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Effects of Outdoor Space Design in Neighborhoods on Quality of Life

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Abstract
This study explores how perceptions and cognitive responses to neighborhood outdoor spaces influence leisure activities and emotional experiences, ultimately affecting QOL. Using structural equation modeling (SEM) survey data from 412 residents in Tainan, Taiwan, the study found that indirect effects mediated by leisure activities and emotional experiences amplify the impact of outdoor spaces on QOL. These findings offer urban designers and policymakers insights into creating spaces that enhance residents' well-being. By examining how specific environmental features affect daily experiences, this research contributes to a broader understanding of sustainable urban development.

Keywords: neighborhood environment, outdoor space, activity type, emotional experience

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1.0 Introduction

Neighborhood outdoor spaces provide immediate access to natural environments for residents. Research indicates that such spaces significantly enhance mental health and quality of life (QOL) by reducing stress, fostering social interactions, and promoting community harmony (Gidlow et al., 2016; Kaplan & Kaplan, 1989). However, poorly designed spaces often fail to engage residents and deliver the intended benefits. For example, outdoor spaces lacking accessibility, adequate seating, or diversity of use are frequently underutilized and fail to support the psychological and social well-being of the community (Koohsari et al., 2018; Sugiyama et al., 2012) . Despite growing interest in the design and benefits of urban green spaces, there is still limited understanding of how specific features of neighborhood spaces address the challenges posed by dense urbanization and mitigate the negative effects of environmental stressors such as crowding and noise.

This study investigates how specific features of outdoor spaces influence leisure activities, emotional experiences, and QOL, particularly in dense urban environments like Tainan, Taiwan. By examining these relationships, the research aims to fill a critical gap in the literature by identifying the direct and indirect effects of outdoor spaces on QOL. Specifically, this study hypothesizes that outdoor space features impact QOL both directly and indirectly, mediated by leisure activities and emotional experiences. Understanding these mechanisms is crucial for designing spaces that are not only functional but also emotionally restorative and socially inclusive.

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2.0 Literature Review

2.1 Features of Neighborhood Outdoor Spaces

Kevin Lynch (Lynch, 1995) identified accessibility, harmony, and safety as critical in outdoor space design. Essential elements include:

- Social spaces: Plazas or gathering spots encouraging interaction.
- Vegetation and lighting: Greenery and adequate illumination for aesthetic and safety purposes.
- Street furniture: Amenities like benches and tables enhance usability.

These elements provide functional benefits and influence emotional and psychological responses. For example, accessible pathways promote use, while vegetation fosters relaxation. Furthermore, existing studies often focus on elements like greenery or lighting. Still, limited research explores how combinations of these features synergistically influence well-being and behavior in urban environments. Additionally, integrating artistic elements and ergonomic designs can create a visually appealing and user-friendly environment, further enhancing the sense of well-being among users (Koohsari et al., 2018; Sugiyama et al., 2012). This study addresses this gap by exploring how the interplay of these features affects leisure activities and emotional experiences.

2.2 Emotional Experiences

Environmental stimuli like light, greenery, and sound elicit emotional responses (Ulrich, 1986). Positive emotional states, such as relaxation, directly enhance QOL, whereas poorly designed spaces may evoke stress. Emotional experiences thus act as a bridge linking physical features to psychological well-being. However, existing research largely overlooks how specific features of urban outdoor spaces influence the intensity and nature of emotional responses, particularly in dense urban contexts. Moreover, prior studies often fail to account for the role of cultural and contextual factors in shaping emotional experiences. This study builds on Ulrich's stress recovery theory by empirically investigating how neighborhood outdoor space features influence emotional states and, in turn, QOL.

2.3 Leisure Activities and QOL

Leisure activities, including social, recreational, athletic, and cultural pursuits, contribute significantly to mental and physical health (Sugiyama et al., 2009). These activities mediate the relationship between outdoor spaces and QOL by promoting physical engagement, social connection, and emotional fulfillment. For instance, a well-maintained park can serve as a venue for individual relaxation and community events, supporting diverse recreational needs. However, existing studies often do not address how variations in activity types mediate the impact of specific outdoor space features on QOL. This study addresses this gap by examining how different activity types, like social, athletic, recreational, and cultural, interact with space features to improve QOL.

2.4 Research Hypotheses

Based on the gaps and insights discussed above, this study proposes the following hypotheses:

H1: Outdoor space features influence leisure activity type directly.
H2: Outdoor space features impact emotional experiences directly.
H3: Outdoor space features affect QOL directly.
H4: Leisure activity type impacts emotional experiences directly.
H5: Leisure activity type influences QOL directly.
H6: Emotional experiences affect QOL directly.
H7: Leisure activity type and emotional experiences mediate the relationship between

By addressing these hypotheses, this study provides an integrated framework to examine how physical space features, leisure activities, and emotional experiences collectively influence QOL.

