepage: https://jjce.just.edu.jo

The Role of Natural Visual Environment in Activating Public Spaces in Erbil

Hana Shakir Issa [1)*]**, *Shaymaa Fadhil Alkubaisi*** [1)]

[1)] *Architectural Engineering Department, Faculty of Engineering, Koya University, Danielle Mitterrand Boulevard, Koya KOY45, Kurdistan Region, Iraq. * Corresponding Author. Email: hana.shakir@koyauniversity.org*

ARTICLE INFO

Article History:
Received: 21/10/2025
Accepted: 14/6/2026

ABSTRACT

This study examines associations between natural visual environments (greenery and water features) and users' perceived activation outcomes in urban public spaces in Erbil, Iraq. Using a cross-sectional, observational mixed-method design with 200 user surveys and systematic field observations across five public parks, outcomes included social interaction, livability/usability, safety/security, cultural identity/diversity, and psychological comfort. The data was analyzed using descriptive statistics, regression, and mediation analysis. Parks with higher observed green-blue input presence and operability were associated with higher mean user-reported activation outcome scores with effect sizes of eta squared 0.430 to 0.531 and Hedges' *g* values of 1.04 to 1.84. In multivariable models, trees/greenery had the largest standardized associations with social interaction and livability/usability, while water features were positively associated with cultural identity and perceived safety/security, and psychological comfort statistically mediated the observed associations between green-blue inputs and user-reported activation outcomes. Given the cross-sectional design and self-reported measures, findings are interpreted as associations rather than causal effects. This study contributes to environmental psychology theory and climate-responsive urban design by specifying perception-based design and maintenance priorities for public-space activation in climate-stressed settings.

Keywords: Arid climate urban design, Erbil, Green-blue infrastructure, Natural visual environment, Psychological comfort, Public space activation.

INTRODUCTION

Urban public spaces are essential to modern city life as regular places for cultural expression and social interaction (Gehl, 2010). Their performance reflects both user experience and spatial configuration. While Carmona et al. (2003) described how the layout of streets, buildings, and open areas relates to visual comprehension and sensory quality, Lynch (1960) highlighted legibility and imageability as perceptual foundations of urban form. In this study, green-blue attributes are treated as environmental inputs, and "activation" refers to user-reported outcomes that co-occur with staying and engagement.

However, in hot arid/semi-arid cities, activation is often constrained by thermal usability and diurnal comfort windows, which increases the practical relevance of shade-providing vegetation and operable water features. Erbil, the capital of Iraq's Kurdistan Region, combines a historic core around the Citadel with rapid post-2003 corridor growth coinciding with increased pressure on usable and well-managed public amenities (Ibrahim et al., 2015; Khoshnaw & Kissfazekas, 2018). Empirical evidence from

Kurdish/Iraqi cities remains comparatively scarce on how distinct green (trees/greenery) and blue (water features) inputs are associated with multidimensional user-reported activation outcomes (social interaction, livability/usability, safety/security, and cultural identity) and whether psychological comfort statistically mediates the observed associations. To address this gap, the study compares five Erbil parks with contrasting green-blue conditions using an explicitly associative, cross-sectional, mixed-method design.

LITERATURE REVIEW

This review positions the study within environment-behavior research and environmental psychology, where public-space activation and user experience are examined through relationships between environmental inputs, perceptual mechanisms, staying-related behaviors, and user-reported activation outcomes. In arid and semi-arid cities, these relationships are further conditioned by climate-responsive design and management factors that constrain and structure the feasibility of sustained outdoor use. Accordingly, the review synthesizes evidence from public-space urban design (activation/social life as use intensity, staying, and activity diversity), environment-behavior research (use-enabling conditions linking setting attributes to use patterns), and environmental psychology (restoration and comfort appraisal as perceptual mechanisms) into a single explicitly associative input –mechanism–outcome pathway for arid/semi-arid public spaces (Figure 1).

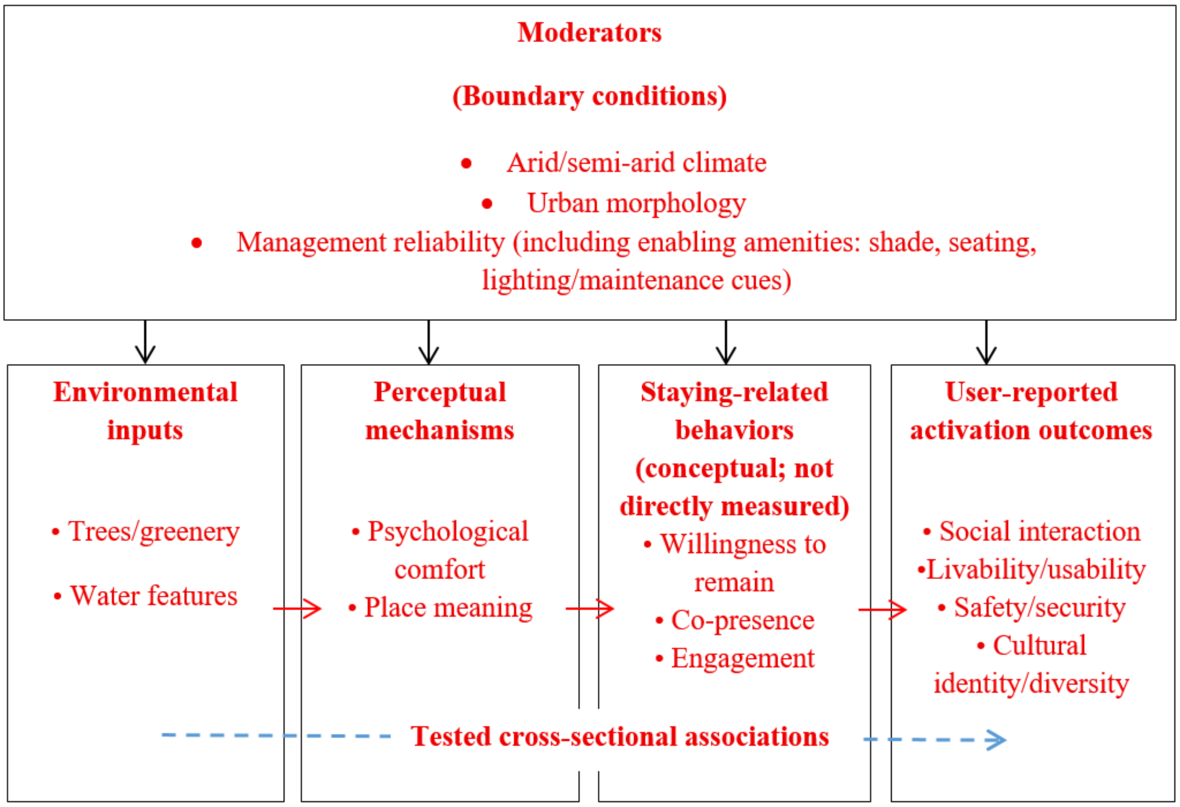

Figure 1. Conceptual framework linking environmental inputs to user-reported public-space activation outcomes through perceptual mechanisms and staying-related behavior

Note: *Solid arrows depict the hypothesized pathway; dashed arrows indicate empirically tested cross-sectional associations. Psychological comfort is evaluated as a statistical mediator in the specified models between environmental inputs and activation outcomes, while contextual moderators are theorized to condition the pathway.*

Conceptual Framework

This study adopts an environment, perception, behavior, and activation pathway. Trees/greenery and water features are treated as environmental inputs;

psychological comfort and place meaning are modeled as perceptual mechanisms; and activation is operationalized via user-reported social interaction, livability/usability, safety/security, and cultural identity/diversity (Figure 1). The framing is explicitly associative, consistent with the cross-sectional observational design. Behavior is conceptualized as staying-related tendencies (e.g., willingness to remain, co-presence, and engagement) that are reflected in user-reported activation outcomes rather than measured as objective behavioral counts. The pathway is anticipated to be conditioned by boundary conditions, such as an arid/semi-arid climate, urban morphology, and management reliability (including shade, seats, and lighting), as depicted in Figure 1.