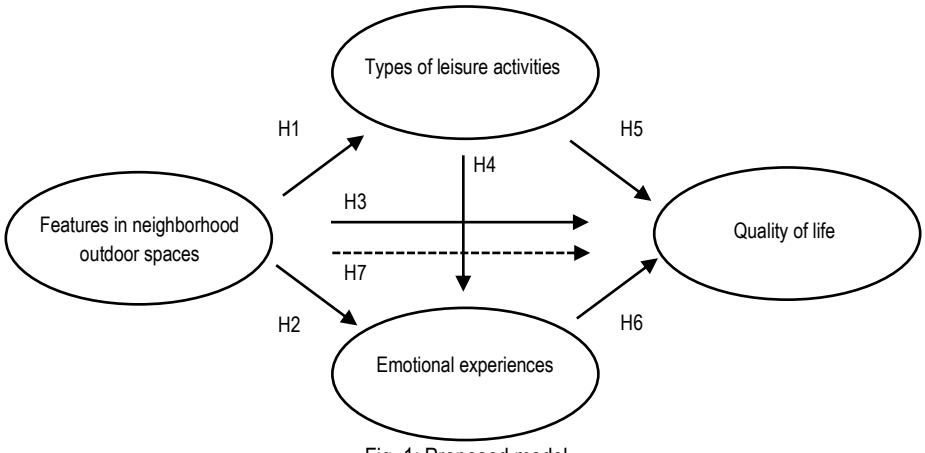

Fig. 1: Proposed model.
Note. Dash lines denote the mediation effect (H7)

3.0 Methodology

3.1 Study Sites

The study surveyed residents from six communities in Tainan, representing diverse urban layouts. Participants included individuals actively using neighborhood outdoor spaces for leisure activities. The communities were selected to capture a variety of urban designs, ranging from courtyard-style layouts to grid-based neighborhoods, ensuring a comprehensive analysis of how spatial configurations influence user experiences.

Fig. 2: Maps of the study site

Table 1. Measurement items for the constructs

Sample community	Typology	Total households*	Householdpercentage	Surveys distributed	Valid surveys
Zhangrong	courtyard	1222	24.3%	104	100
Hewei	cluster	248	4.9%	32	30
Dapeng	courtyard	506	10.0%	43	41
Dongmen	on grid	532	10.6%	52	50
Xinxing Phase-3	on grid	1410	28%	115	108
Xinxing High Rise	cluster	1120	22.2%	94	83
Total		5038	100.0%	440	412

Valid response rate：93.6%

3.2 Measurement of variables

This study identifies neighborhood outdoor features based on Kevin Lynch's six elements of site planning (Zhang & Lin, 2011) and additional features by Yung, Conejos, and Chan (2016). The eight factors assessed include spatial arrangement, lighting, paved surfaces, street furniture, buildings, open spaces, artifacts (e.g., seating, street lamps), and vegetation (Table 2, A1-A44). These were evaluated on criteria such as accessibility, space size, harmony, upkeep, comfort, and safety.

Leisure activities were divided into four categories (Table 2, B1-B4): social, sports, recreational, and knowledge/cultural activities. Emotional experiences followed Mehrabian and Russell's (1974) constructs of pleasure, arousal, and dominance, with ten adjective pairs for measurement (Table 2, C1-C10). Quality of life (QOL) was assessed using WHOQOL's domains—physical, psychological, social, and environmental (Andrades Barrientos & Valenzuela Suazo, 2007; Marans & Kweon, 2011; Veenhoven, 2013)—and an additional overall satisfaction question (Table 2, D1-D5).

Nine demographic variables, such as gender, age, and residency duration, were included to account for diverse respondent backgrounds. Respondents were grouped into eight age brackets, excluding those aged 12 and below for language considerations. This comprehensive framework facilitates analyzing how neighborhood spaces influence activities, emotions, and QOL.

Table 2. Measurement items for the constructs

Perception of Elements in Neighborhood Outdoor Recreational Spaces	
A1	Outdoor circulation spaces within the neighborhood are easily accessible.
A2	The size of outdoor circulation spaces within the neighborhood is appropriate.
A3	The outdoor circulation spaces within the neighborhood are well-maintained.
A4	The quantity of street furniture in the neighborhood's outdoor passage spaces is sufficient.
A5	The street furniture in the neighborhood's outdoor passage spaces features diverse designs.
A6	The outdoor passage spaces in the neighborhood harmonize well with the surrounding building masses.
A7	The public art in the neighborhood's outdoor passage spaces evokes a sense of pleasure.
A8	The advertisement signage in the neighborhood's outdoor passage spaces features diverse styles.
A9	The pavement in the neighborhood's outdoor passage spaces is well-maintained.
A10	The planting in the neighborhood's outdoor passage spaces is diverse.

A11	The planting in the neighborhood's outdoor passage spaces provides good shade and sun protection.
A12	The natural lighting in the neighborhood's outdoor passage spaces is sufficient.
A13	The nighttime lighting in the neighborhood's outdoor passage spaces is effective.
A14	The active crowd in the neighborhood's outdoor passage spaces creates a vibrant atmosphere.
A15	The neighborhood park is easily accessible.
A16	The size of the neighborhood park is appropriate.
A17	The neighborhood park is well-maintained.
A18	The quantity of street furniture in the neighborhood park is sufficient.
A19	The street furniture in the neighborhood park features diverse designs.
A20	The neighborhood park harmonizes well with the surrounding building masses.
A21	The public art in the neighborhood park evokes a sense of pleasure.
A22	The pavement in the neighborhood park is well-maintained.
A23	The planting in the neighborhood park is diverse.
A24	The planting in the neighborhood park provides good shade and sun protection.
A25	The natural lighting in the neighborhood park is sufficient.
A26	The nighttime lighting in the neighborhood park is effective.
A27	The active crowd in the neighborhood park creates a vibrant atmosphere.
A28	The outdoor interaction spaces within the neighborhood are easily accessible.
A29	The size of outdoor interaction spaces within the neighborhood is appropriate.
A30	The outdoor interaction spaces within the neighborhood are well-maintained.
A31	The quantity of street furniture in the neighborhood's outdoor interaction spaces is sufficient.
A32	The street furniture in the neighborhood's outdoor interaction spaces features diverse designs.
A33	The outdoor interaction spaces within the neighborhood harmonize well with the surrounding building masses.
A34	The public art in the neighborhood's outdoor interaction spaces evokes a sense of pleasure.
A35	The advertisement signage in the neighborhood's outdoor interaction spaces showcases a variety of styles.
A36	The pavement in the neighborhood's outdoor interaction spaces is well-maintained.
A37	The planting in the neighborhood's outdoor interaction spaces is diverse.
A38	The planting in the neighborhood's outdoor interaction spaces provides good shade and sun protection.
A39	The natural lighting in the neighborhood's outdoor interaction spaces is sufficient.
A40	The nighttime lighting in the neighborhood's outdoor interaction spaces is effective.
A41	The active crowd in the neighborhood's outdoor interaction spaces creates a vibrant atmosphere.
A42	The overall outdoor spaces in the neighborhood are easily accessible.
A43	The size of the overall outdoor spaces in the neighborhood is appropriate.
A44	The overall outdoor spaces in the neighborhood are well-maintained.
Types of Leisure Activities	
In the community, you often engage in...	
B1	Social-oriented leisure activities
B2	Sports-oriented leisure activities
B3	Recreational-oriented leisure activities
B4	Knowledge, cultural, and arts-oriented leisure activities
Emotional Experience	
How does the overall outdoor space in the community make you feel?	
C1	Unhappy / Happy
C2	Troubled / Pleasant
C3	Dissatisfied / Satisfied
C4	Disappointed / Hopeful
C5	Relaxed / Stimulated
C6	Calm / Excited
C7	Tired / Alert
C8	Controlled / In Control
C9	Submissive / Dominant
C10	Restricted / Free
Quality of Life	
D1	You are satisfied with your ability to carry out daily activities.
D2	You feel that your life is meaningful.
D3	You are satisfied with your interpersonal relationships within the community.
D4	You are satisfied with the community environment you live in.
D5	Overall, you are satisfied with your current quality of life.

3.3 Analytical Methods

Exploratory Factor Analysis (EFA)

To ensure construct stability and consistency, item analysis preceded exploratory factor analysis (EFA). The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity assessed data suitability. Reliability for each factor was measured using Cronbach's alpha (Hair, 2010).

Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM)

Structural equation modeling (SEM)

A confirmatory tool, followed EFA to refine factors with high extractability. Confirmatory factor analysis (CFA) assessed model fit, eliminating factors until acceptable goodness of fit was achieved. Factor loading helped select balanced index variables. The Bollen-Stine Bootstrap method adjusted the model to ensure fit, addressing normality issues and avoiding Chi-square test inflation (Enders, 2005; Hair, 2010).

Mediation Variable Evaluation

SEM identified mediation variables within constructs, useful for social science research on causality. Mediation effects were tested based on two conditions: independent significance and weakened direct effects upon introducing mediators (Baron & Kenny, 1986; Hair, 2010).

4.0 Findings

4.1 Descriptive Statistics

Among the 440 surveys collected, 412 were valid. Male participation slightly exceeded female. The 31-40 age group was most represented (18%), while school-aged participants (13-18 years) had the lowest participation, likely due to after-school commitments. Students (26.5%) formed the largest professional group, followed by service workers (16%) and homemakers (14.3%), reflecting greater time flexibility. College degree holders accounted for 41.7% of respondents, and 76.2% owned their homes. Most had resided in their communities for 10-15 years. Family and relatives were the most common activity companions (38.6%), with 33.7% using spaces after 7 PM and 44.7% engaging for 30 minutes to an hour, consistent with previous findings (Gorely et al., 2009; Heiwe & Jacobson, 2011; Pate et al., 1995) (Table 3).

Table 3. Attributes of resident participants

Characteristics	Sample	Percentage
Gender		
Male	212	51.50%
Female	200	48.50%
Age		
13-15 years old	28	6.80%
16-18 years old	28	6.80%
19-22 years old	44	10.70%
23-30 years old	58	14.10%
31-40 years old	74	18.00%
41-50 years old	51	12.40%
51-60 years old	56	13.60%
60 years old and above	73	17.70%
Occupation		
Agriculture	1	0.02%
Service industry	66	16.20%
Industry/Manufacturing	47	11.40%
Commerce	22	5.30%
Military/Civil Service	25	6.10%
Student	109	26.50%
Homemaker	59	14.30%
Retired	45	10.90%
Other	38	9.20%
Education Level		
Elementary School (or below)	34	8.30%
Middle School	57	13.80%
High School (Vocational)	106	25.70%
University (College)	172	41.70%
Graduate School or above	43	10.40%
Duration of Residence		
Less than 1 year	39	9.20%
1-5 years	84	20.40%
5-10 years	82	19.90%
10-15 years	106	25.70%
More than 15 years	101	24.50%
Companions During Activities		
Alone	136	33.00%
Family members	159	38.60%
Partner	13	3.20%
Classmates, friends	104	25.202%
Housing Ownership		
Owned	3114	75.80%
Rented	89	22.30%
Borrowed accommodation	1	0.20%
Assigned housing (dormitory)	8	1.90%
Activity Time Periods		
Before 8 AM	50	12.10%
12-2 PM	13	3.20%
2-5 PM	97	23.50%
5-7 PM	87	21.10%
After 7 PM	139	33.70%
Duration of Stay		
Within 30 minutes	144	27.70%
30 minutes to 1 hour	184	44.70%
1 to 2 hours	73	17.70%

More than 2 hours	41	10.00%

4.2 Reliability analysis

Reliability analysis assessed the constructs using corrected item-total correlation. Cronbach's alphas were 0.956 for neighborhood outdoor leisure spaces, 0.701 for leisure activity type, 0.856 for emotional experience, and 0.784 for quality of life. According to Cortina (1993), α≥0.70 indicates high reliability, while 0.70≥α≥0.60 reflects moderate reliability.