Public-space Theory and Activation

Public-space activation is commonly understood through use intensity, length of stay, activity diversity, and sustained social life (Whyte, 1980; Gehl, 2011). Operationally, activation indicators are sensitive to environmental conditions and enabling amenities, such as seating, shade, and management reliability (Mehta & Bosson, 2021). Contemporary scholarship further emphasizes that activation is associated not only with design quality, but also with accessibility, inclusiveness, and long-term management/stewardship, which are often associated with how spaces are used and experienced in practice (Li et al., 2022). Accordingly, activation is treated as a user-reported outcome domain for comparative interpretation across parks, rather than as an objective behavioral count metric.

Thermal Comfort and Climate as Constraints on Activation

Thermal exposure and diurnal comfort windows constrain activation in hot, dry, and semi-arid cities; consequently, microclimatic performance is closely linked to outdoor usability (Nikolopoulou & Steemers, 2003; Hassan & Kawther, 2021). According to studies conducted in Iraqi contexts, vegetation-based mitigation has been associated with improved outdoor comfort (Salman & Saleem, 2021), and Erbil studies show that use concentrates in vegetated and shaded areas, which is consistent with time-shifted visitation under hot conditions (Ali et al., 2019). Psychological comfort is emphasized as a key perceptual pathway linking heat-mitigating attributes to user-reported activation outcomes.

Social Interaction

Comfortable staying conditions are associated with longer stays and more varied social behavior (Shedid & Hefnawy, 2022). In Iraqi cities, common areas and walking/cycling-supportive environments are associated with everyday social communication (Tareq & Al-Kindy, 2025), while active edges and services may reinforce liveliness where infrastructural conditions enable lingering (Rahman et al., 2020). This is consistent with interpreting between-park differences in social interaction in relation to staying-supportive environmental and infrastructural conditions.

Safety and Security

Perceived safety is crucial for the use and continued visitation in many settings, especially during the evening when visibility and lighting become critical factors. Findings from Iraqi urban studies link perceived safety to legible paths, maintenance quality, and lighting adequacy (Hajiyat et al., 2021). This aligns with the Crime Prevention Through Environmental Design (CPTED) mechanisms that emphasize surveillance, territoriality, access control, and maintenance cues (Cozens et al., 2005). Kurdistan Region studies similarly connect park safety perceptions to lighting and management reliability (Musheer et al., 2024). Perceived safety/security is interpreted alongside documented lighting and maintenance cues as salient safety-related signals for users.

Cultural Identity and Place Attachment

Cultural identity and place meaning are associated with how users value public spaces and place attachment is often linked to revisit intentions and ongoing engagement. Symbolic anchors and coherent visual cues can be associated with belonging and perceived identity (Fathi & Heidari, 2018; Zhang et al., 2024), consistent with multidimensional models of place attachment (Scannell & Gifford, 2010). In parks, historically meaningful settings may therefore reinforce shared memory and engagement (Bazrafshan et al., 2021). Cultural identity/diversity is measured as an activation dimension linked to context-specific symbolic cues.

Green-Blue Infrastructure as Comfort and Restorative Infrastructure for Activation

Green-blue infrastructure is conceptualized as multifunctional urban infrastructure due to its thermal moderation and restorative co-benefits in climate-stressed cities (Tzoulas et al., 2007). Prior work linked exposure to green and blue elements to affect and well-being mechanisms that plausibly align with higher comfort appraisal and willingness to stay (Mishra et al., 2020; White et al., 2020). In arid Middle Eastern contexts, the contribution of water features depends on operability and maintenance (Alshira'h, 2022), consistent with restoration-oriented interpretations that motivate modeling psychological comfort as a mediator (Kaplan & Kaplan, 1989). In this study, trees/greenery and water features are treated as distinct inputs.

Overall, the literature converges on a single, testable pathway for arid/semi-arid cities in which environmental inputs (green-blue attributes) and boundary conditions (management reliability, including enabling amenities) associated with higher user-reported activation outcomes partly via psychological comfort appraisals, within the associative framework. The present study evaluates this associative pathway across five Erbil parks by distinguishing green *versus* blue inputs under operability constraints and testing psychological comfort as a statistical mediator of observed input-outcome associations; the theoretical advance is the disciplined integration of public-space "social life" theory, restoration/comfort appraisal, and CPTED safety cues into one context-sensitive input → mechanism → activation specification.

Research Gap

Comparative, multi-park studies in hot arid/semi-arid cities that use matched user-reported activation measures and separate green (trees/greenery) from blue (water features) inputs under operability constraints remain relatively scarce, particularly in Kurdish/Iraqi contexts. Existing work often examines thermal usability, comfort/restoration, and CPTED-consistent safety cues in parallel and rarely evaluates psychological comfort as a statistical mediator of associations between environmental inputs and activation outcomes. Accordingly, this study uses a comparative design across five Erbil parks to examine associations between separated green and blue inputs and multidimensional user-reported activation outcomes, and to assess psychological comfort as a statistical mediator.

RESEARCH METHODOLOGY

Research Design and Approach

A mixed-method, convergent design was used to examine associations between green-blue infrastructure (as perceived/observed environmental inputs) and public-space activation outcomes in Erbil. Survey-based measures were analyzed alongside structured field observations and spatial documentation to contextualize perceptual and behavioral evidence across five parks. By employing the study framework, the approach allows park-level comparisons while retaining contextual interpretation through observed site circumstances.

Study Area Context

Erbil is organized around the Citadel (Qala) as a historic center (Ibrahim et al., 2015). As the capital of the Kurdistan Regional Government and one of Iraq's major cities, it serves as the Kurdistan Region's primary administrative center and a major metropolitan service hub within northern Iraq's regional urban system (Encyclopaedia Britannica, 2025). Since 2003, the city has expanded rapidly, reshaping public-space distribution, mobility corridors, and socio-spatial differentiation (Khoshnaw & Kissfazekas 2018). Kurdistan Region statistics reported a total population of 6,556,752 in 2023 (urban: 5,142,526) and an Erbil Governorate population density of 161 people/km² in 2023 (Kurdistan Region Statistics Office, 2023a, 2023b). Socio-economic indicators for Erbil Governorate reported unemployment of 17.7% in 2021 and poverty of 6.7% in 2018, and housing tenure is predominantly owner-occupied (75.4% of households in 2012) (Kurdistan Region Statistics Office, 2021; Kurdistan Region Statistics Office, 2018; Kurdistan Region Statistics Office and Central Statistics Organization, 2014). Climatically, Erbil's hot arid/semi-arid conditions are associated with strong seasonal and diurnal constraints on outdoor comfort; July maxima are ~41–42°C with low humidity (low-20% range), while winter normal are cooler (January: 11.9°C high; 5.2°C low) with higher humidity (~57%) and typical monthly rainfall of ~58 mm (Kurdistan Region Statistics Office, 2022; Weather Atlas, 2024). Rainfall is highly seasonal, and periodic drought pressure can constrain irrigation supply and the continuous operation of fountains and lakes; thus, any potential cooling/restorative roles of blue infrastructure may be contingent on reliable water management and maintenance rather than nominal presence (Hama et al., 2014; World Bank, 2021). Accordingly, shade continuity and water-feature operability were documented for each site (Table 1). The five parks span distinct urban-morphological settings (historic core/CBD area, corridor/neighborhood, and peripheral expansion-corridor), providing contrasting location contexts for comparison. Transferability is discussed in relation to cities with broadly comparable arid/semi-arid constraints, rapid metropolitan growth, and maintenance-dependent green-blue amenities, particularly within similarly structured regional administrative/service centers.