4.3 Latent variables in neighborhood outdoor leisure space features:

Factor analysis was conducted using principal component analysis to identify components of neighborhood outdoor spaces. Items with eigenvalues above one were analyzed, and the varimax method was applied to refine the axis, removing items with factor loadings below 0.40 (Hair, 2010). This process eliminated 12 items, resulting in seven factors that explained 66.443% of total variance. The factors—social spaces, public arts and signage, street furniture, circulation paths, pavement and vegetation, night lighting, and park space planning—all had Cronbach's alpha values exceeding 0.7, indicating strong reliability. (Table 4)

Table 4. Analysis of perceptual factors in neighborhood outdoor recreational space features

Item	Factor						
	1	2	3	4	5	6	7
	Communication Space	Public Art and Signage	Street Furniture	Circulation Path	Paved Surface Planting	Nighttime Lighting	Park Space Planning
A42 The overall outdoor spaces in the neighborhood are easily accessible.	.763	-.009	-.041	.166	.140	.058	.221
A41 The active crowd in the neighborhood's outdoor interaction spaces creates a vibrant atmosphere.	.669	.279	.205	.095	.088	.160	-.214
A39 The natural lighting in the neighborhood's outdoor interaction spaces is sufficient.	.659	.029	.107	.050	.221	.208	.009
A30 The outdoor interaction spaces within the neighborhood are well-maintained.	.657	.158	.219	.153	.096	.086	.258
A43 The size of the overall outdoor spaces in the neighborhood is appropriate.	.654	.139	.002	.248	.127	.047	.427
A28 The outdoor interaction spaces within the neighborhood are easily accessible.	.646	-.002	.266	.194	-.113	.144	.092
A44 The overall outdoor spaces in the neighborhood are well-maintained.	.646	.112	-.003	.161	.236	.092	.480
A29 The size of outdoor interaction spaces within the neighborhood is appropriate.	.619	.246	.249	.221	-.010	.010	.249
A37 The planting in the neighborhood's outdoor interaction spaces is diverse.	.602	.291	.080	-.006	.435	.106	-.037
A27 The active crowd in the neighborhood park creates a vibrant atmosphere.	.577	.071	.314	.138	.107	.277	.018
A35 The advertisement signage in the neighborhood's outdoor interaction spaces showcases a variety of styles.	.080	.827	.094	.120	-.110	.168	.060
A34 The public art in the neighborhood's outdoor interaction spaces evokes a sense of pleasure.	.189	.819	.101	.067	.026	.088	.192
A21 The public art in the neighborhood park evokes a sense of pleasure.	.124	.746	.265	.055	.123	.095	.298
A8 The advertisement signage in the neighborhood's outdoor passage spaces features diverse styles.	.098	.715	.074	.160	.287	.038	.009
A7 The public art in the neighborhood's outdoor passage spaces evokes a sense of pleasure.	.096	.705	.143	.150	.352	.156	.144
A5 The street furniture in the neighborhood's outdoor passage spaces features diverse designs.	.141	.420	.374	.335	.256	.026	-.127
A18 The quantity of street furniture in the neighborhood park is sufficient.	.165	.195	.781	.103	.058	.042	.241
A19 The street furniture in the neighborhood park features diverse designs.	.252	.300	.764	.053	.155	.062	.099
A20 The neighborhood park harmonizes well with the surrounding building masses.	.306	.112	.570	.023	.320	.152	.274
A6 The outdoor passage spaces in the neighborhood harmonize well with the surrounding building masses.	.133	.036	.449	.362	.357	.152	.165
A2 The size of outdoor circulation spaces within the neighborhood is appropriate.	.212	.172	.070	.808	.156	-.013	.141
A1 Outdoor circulation spaces within the neighborhood are easily accessible.	.217	.069	.137	.790	.076	.057	.053
A3 The outdoor circulation spaces within the neighborhood are well-maintained.	.199	.208	.026	.749	.152	.065	.087
A10 The planting in the neighborhood's outdoor passage spaces is diverse.	.268	.102	.163	.141	.738	-.056	.073
A9 The pavement in the neighborhood's outdoor passage spaces is well-maintained.	.175	.106	.229	.215	.637	.221	.115