Table 1. Contextual characteristics of the five case-study parks in Erbil

Attribute	Shar Park	Gilkand Park	Minara Park	Peshmargah Park	Zanyari Park
Location	South foot of the Erbil Citadel (Qala't), city center	30-Meter (Barzani Namr) St., near Erbil Int'l Hotel (Sheraton), opposite Univ. of Kurdistan	Halabja Rd., near the city center.	100-Meter Rd. corridor (~8 km north of city center)	30-Meter (Barzani) St. and Mahata St.; within the Shanadar Park sequence
Area (m²)	6,200	71,000	80,000	189,078	8,200
Accessibility & connectivity	Highly permeable pedestrian-oriented access, multiple bazaar lanes, and arterial frontage on Kirkuk Rd.	Good vehicular/transit access via 30-Meter St.; constrained pedestrian environment; key gate; desire line closure; parking pressures	Multiple gates, landmark-based wayfinding, strong linkage to street grid, and traffic exposure along Halabja Rd. affect edge comfort	Regional accessibility via 100-Meter Rd., multiple pedestrian gates; available parking, and strong district-level linkages	Neighborhood walkability via Zanyari St. /Barzani, sidewalks and local active edges, and limited arterial connectivity
Surrounding land use/edges	Historic-commercial, religious, and civic functions; tourism-oriented edges.	Commercial corridor with university/institutional and residential buildings, and municipal offices.	Government offices, commercial entities, residential buildings, and cultural facilities.	Predominantly residential and retail with institutional facilities.	Residential fabric with local shops, cafés, and everyday services.
District socio-economic context (proxy)	Historic core/CBD; tourism–bazaar economy; high pedestrian intensity and diverse daily users.	Inner-city commercial-institutional corridor; higher service intensity and visitor flow.	Near-center administrative/ civic corridor; mixed surrounding residential catchment.	Peripheral expansion-corridor metropolitan park; destination-scale catchment with car-oriented access.	Neighborhood-scale park in an older residential area; predominantly local users.
Green infrastructure	Compact planting and flower beds; localized microclimatic relief	Substantial mature tree canopy; green cover and flower beds	Trees, flower beds, lawns, and shading supported by tree cover	Extensive lawns/gardens, flower beds, and substantial mature tree canopy	Gardens and lawns, shaded walkways, and flower beds
Blue infrastructure (water)	The Citadel fountain system was functional (during the survey period); it was a major	Water features present but frequently non-functional (during the survey period)	Intermittent operation; frequently off (during survey period)	Two lakes plus connected fountains/streams (functional during the survey period)	Small fountains, frequently non-functional (during survey period)

	cooling/attraction anchor.				
Shade availability	Low-moderate	Moderate-high	Moderate-high	High	Moderate
Lighting & maintenance	Lighting: adequate; Maintenance: high; active edges	Lighting: weak; Maintenance: low; limited night use	Lighting: patchy; Maintenance: moderate-low; fountain issues constrain evening use	Lighting: good; Maintenance: high; consistent with long stays during the observation window.	Lighting: patchy; Maintenance: low–moderate; reduced night accessibility
Observed evening attendance (weekday field headcount, 17:00–22:00; typical range → peak)	~100 → 250–300+ (peak)	~10 → ~25 (peak)	~30-40 → ~50–60 (peak)	~70–100 → ~200–250 (peak)	~20–25 → ~35–40 (peak)

Note: *District socio-economic context is reported as a proxy (centrality, development pattern, service intensity, catchment), not household income. Water-feature status reflects observed operability during the survey period and may vary with seasonal water availability and maintenance. Headcounts are approximate simultaneous users recorded during repeated weekday visits (June–August 2025); peaks varied by park and weekends were generally higher. No archival attendance records were available.*

Case Study Parks and Site Selection

Five public parks Shar, Gilkand, Minara, Peshmargah, and Zanyari were selected to represent variation in green-blue infrastructure and activation-relevant conditions. Figure 2 maps the sites and highlights three contrasting urban contexts (historic core/CBD, corridor/neighborhood, and peripheral expansion-corridor). Functional diversity (walking, sitting, family use, social gathering), accessibility/connectivity (legible entry points and network reachability), and the visible and functional condition of natural elements (tree canopy/greenery and water features) were the criteria prioritized in the study. These criteria were prioritized, because they align with the study framework and are commonly linked to public-space use/activation in urban design and environment-behavior research (e.g., Whyte, 1980; Carmona et al., 2003; Gehl, 2011), while other contextual factors (e.g., size, surrounding land use, socioeconomic context, and maintenance/management conditions) were documented for interpretation (Table 1) rather than used as inclusion filters. All five sites are widely recognized reference parks within Erbil's public-space network, supporting interpretable cross-park user ratings despite differences in area. Accordingly, between-park comparisons are defined at the respondent level within comparable evening sampling windows, rather than as estimates of total visitation or per-unit-area intensity. Area and headcount ranges are reported descriptively (Table 1) to contextualize capacity and relative popularity during the dominant use window, not as modeled predictors. Urban-morphological setting is likewise reported for interpretation, but not modeled, because standardized objective morphology metrics were not measured across the five sites.

Data Collection Instruments and Procedures

Data was collected using two questionnaires and systematic field observation**.** The primary questionnaire measured social interaction, livability/usability, perceived safety and security, cultural identity and diversity, and psychological comfort, alongside user characteristics and improvement priorities. A second comparative instrument asked respondents to rate the five parks directly using uniform criteria to strengthen between-park assessment. Measures were selected from environment-behavior and environmental psychology literature to fit the Erbil context and the study's input–mechanism–outcome framework. Responses were recorded on a five-point percentage Likert scale (0%, 25%, 50%, 75%, 100%) and were administered in Kurdish, Arabic, and English. Construct scores were computed as item averages after these responses were coded on a 1–5 scale (1 = 0%, 5 = 100%) for analysis. Observations and approximate headcounts were conducted during June–August 2025, primarily in the dominant evening window (17:00–22:00), using field notes and photographic documentation to document shade/light conditions, crowd density, movement/staying behavior, and amenity operability (particularly water features and lighting cues). Since no publicly available or archival/official standardized daily or annual visitation figures could be found for any of these locations, repeated weekday evening headcounts conducted during the survey period (recording typical ranges and observed peaks of visible users in main activity areas and primary circulation paths for each park) are reported only as a time-bounded proxy of relative popularity during the dominant use window (Table 1), not as total daily/annual attendance, and are interpreted as an order-of-magnitude indicator of peak-period evening attendance rather than full-day or annual totals.