A11 The planting in the neighborhood's outdoor passage spaces provides good shade and sun protection.	.027	.317	.057	.155	.596	.187	.310
A26 The nighttime lighting in the neighborhood park is effective.	.183	.105	.093	.005	.016	.808	.249
A13 The nighttime lighting in the neighborhood's outdoor passage spaces is effective.	.113	.096	.079	.156	.216	.776	.059
A40 The nighttime lighting in the neighborhood's outdoor interaction spaces is effective.	.295	.240	.044	-.059	.024	.729	.184
A17 The neighborhood park is well-maintained.	.195	.158	.286	.103	.082	.276	.635
A22 The pavement in the neighborhood park is well-maintained.	.182	.233	.301	.137	.169	.234	.570
A24 The planting in the neighborhood park provides good shade and sun protection.	.241	.237	.196	.088	.173	.233	.565
Eigenvalue	11.480	2.565	1.983	1.536	1.417	1.225	1.055
Variance Explained by Factor (%)	15.727	12.301	8.285	8.052	7.500	7.467	7.111
Cumulative Variance Explained by Factor (%)	15.727	28.028	36.312	44.365	51.865	59.331	66.443
Cronbach's alpha	0.902	0.879	0.811	0.816	0.710	0.810	0.738
Kaiser-Meyer-Olkin	0.912						
Bartlett's test of sphericity	0.000						

4.4 Confirmatory factor analysis (CFA)

The factors affecting neighborhood outdoor spaces were identified through exploratory factor analysis using CFA. A model was developed to correlate measured and latent variables with a composite reliability threshold of 0.7 (Hair, 2010). Seven factors of "Neighborhood Outdoor Leisure Space" underwent second-order CFA, resulting in the removal of 14 items to improve fit, achieving a composite reliability of 0.828. For "Types of Recreational Activities," the composite reliability was 0.745. Adjustments for "Emotional Experience" led to the elimination of "Sense of Arousal" and four questions, yielding a reliability of 0.826. In "Quality of Life," one item was removed, achieving a composite reliability of 0.779.

Table 5. CFA model convergent validity

Dimensions and Indicators	Unstandardized Factor Loadings	S.E.	C.R. (t-Value)	P	Standardized estimates		
					AVEc/ loading	CRd/indicator reliabilityaa	Measurement errorb
Neighborhood Outdoor Space Elements					0.414c	0.828d	
Interactive Space Planning	1.000				0.780	0.608	0.392
Public Art and Signage	1.171	0.104	11.24	***	0.600	0.360	0.640
Street Furniture	1.168	0.094	12.386	***	0.644	0.415	0.585
Circulation Pathways	0.808	0.075	10.755	***	0.554	0.307	0.693
Ground Cover Planting	1.035	0.084	12.273	***	0.636	0.404	0.596
Nighttime Lighting	0.971	0.108	8.960	***	0.474	0.225	0.775
	1.219	0.082	14.862	***	0.762	0.581	0.419
Types of Recreational Activities					0.426c	0.745d	
Social-Oriented	1.000			***	0.771	0.594	0.406
Sports-Oriented	0.662	0.069	9.633	***	0.544	0.296	0.704
Recreational-Oriented	0.852	0.073	11.682	***	0.652	0.425	0.575
Knowledge, Cultural, and Artistic-Oriented	0.710	0.064	11.128	***	0.622	0.387	0.613
Emotional Experience					0.707c	0.826d	
Pleasure	1.000			***	0.948	0.899	0.101
Sense of Control	0.652	0.050	13.103	***	0.718	0.516	0.484
Quality of Life					0.479c	0.779d	
Daily Activities	1.000			***	0.457	0.209	0.791
Interpersonal Relationships	1.605	0.198	8.101	***	0.676	0.457	0.543
Community Environment	2.045	0.247	8.296	***	0.835	0.697	0.303
Overall Quality of Life	1.825	0.217	8.409	***	0.744	0.554	0.446