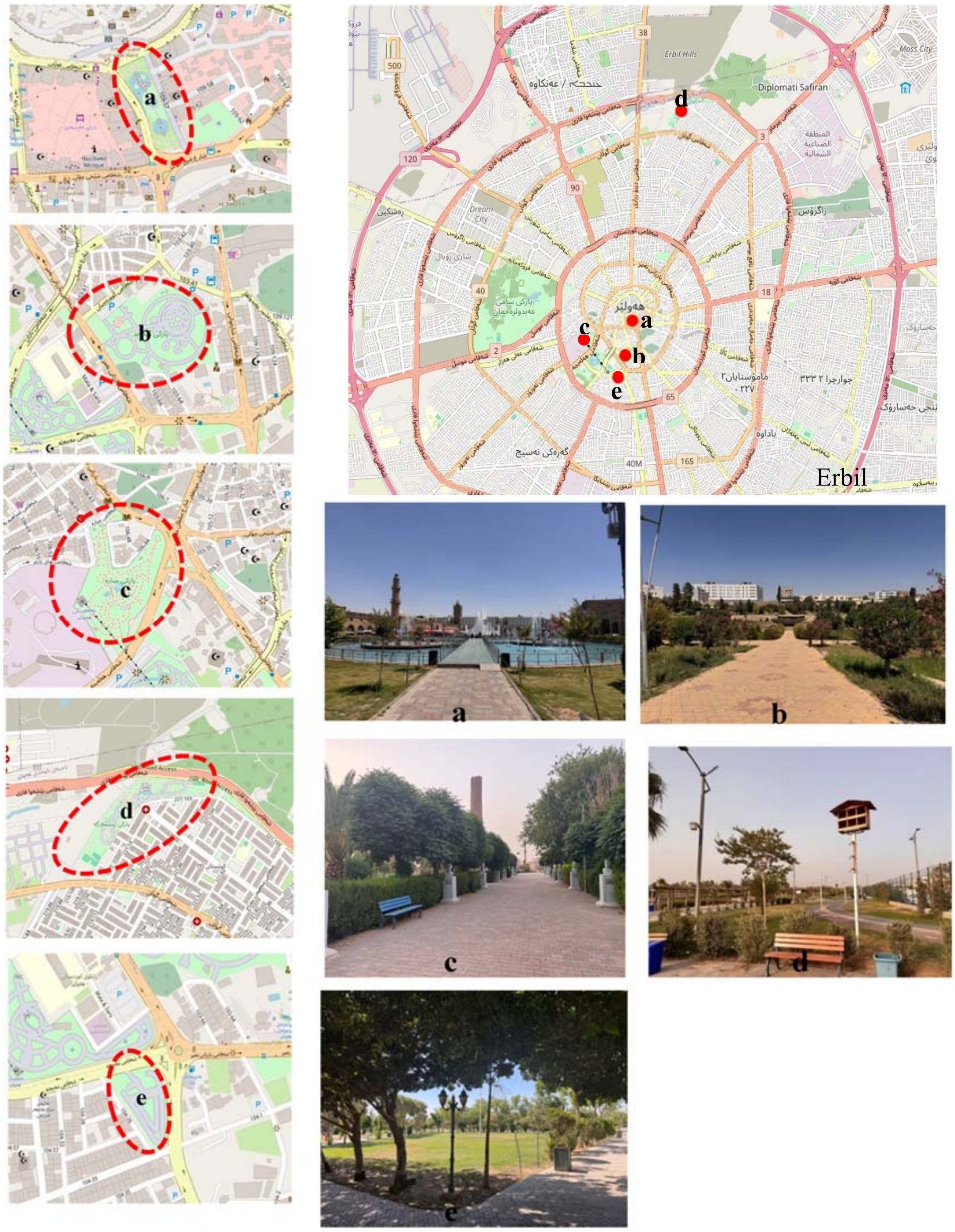

Figure 2. Locations of the five case-study parks in Erbil (a = Shar, b = Gilkand, c = Minara, d = Peshmargah, e = Zanyari), selected to represent contrasting urban contexts and surrounding edges (central heritage-adjacent, commercial corridor, and peripheral settings). Base map: OpenStreetMap contributors; site photographs by the authors

Sample Size and Sampling Strategy

A total of 200 park users were surveyed using an equal number of 40 respondents per park to enable balanced between-park comparisons using matched user-report measures. This equal allocation was selected to allow a stable per-park sample while remaining feasible across the five sites. Time-location sampling strategies were used to recruit participants, targeting eligible users during specified time blocks at key sites of intercept (main entry and principal circulation nodes). Every third eligible person was intercepted after a first random start, and non-responders were followed by the next eligible person in line. Eligible participants comprised park users across age groups present at the time of intercept; for respondents under 18, participation proceeded only when accompanied by a guardian, using guardian consent and minor assent.

Data Analysis Methods

The study used descriptive statistics with inferential methods appropriate for association testing and between-park comparison. Welch ANOVA, Games-Howell *post-hoc* tests, independent t-tests, Pearson correlations, OLS regression with robust standard errors, and bootstrap mediation analysis were implemented. Welch-based methods were used to assist inference under unequal variances, and effect sizes were reported to quantify practical magnitude. Effect sizes were interpreted using conventional thresholds (η^2: 0.01 small, 0.06 medium, 0.14 large; Hedges' g: 0.20 small, 0.50 medium, 0.80 large, >1.20 very large) to describe the magnitude of observed differences/associations and not to imply causal effects (Cohen, 1988; Lakens, 2013). Participation was voluntary and predicated on informed consent, and respondents were free to discontinue participation at any moment without facing any repercussions.

RESULTS

Usage Patterns and Characteristics of Respondents

In total, 200 respondents were questioned: 40 per park. The sample distribution was 56% males and 44% females across all parks. Age distributions were mainly in the 30-45-year group at 38%, while the 46-60-year group comprised 27.5%, with younger and older groups also represented (18–29: 20.0%; under 18: 7.0%; over 60: 7.5%). These shares reflect intercepted respondents rather than a census of all users; during family-group visits, an accompanying adult typically completed the questionnaire, which likely reduced the representation of children/adolescents among respondents despite their presence during the sampling window, rather than indicating non-attendance by younger users. Over 71% of respondents had stayed in Erbil for more than 10 years, which indicates that responses are more representative of residents who have stayed long rather than transient visitors. Visit patterns were primarily classified as informal/recreational visits 48.5%. Evening visits of 89.5% and nighttime visits of 46% were considerably higher than either morning visits at 5.5% or midday visits at 4.5%. These temporal patterns were also consistent with field observations, with higher user concentrations occurring from 18:00-22:00, especially in covered or green areas. Weekday evening headcounts during the dominant use window (17:00-22:00) are summarized in Table 1 and indicate higher relative evening popularity in Shar and Peshmargah, moderate levels in Minara and Zanyari, and lower levels in Gilkand, serving as a time-bounded proxy for cross-park popularity. The most common reasons given by respondents for using parks were restorative and nature-related: relaxation (62%) and connection with nature (51.5%) were followed by aesthetic enjoyment (40%) and family activities (39.5%); socialization (28.5%) and exercise (26.5%) were reported less frequently. Accordingly, the most popular park feature was vegetation (71%), which was followed by water features (36%) and comfort-promoting amenities, like sitting and shade (56%). Scale reliability was acceptable to excellent (Cronbach's α = 0.720–0.847).

Park-level Mean Scores across Natural Environment Inputs and Activation Outcomes

Park-level mean scores were summarized using descriptive means (±SD) and visualized across dimensions. Table 2 and Figure 3 display marked between-park differences in user-reported activation outcomes and natural-environment input ratings: Shar and Peshmargah reported higher mean scores across social interaction, livability/usability, and safety/security, whereas Gilkand and Zanyari reported lower mean scores; Minara is mid-range overall, but comparatively higher on cultural identity (M = 3.97). This high-low clustering is consistent with the study's conceptual framework (Figure 1), in which multiple environmental inputs and enabling conditions (Table 1) are expected to co-occur with higher user-reported activation outcomes through perceptual mechanisms, rather than reflecting a single isolated feature. Field observations descriptively were consistent with this pattern, noting longer stationary stays and more intergenerational co-presence around shaded seating and operable water features in higher-scoring parks, while lower-scoring parks showed more passage-dominated use and shorter-duration presence.

Table 2. Mean scores of activation outcomes and natural-environment input ratings across parks (N=200)

Parks	Social Interaction Mean (SD)	Livability & Usability Mean (SD)	Safety & Security Mean (SD)	Cultural Identity Mean (SD)	Natural Environment Mean (SD)
Bakhi Shar	4.02 (0.46)	3.91 (0.44)	3.56 (0.26)	4.09 (0.35)	4.02 (0.53)
Gilkand	3.17 (0.54)	3.09 (0.41)	2.92 (0.43)	3.00 (0.54)	2.75 (0.42)
Minara	3.54 (0.52)	3.31 (0.55)	3.09 (0.35)	3.97 (0.44)	3.41 (0.57)
Peshmargah	3.97 (0.73)	3.85 (0.67)	3.62 (0.23)	3.05 (0.46)	3.90 (0.55)
Zanyari	3.53 (0.54)	3.10 (0.68)	3.02 (0.37)	2.76 (0.73)	3.10 (0.64)

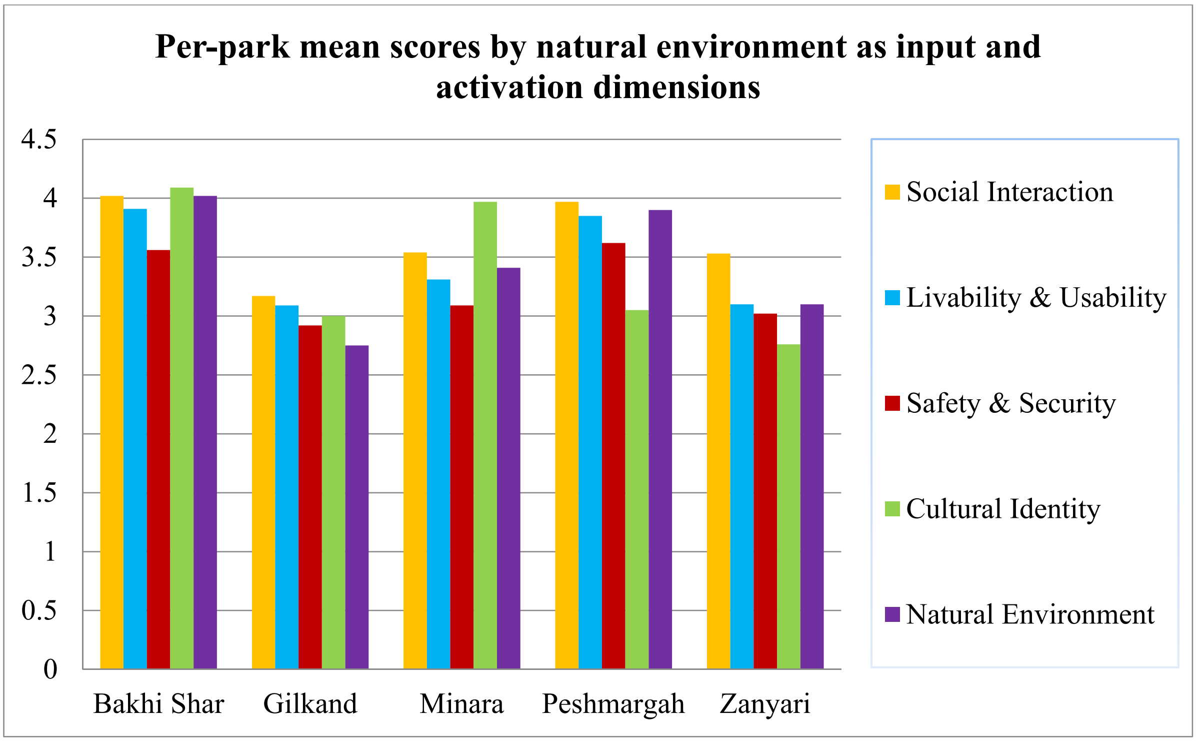

Figure 3. Per-park mean scores (±SD) across activation outcomes (SI, LU, SS, CI), with natural environment shown as an input rating for comparison (not an activation outcome)

Between-park Differences in Activation Outcomes

Between-park differences were tested using Welch ANOVA to accommodate unequal variances (Table 3). All activation outcomes differed significantly across parks, with the largest between-park variation observed for cultural identity ($\eta^2 = 0.531$; $\omega^2 = 0.520$). These effect sizes were large by conventional thresholds ($\eta^2 \geq 0.14$; see Methods), indicating that park-to-park differences were consistently observed and meaningful within this sample, consistent with the interpretation that activation outcomes co-vary with broader park quality and enabling conditions rather than reflecting isolated strengths in single dimensions.

Table 3. Welch's ANOVA results for activation outcomes and natural-environment input ratings (N=200)

Measured Dimension (Outcome/Input)	Welch's F	df_1, df_2	p-value	η^2	ω^2	Effect Size
Social Interaction/outcome	16.75	4, 97.09	< .001	0.241	0.224	Large
Livability & Usability/ outcome	25.25	4, 96.48	< .001	0.296	0.281	Large
Safety & Security/ outcome	41.96	4, 96.23	< .001	0.430	0.417	Large
Cultural Identity/ outcome	65.26	4, 96.33	< .001	0.531	0.520	Large
Natural Environment (input rating)	47.37	4, 96.98	< .001	0.442	0.429	Large

***Note**: η^2 magnitude labels follow Cohen thresholds (0.01 small, 0.06 medium, 0.14 large); values above 0.14 are reported as large.*

Associations between Natural-Environment Inputs and Activation Outcomes

To quantify practical magnitude, parks were contrasted as higher *versus* lower natural-environment input-rating groupings (Shar/Peshmargah *vs.* Gilkand/Zanyari; Minara excluded to maximize contrast). Higher natural-environment input-rating parks exhibited significantly higher mean scores than lower input-rating parks across activation outcomes with differences that were consistently large (Hedges' g = 1.04–1.84); the largest separation was for perceived safety/security (g = 1.84) (see Appendix Table A1). These between-group differences are interpreted as cross-sectional co-occurrence patterns: higher rated green-blue conditions co-occurred with higher user-reported activation outcomes. This interpretation is also descriptively consistent with observed evening use concentrating around shaded seating and operable amenities (Table 1).