a CRd(λ^2); bMeasurement error (1-λ^2); cAVE value; d CR value

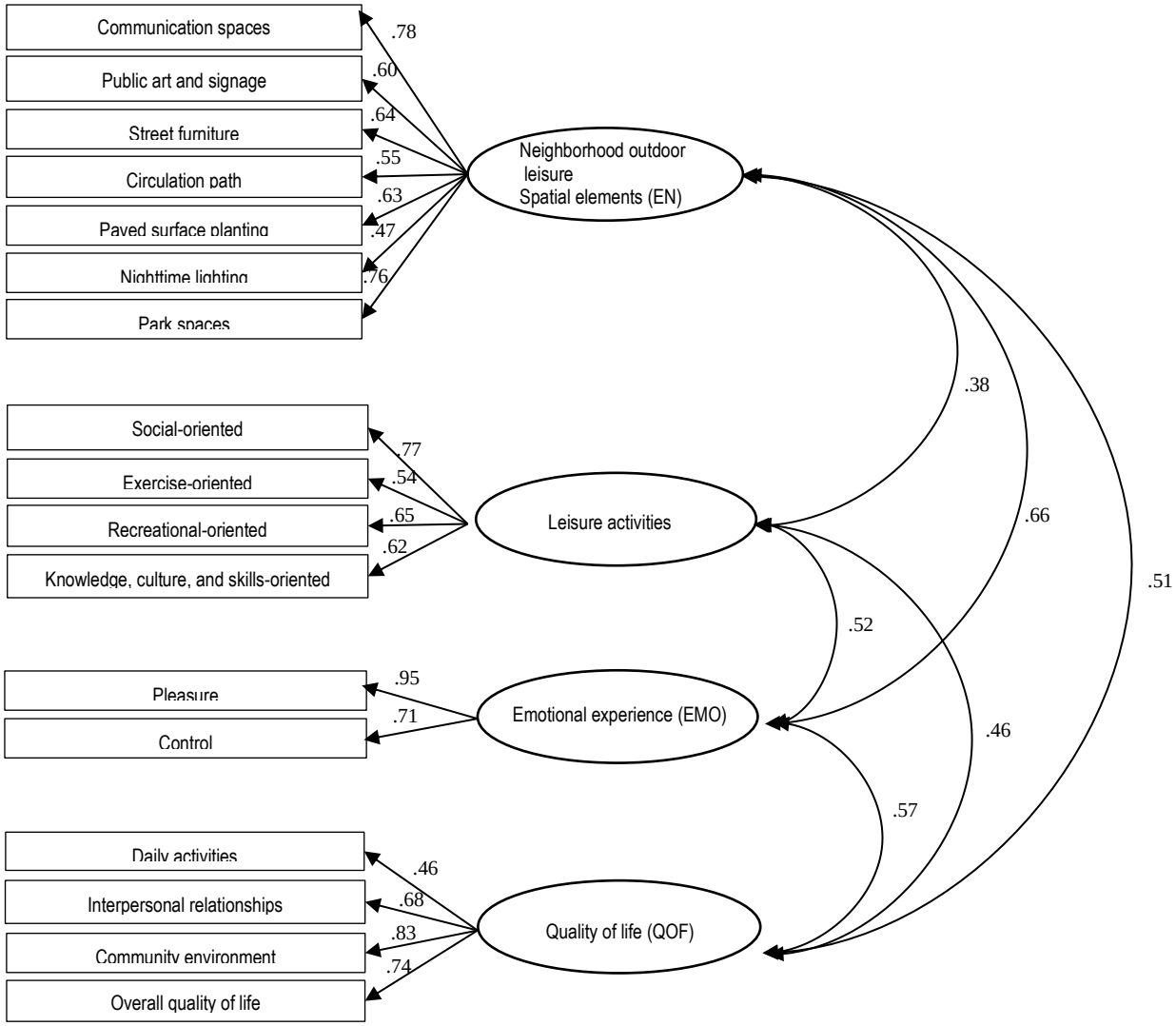

Fig. 3: Measurement model statistical analysis

Table 6. Bollen-Stine Bootstrap modified measurement model goodness of fit

Model indicator	Recommended Standards(Fit standard or critical value)	Model fit	Model fit judgement
Bollen-Stine χ2	The smaller the better	129.330	
DF (degree of freedom)	The larger the better	114	
Normed Chi-sqr (χ2/DF)	1<χ2/DF<3	1.134	yes
GFI	>0.9	0.948	yes
AGFI	>0.8	0.929	yes
RMSEA	<0.08	0.018	yes
SRMR	<0.08	0.054	yes
TLI (NNFI)	>0.9	0.992	yes
CFI	>0.9	0.993	yes
IFI	>0.9	0.993	yes
Hoelter's N (CN)	>200	363.743	yes

Table 7. Model discriminant validity

Parameter			Estimate	bias-corrected		percentile	
				Lower	Upper	Lower	Upper
Neighborhood Outdoor Spatial Elements	<-->	Types of Leisure Activities	0.382	0.257	0.506	0.254	0.503
Neighborhood Outdoor Spatial Elements	<-->	Emotional Experience	0.664	0.569	0.736	0.578	0.740
Neighborhood Outdoor Spatial Elements	<-->	Quality of Life	0.513	0.409	0.611	0.408	0.609
Types of Leisure Activities	<-->	Emotional Experience	0.520	0.392	0.634	0.391	0.633
Types of Leisure Activities	<-->	Quality of Life	0.461	0.335	0.585	0.336	0.585
Emotional Experience	<-->	Quality of Life	0.569	0.476	0.660	0.474	0.659

4.5 Validity of the measurement model

The measurement model was evaluated for convergent and discriminant validity. Convergent validity was supported with factor loadings exceeding 0.5, composite reliability (CR) above 0.6, and average variance extracted (AVE) exceeding 0.5 for emotional experience

(AVE = 0.707). While AVE for other constructs was below 0.5, CR values above 0.6 indicated acceptable convergent effects (Fornell & Larcker, 1981; Hair, 2010). Discriminant validity, assessed using the Bootstrap confidence interval method, showed no overlap of standardized correlation confidence intervals with 1, confirming distinctiveness among constructs (Torkzadeh, Koufteros, & Pflughoeft, 2003). The overall structural model fit was verified using the Bollen-Stine Bootstrap.

4.6 The structure model

The structural model demonstrated validity with satisfactory goodness-of-fit (GOF) indices: χ^2 = 128.776 (df = 113), χ^2/df = 1.140, GFI = 0.948, AGFI = 0.929, RMSEA = 0.017, SRMR = 0.051, NNFI = 0.992, CFI = 0.993, and IFI = 0.993 (Hair et al., 2010; Byrne, 2016; Schreiber et al., 2006; Tabachnick & Fidell, 2007). Path coefficients between constructs were significant, confirming the causality of the six hypothesized models (H1-H6) (Table 8).

The correlation coefficients between the four constructs in the structural model, derived from causality path estimation, are as follows: 0.37 (H1: NE → AT), 0.55 (H2: NE → EMO), 0.23 (H3: NE → QOL), 0.28 (H4: AT → EMO), 0.19 (H5: AT → QOL), and 0.31 (H6: EMO → QOL). All six coefficients are statistically significant ($p < 0.01$), affirming the robustness of the structural model. These results validate the hypothesized causal relationships H1 through H6. Specifically, elements of neighborhood outdoor leisure spaces (NE) directly influence the type of leisure activity (AT), emotional experiences (EMO), and quality of life (QOL). Furthermore, leisure activity type (AT) has a direct impact on both emotional experiences (EMO) and quality of life (QOL), while emotional experiences (EMO) also directly affect quality of life (QOL). Thus, the study confirms support for hypotheses H1 to H6 (Fig. 4).