Appendix Table A1. Higher versus lower natural-environment input-rating parks: descriptive and inferential results (Welch t-tests; N = 160)

Outcome Variable	Higher input-rating Mean ± SD	Lower input-rating Mean ± SD	Mean Difference [95% CI]	Hedges' g	p-value
Social Interaction	3.99±0.61	3.35±0.57	0.64 [0.46, 0.83]	1.09	<0.001
Livability & Usability	3.88±0.56	3.10±0.56	0.79 [0.61, 0.96]	1.40	<0.001
Safety & Security	3.59±0.25	2.97±0.40	0.62 [0.51, 0.72]	1.84	<0.001
Cultural Identity	3.57±0.67	2.88±0.65	0.69 [0.48, 0.89]	1.04	<0.001

Connections between Activation Dimensions and the Natural Environment

Pearson correlations indicated that the Natural Environment (input) score was positively associated with all activation dimensions (all p <0.001). The strongest correlation was with livability and usability (r = 0.759), followed by social interaction (r = 0.651) and safety and security (r = 0.602) and it was moderate for cultural identity (r = 0.478). Ordinary least squares regression estimated adjusted associations between natural environment elements and activation dimensions; associations were strongest for livability and usability (β = 0.677) and social interaction (β = 0.536), while associations for safety (β = 0.385) and cultural identity (β = 0.255) were moderate, but still significant.

Multiple regression separated the natural environment into greenery/trees and water features. In adjusted models, greenery/trees showed stronger associations with social interaction (β = 0.411) and livability/usability (β = 0.398). Water features had significant adjusted associations with livability/usability (β = 0.342), safety/security (β = 0.218), and cultural identity (β = 0.208), but not with social interaction after accounting for greenery/trees (see Appendix Table A2). This pattern is interpreted cautiously as consistent with site differences in water-feature operability and maintenance documented in the site profiles (Table 1), rather than as a single-element causal mechanism.

Appendix Table A2. Multiple regression of activation dimensions on trees/greenery and water features (OLS; N=200)

Outcome Variable	Natural Environment Inputs	β (std.)	SE (HC3)	95% CI	p-value	R^2 adj.
Social Interaction	Greenery/Trees	0.411	0.091	[0.234, 0.588]	<0.001	0.433
	Water	0.122	0.127	[-0.128, 0.371]	.339	
Livability & Usability	Greenery/Trees	0.398	0.060	[0.280, 0.516]	<0.001	0.572
	Water	0.342	0.098	[0.151, 0.534]	<0.001	
Safety & Security	Greenery/Trees	0.222	0.081	[0.063, 0.381]	0.006	0.540
	Water	0.218	0.088	[0.046, 0.389]	0.013	
Cultural Identity	Greenery/Trees	0.049	0.074	[-0.095, 0.194]	0.506	0.600
	Water	0.208	0.106	[0.001, 0.414]	0.049	

***Note**: All models control for gender, age, visit frequency, residency, and park fixed effects. HC3 robust standard errors applied.*

Mediation through Psychological Comfort

Mediation was tested using bootstrap indirect-effects models. Both water features ($\beta = 0.259$; $p = 0.013$) and greenery ($\beta = 0.451$) were positively associated with psychological comfort, and bootstrap indirect effects were consistent with psychological comfort statistically mediating the observed associations with social interaction (indirect = 0.200) and safety perceptions (indirect = 0.112). Overall, greenery exhibited stronger mediated pathways than water features, while water showed additional indirect contributions to safety-related perceptions, consistent with the interpretation that blue infrastructure may represent a conditional enabling feature when functional and well maintained.

Design Preferences and Implementation Priorities

Respondents most strongly endorsed nature-oriented design attributes (e.g., natural landscape, green-blue integration, and universal accessibility). Priority preferences emphasized interventions that target thermal comfort and evening use: shade (58.5%), lighting (53.0%), and functional water features (44.5%), consistent with a bundled implementation emphasis rather than an isolated aesthetic upgrade. Reported implementation constraints were highest for shade/tree cover (M = 4.13), followed by maintenance limitations affecting green-blue provision (M = 3.91), and inadequate lighting/visibility (M = 3.72). Regression results indicated that higher ratings of greenery ($\beta = -0.248$, $p < 0.001$) and water bodies ($\beta = -0.239$, $p = 0.012$) were associated with lower perceived implementation barriers, consistent with higher perceived natural-environment input quality co-occurring with fewer reported obstacles to improvement. Sense of place ratings were above the scale midpoint, with Shar and Minara highest and Zanyari lowest; in multivariable models, water features significantly associated with sense of place, whereas greenery was not significant when both predictors were included.

Qualitative open-ended responses indicated four recurring needs: greater provision of thermal comfort/shading, upgraded lighting, functional water features, and basic services (e.g., toilets and seating). Site-specific suggestions were consistent with measured gaps, including greater emphasis on heritage-oriented programming and lighting in Minara and fountain repairs and illumination upgrades in Gilkand.

Validation and Triangulation of Results

An independent confidence-weighted instrument provided convergent validation: agreement was good

(Kendall's W = 0.738), park rankings were comparable across instruments, and construct-level correlations were high (r = 0.67–0.97). Figure 4 reproduces the same between-park ordering observed in the main instrument, indicating that the between-park ordering was consistent across instruments within the study scope.

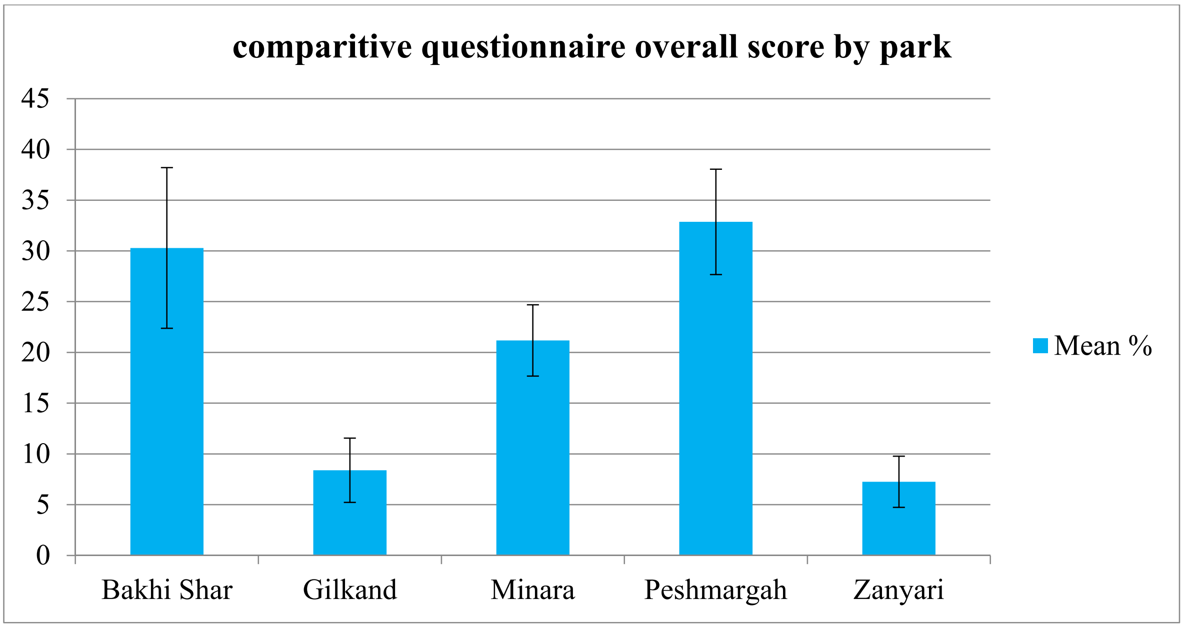

Figure 4. Comparative instrument overall preference scores by park (mean across 14 criteria, %; error bars = 95% CI), providing a convergent ranking that reproduces the main instrument's between-park ordering (robustness check within the study scope)

DISCUSSION

This study provides additional associative evidence that, in Erbil's hot arid/semi-arid conditions, higher perceived green-blue input quality tends to co-occur with higher user-reported activation outcomes, particularly where lighting and maintenance conditions are also rated favorably. Integrating survey results with documented site profiles (Table 1) is consistent with interpreting a bundled performance profile (shade continuity, operable water features, readable access, and sufficient lighting) as co-occurring with higher evening-dominant use, rather than "nature presence" alone. In this context, user-reported priorities are consistent with climate-responsive logic: shade was the top improvement priority (58.5%) and the strongest barrier to staying (M = 4.13), while lighting (53.0%) and water-feature functionality (44.5%) were also emphasized, consistent with the evening-dominant sampling window and the time-bounded headcount patterns reported for the peak-use period (Table 1).

Element-specific modeling indicates differentiated adjusted association patterns: trees/greenery were more strongly associated with social interaction and livability/usability, whereas water features showed comparatively stronger associations with symbolic and experiential outcomes, particularly when operational. These findings are consistent with the proposed pathway, where psychological comfort statistically mediated the observed associations. The large observed difference in perceived safety between high- and low-natural-environment parks is interpreted cautiously. While CPTED frameworks emphasize surveillance and maintenance cues as foundations of perceived safety (Cozens et al., 2005), the present study did not quantify formal CPTED or morphological indicators (e.g., sightline continuity, enclosure, adjacency risk). Therefore, the observed safety advantage is best interpreted as a contextual co-occurrence of high-quality landscapes with lighting, legibility, and maintenance rather than evidence of a vegetation-only causal effect.

Maintenance was consistently aligned with activation-related ratings as an enabling condition: higher perceived maintenance quality was associated with lower reported implementation barriers and higher user satisfaction, and it co-occurred with the observed operability of shade, lighting, and water features during the study period. Consistent with this, parks with higher user-reported activation scores (Shar and Peshmargah) combined stronger maintenance and operable amenities, whereas parks with lower user-reported scores (Gilkand and Zanyari) showed patterns of lower maintenance/operability ratings and non-functional water features, mirroring respondents' emphasis on maintenance as a key barrier (M = 3.91) and the site profiles (Table 1). These findings are consistent with prioritizing bundled intervention packages (shade-providing tree canopy, functional water features, and adequate lighting) rather than isolated upgrades. Additionally, the independent comparative instrument corroborated the between-park ordering, suggesting that observed differences in perceived environmental quality and enabling conditions were consistent within this case-study scope.

CONCLUSIONS

This study provides empirical evidence of statistically significant associations between perceived natural-environment quality and public-space activation across five parks in Erbil. Between-park differences were large for several outcomes, including cultural identity/diversity ($\eta^2 = 0.531$), and contrasts between higher- and lower-natural-environment groupings were large for perceived safety (Hedges' g = 1.84). Associations were differentiated: trees/greenery showed stronger associations with social interaction and livability/usability, whereas water features showed stronger associations with cultural identity and place-meaning-related ratings in functional and well-maintained spaces. The user feedback is highly climate-sensitive, where evening visitation is dominant (89.5%), and respondents prioritized nature integration (91.5%), shade (58.5%), lighting (53.0%), and functional water features (44.5%), which is consistent with the proposed comfort-related pathway. In heat-limited Erbil conditions, higher perceived green-blue quality co-occurs with higher reported activation; design implications emphasize maintaining shade continuity, adequate lighting, and operable water features as enabling conditions for evening-dominant park use. Given the cross-sectional, single-city design and the absence of objective microclimate, CPTED/ morphology, and explicit socio-economic/land-use measures, findings are interpreted as associations and are most transferable to comparable arid/semi-arid, evening-dominant contexts.

Recommendations

- Prioritizing shade as enabling infrastructure by accelerating tree planting and installing temporary shade canopies to provide shaded seating areas and connect these areas along routes to potentially facilitate longer stays and optional engagement.
- Upgrading evening usability by strengthening lighting at entrances, primary routes, and heavily used social spaces, consistent with reported safety concerns, and addressing avoidance of poorly lit areas.
- Maintaining the operability of blue-infrastructure elements (fountains and irrigation-enabled water features) to sustain user-valued experiential benefits.
- Adopting integrated maintenance upgrades: Packaged treatments (lighting, shading, and operable water features) should be prioritized in parks with lower user-reported activation scores, and results should be assessed using pre/post indicators (e.g., dwell duration, activity diversity, perceived safety).
- To strengthen transferability beyond the present Erbil case studies, future research should oversample 20–30-year-olds and include objective contextual measurements (socio-economic and morphological parameters, like visibility and sightlines).

Study Limitations

Because the design is cross-sectional and limited to five Erbil parks with summer evening sampling (primarily 17:00–22:00), findings should be interpreted as associative and generalized mainly to comparable arid/semi-arid, evening-dominant contexts. The study used intercept sampling of current park users, missing those who avoid public spaces entirely and their reasons for non-use. The absence of objective microclimate, CPTED/morphological measures, and explicit socio-economic/land-use models in the study may partly account for variations in activation results between parks. In addition, objective behavioral metrics (e.g., dwell time or activity counts) were not measured; therefore, outcomes reflect user-reported perceptions rather than observed behavioral performance. Observed park-use levels were recorded as approximate instantaneous counts during the study windows and are interpreted only as time-specific, descriptive indicators of relative popularity, not as full-day, annual, or archival attendance estimates.

Conflict of Interests

There is no conflict of interests disclosed by the authors.

Funding Information

No funding agency specifically awarded a grant for this study.

REFERENCES

Ali, O.H., Ja'afar, N.H., Mat Sulaiman, M.K.A., & Khalaf, O.A. (2019). Square as urban space in Iraq: The effectiveness of design attributes on social interaction. *International Journal of Recent Technology and Engineering*, *7*(6S2), 305-310.

Alshira'h, M.A. (2022). The role of water facilities in designing public open and green space. *Arab Journal for Scientific Publishing, 5*(49), 10-23. https://www.ajsp.net/research/The%20Role%20of%20Water%20Facilities%20in%20Designing%20Public%20Open%20and%20Green%20Space.pdf

Bazrafshan, S., Mikaeili Tabrizi, A., Bauer, N., & Kienast, F. (2021). Place attachment through interaction with urban parks: A cross-cultural study. *Urban Forestry & Urban Greening*, *61*, 127103. https://doi.org/10.1016/j.ufug.2021.127103

Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2003). *Public places, urban spaces: The dimensions of urban design*. Architectural Press, Oxford, UK

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates, Hillsdale, NJ, USA.

Cozens, P.M., Saville, G., & Hillier, D. (2005). Crime prevention through environmental design (CPTED): A review and modern bibliography. *Property Management, 23*(5), 328-356. https://doi.org/10.1108/02637470510631483

Encyclopaedia Britannica. (2025, December 3). *Erbil*. Encyclopaedia Britannica. https://www.britannica.com/place/Erbil

Fathi, M.S., & Heidari, F. (2018). The role of façades in the formation of physical identity in the Iranian cities. *International Journal of Human Capital in Urban Management, 3*(1), 69-80. https://doi.org/10.22034/ijhcum.2018.03.01.008

Gehl, J. (2010). *Cities for people*. Island Press, Washington, DC, USA.

Gehl, J. (2011). *Life between buildings: Using public space* (J. Koch, Trans.). Island Press, Washington, DC, USA (Original work published 1971).