Table 8. Model goodness of fit after Bollen-Stine Bootstrap modification

Model indicator	Recommended Standards(Fit standard or critical value)	Model fit	Model fit judgement
Bollen-Stine χ2	The smaller the better	128.776	
DF (degree of freedom)	The larger the better	113	
Normed Chi-sqr (χ2/DF)	1<χ2/DF<3	1.140	yes
GFI	>0.9	0.948	yes
AGFI	>0.8	0.929	yes
RMSEA	<0.08	0.018	yes
SRMR	<0.08	0.051	yes
TLI (NNFI)	>0.9	0.992	yes
CFI	>0.9	0.993	yes
IFI	>0.9	0.993	yes
Hoelter's N (CN)	>200	362.140	yes

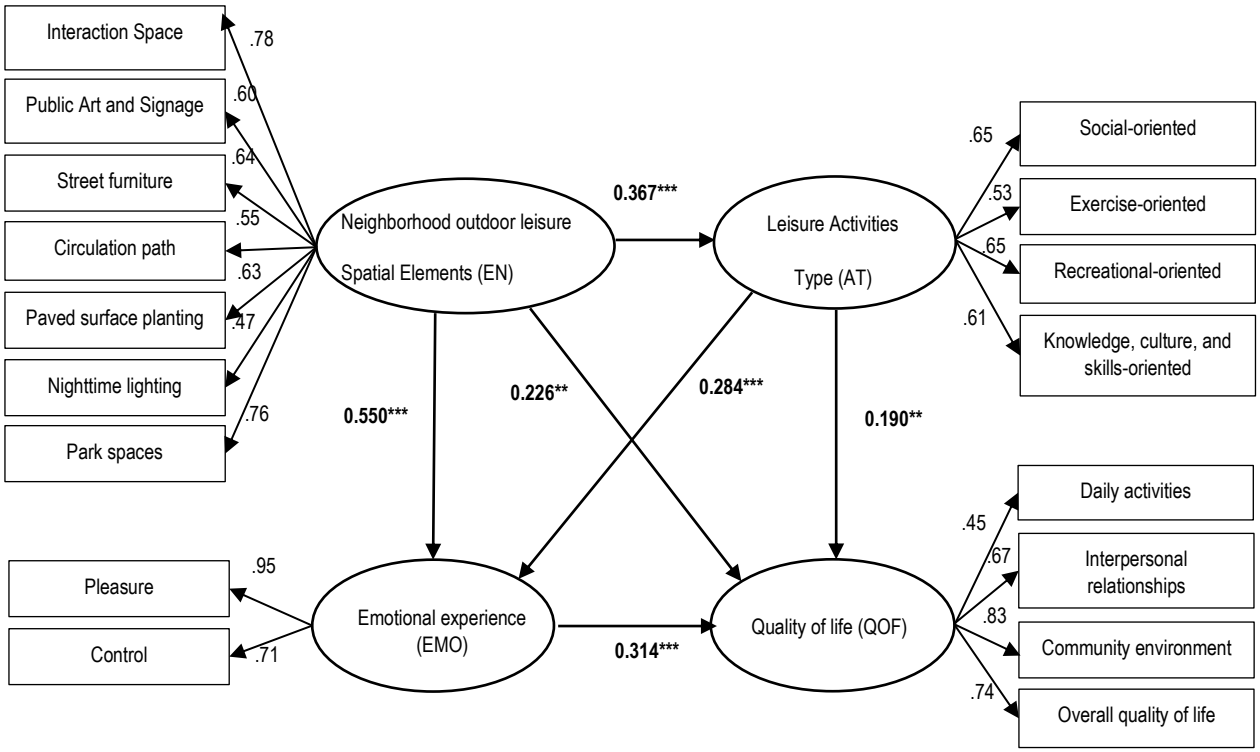

Fig. 4: Model standardized path estimation

4.7 Effects of leisure activities and emotional experiences to quality of life

To evaluate the mediation effects of leisure activity types and emotional experiences on the relationship between neighborhood outdoor leisure space elements and quality of life (QOL), two conditions must be met: (1) the relationships among constructs must be significantly

independent, and (2) the direct effects of outdoor leisure space elements on QOL must diminish in the presence of mediating variables, indicating mediation (Hair, 2010).

As presented in Table 8, the regression relationships among constructs were statistically significant. For the model examining emotional experience as a mediator, the indirect effect of outdoor leisure space elements on QOL (0.173) was weaker than the direct effect, confirming that emotional experience functions as a mediating variable. Similarly, in the model with leisure activity type as the mediator, the indirect effect (0.069) was weaker than the direct effect, demonstrating its mediation role. In the combined mediation model involving both activity types and emotional experiences, the indirect effect (0.033) was also weaker than the direct effect, suggesting a remote mediation effect (Table 9).

These findings indicate that neighborhood outdoor leisure space elements influence QOL through their impact on leisure activity choices and emotional experiences. Additionally, such spaces stimulate specific leisure activities and emotional responses, ultimately enhancing individual QOL. Therefore, hypothesis H7—asserting that leisure activity types and emotional experiences mediate the relationship between outdoor leisure space elements and QOL—is supported.