Hajiyat, S.R.M., Kozlowski, M., & Abu Bakar, N.A. (2021). The impact of physical environment on perceived safety of urban public space in Baghdad, Iraq. *Alam Cipta, 14*(1), 46-57.

Hama, R.H., Hamad, R.T., & Aziz, F.H. (2014, April). Climate change in relation to rainfall and temperature in Erbil province, Kurdistan, Iraq. *Geo Tunis (8th International Congress)*. https://www.geosp.net/wp-content/uploads/2014/05/Rawa-H.-Hama-Rabar-T.-HamadDr.Farhad-H.-Aziz.pdf

Hassan, R.H., & Kawther, K.K. (2021). The impact of light and shading on creating interactive and active urban spaces. *IOP Conference Series: Earth and Environmental Science, 856*(1), 012057. https://doi.org/10.1088/1755-1315/856/1/012057

Ibrahim, R. I., Mushatat, S. A., & Abdelmonem, M. G. (2015). City profile: Erbil. *Cities, 49*, 14-25. https://doi.org/10.1016/j.cities.2015.07.001

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge University Press, Cambridge, UK.

Khoshnaw, R., & Kissfazekas, K. (2018). Urban form and sustainability in historic cities: A case study of two neighbourhoods in Erbil City, Iraq. *Építés-Építészettudomány, 47*(1-2), 189-215. https://doi.org/10.1556/096.2018.014

Kurdistan Region Statistics Office, & Central Statistics Organization. (2014, June). *Short report of the Iraq Household Socio-Economic Survey (IHSES II) 2012*. Kurdistan Region Statistics Office, Ministry of Planning, Kurdistan Regional Government, Erbil, Iraq. https://krso.gov.krd/content/upload/1/root/summury-of-kurdistan-in-iraqi-houshold-socio-economic-survey-ihses2012.pdf

Kurdistan Region Statistics Office. (2018). *Poverty rate in Kurdistan Region (SWIFT survey 2018).* Kurdistan Region Statistics Office, Ministry of Planning, Kurdistan Regional Government, Erbil, Iraq. https://krso.gov.krd/en/indicator/poverty-rate

Kurdistan Region Statistics Office. (2021). *Labor force indicators (including unemployment rate by governorate).* Kurdistan Region Statistics Office, Ministry of Planning, Kurdistan Regional Government, Erbil, Iraq. https://krso.gov.krd/en/indicator/ population-and-labor-force/labor-force

Kurdistan Region Statistics Office. (2022, July). *Weather statistics in Kurdistan Region governorates for the years 2012-2021.* Agriculture and Environment Statistics Department, Erbil, Iraq. https://krso.gov.krd/content/upload/1/root/%D8%AF%D8%A7%D8%AA%D8%A7%D9%89-%D9%83%D9%87%E2%80%8C%D8%B4-%D9%88-%D9%87%D9%87%E2%80%8C%D9%88%D8%A7-20-2-2020-%D8%A6%D9%8A%D9%86%DA%AF%D9%84%D9%8A%D8%B2%D9%891.pdf

Kurdistan Region Statistics Office. (2023a). *Population projection (2023): Total population, urban/rural distribution, and growth rate.* Kurdistan Region Statistics Office, Ministry of Planning, Kurdistan Regional Government, Erbil, Iraq. https://krso.gov.krd/en/indicator/population-and-labor-force/population/papulation-projection

Kurdistan Region Statistics Office. (2023b). *Population density (people/km²) (2023): Kurdistan Region and governorates.* Kurdistan Region Statistics Office, Ministry of Planning, Kurdistan Regional Government, Erbil, Iraq. https://krso.gov.krd/en/indicator/ population-and-labor-force/population/population-density-people/km2

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology, 4*, Article 863. https://doi.org/10.3389/fpsyg.2013.00863

Li, J., Dang, A., & Song, Y. (2022). Defining the ideal public space: A perspective from the publicness. *Journal of Urban Management, 11*(4)**,** 479-487. https://doi.org/10.1016/j.jum.2022.08.005

Lynch, K. (1960). *The image of the city*. MIT Press, Cambridge, MA, USA.

Mehta, V., & Bosson, J.K. (2021). Revisiting lively streets: Social interactions in public space. *Journal of Planning Education and Research, 41*(2), 160-172. https://doi.org/10.1177/0739456X18781453

Mishra, H.S., Bell, S., Vassiljev, P., Kuhlmann, F., Niin, G., & Grellier, J. (2020). The development of a tool for assessing the environmental qualities of urban blue spaces. *Urban Forestry & Urban Greening, 49*, 126575. https://doi.org/10.1016/j.ufug.2019.126575

Musheer, S.K., Abdullah, H.K., & Abubakir, S.S. (2024). Perceived safety in community parks: The case of Erbil. *Journal of Linguistics and Social Sciences, 2*(2), 17-24. https://doi.org/10.24042/jlss.v2i2.24018

Nikolopoulou, M., & Steemers, K. (2003). Thermal comfort and psychological adaptation as a guide for designing urban spaces. *Energy and Buildings, 35*(1), 95-101. https://doi.org/10.1016/S0378-7788(02)00084-1

Rahman, N.A., Ghani, I., Teh, M.Z., & Ibrahim, K.A. (2020). Rethinking urban public space: Physical and functional analysis through visual surveys. *IOP Conference Series: Earth and Environmental Science, 409*(1), 012002. https://doi.org/10.1088/1755-1315/409/1/012002

Salman, A.M., & Saleem, Y.M. (2021). The effect of Urban Heat Island mitigation strategies on outdoor human thermal comfort in the city of Baghdad. *Frontiers of Architectural Research, 10*(4), 838-856. https://doi.org/10.1016/j.foar.2021.07.002

Scannell, L., & Gifford, R. (2010). Defining place attachment: A tripartite organizing framework. *Journal of Environmental Psychology, 30*(1), 1-10. https://doi.org/10.1016/j.jenvp.2009.09.006

Shedid, M.Y., & Hefnawy, N.H. (2022). Influence of landscape elements on visual design elements in order to enhance the visual quality of urban spaces. *Journal of Engineering Research, 6*(4), 127-134. https://doi.org/10.21608/erjeng.2022.265464

Tareq, D.N., & Al-Kindy, S.K. (2025). Sustainable development of investment in residential complexes in Baghdad–Iraq. *Jordan Journal of Civil Engineering, 19*(5), 1-9. https://doi.org/10.14525/JJCE.v19i5.01

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemelä, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. *Landscape and Urban Planning, 81*(3), 167-178. https://doi.org/10.1016/j.landurbplan.2007.02.001

Weather Atlas. (2024). *Erbil, Iraq—Weather in January*. https://www.weather-atlas.com/en/iraq/erbil-weather-january

White, M. P., Elliott, L. R., Gascon, M., Roberts, B., & Fleming, L. E. (2020). Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research, 191*, 110169. https://doi.org/10.1016/j.envres.2020.110169

Whyte, W.H. (1980). *The social life of small urban spaces*. Conservation Foundation, Washington, DC, USA.

World Bank. (2021, November 24). Iraq: Rising fiscal risks, water scarcity and climate change threaten gradual recovery from pandemic. https://www.worldbank.org/en/news/press-release/2021/11/24/iraq-rising-fiscal-risks-water-scarcity-and-climate-change-threaten-gradual-recovery-from-pandemic

Zhang, F., Sun, X., Liu, C., & Qiu, B. (2024). Effects of urban landmark landscapes on residents' place identity: The moderating role of residence duration. *Sustainability, 16*(2), 761. https://doi.org/10.3390/su16020761