Table 9. Mediation variables for emotional experience

Standardized estimates	Direct effect	Indirect effect	Overall
NE→AT→QOL	0.226	0.069	0.295
NE→EMO→QOL	0.226	0.173	0.399
NE→AT→EMO	0.550	0.104	0.654
AT→EMO→QOL	0.190	0.089	0.279
NE→AT→EMO→QOL	0.226	0.275a	0.501

Neighborhood outdoor space elements (NE), leisure activity types (AT), emotional experience (EMO), qualify of life (QOL)
NE→AT→EMO→QOL remote mediation:0.367*0.284*0.314=0.033
a.NE→AT→EMO→QOL indirect effect:0.069+0.173+0.033=0.275

5.0 Discussion

5.1 Feedback on previous studies

This study provides empirical evidence that neighborhood outdoor leisure space elements significantly influence leisure activity types, emotional experiences, and quality of life (QOL). The findings demonstrate that leisure activity types and emotional experiences are critical mediators, amplifying the indirect effects of outdoor space elements on QOL. The results corroborate prior research indicating that environmental design plays a pivotal role in shaping human well-being through sensory and emotional stimulation (Sheets & Manzer, 1991; Giles-Corti et al., 2005; Abbasi et al., 2016).

Building on existing literature, this study highlights that the indirect effects of leisure activity types and emotional experiences on QOL are greater than their direct effects. This underscores the importance of fostering meaningful and enjoyable interactions within these spaces. For instance, Sugiyama et al. (2009) emphasized that open spaces reduce loneliness and enhance satisfaction, particularly among the elderly. Similarly, recent studies suggest that green infrastructure not only mitigates urban stress but also encourages active lifestyles (Kabisch & Haase, 2014; Korpela et al., 2018).

Notably, parks emerged as a critical component in outdoor space planning. Their therapeutic benefits, combining natural elements with community engagement, align with findings from Koohsari et al. (2018) and Fastame et al. (2018), which show that such spaces support mental and physical health across diverse demographic groups. This is especially relevant in urban renewal contexts, where thoughtful designs can revitalize community ties and individual well-being (Yung et al., 2016).

5.2 Insights from Findings

Cumulative Effects of Design Elements: The study identifies social spaces, parks, street furniture, vegetation, and thoughtful pavement as crucial elements that directly stimulate leisure activities and emotional engagement. This confirms the importance of well-designed public spaces in urban planning (Gehl, 1987; Kabisch & Haase, 2014).

Mediation Role of Emotional Experiences: Emotional responses to outdoor environments amplify the QOL impact, supporting the theory that such spaces facilitate stress relief, improve mood, and foster positive social interactions (Ulrich, 1986; Kaplan, 1985).

Activity Types and Inclusivity: Neighborhood spaces cater to diverse leisure activities, promoting physical health, social bonding, and mental well-being. These align with Paggi et al. (2016), who observed leisure activities' role in enhancing life satisfaction across different age groups.

5.3 Implications for Urban Design

Design for Emotional and Social Engagement: Urban designers should prioritize creating spaces that facilitate both social interaction and personal reflection. Elements such as accessible seating, well-maintained greenery, and aesthetically pleasing pathways can enhance user engagement and emotional response (Russell & Snodgrass, 1987; Triguero-Mas et al., 2017).

Multifunctional Spaces for Diverse Activities: Incorporating areas for recreational, educational, and social activities can cater to varied community needs. For example, integrating natural elements like vegetation and water features can evoke positive emotional states (Ulrich, 1983; Tyrväinen et al., 2014).

Equitable Access and Inclusivity: Ensuring outdoor leisure spaces are accessible to all age groups, physical abilities, and socio-economic backgrounds is essential. Features like shaded areas, interactive art installations, and safe pathways can make these spaces inviting for diverse users.

Evidence-Based Urban Renewal: The findings support the inclusion of emotional and experiential metrics in urban design evaluations. As highlighted by Scannell & Gifford (2010), such approaches ensure that spaces are functional and deeply aligned with human psychological needs.

6.0 Conclusion and Recommendation

6.1 Value of the findings

This study demonstrates that neighborhood outdoor leisure spaces significantly influence residents' quality of life (QOL) through direct effects on leisure activity types and emotional experiences and indirect pathways mediated by these factors. By empirically validating the role of outdoor space features in shaping psychological and social outcomes, this research contributes to the growing body of knowledge in environmental psychology and urban design. It provides a nuanced understanding of how specific spatial features, such as accessibility, vegetation, and social spaces, interact to enhance QOL.

Furthermore, this study bridges theoretical frameworks and practical applications by presenting an integrated model that captures the interplay between environmental design and human behavioral responses. Doing so advances existing literature by addressing critical gaps, such as the indirect effects of space features on emotional well-being and the role of leisure activities as mediating variables. The findings offer valuable insights for urban planners and policymakers, equipping them with evidence-based guidelines for creating outdoor spaces that are not only functional but also emotionally restorative, socially inclusive, and sustainable.

6.2 Study Limitations

Some limitations are as follows. Geographical Scope: The study was conducted in Tainan, Taiwan, limiting the generalizability of findings to other cultural or urban contexts. Cross-Sectional Data: The use of a cross-sectional survey restricts insights into long-term impacts and causal relationships. Self-Reported Responses: Reliance on self-reported data introduces potential biases, such as social desirability or recall inaccuracies. Limited Demographic Scope: The study's focus on specific communities and age ranges may exclude insights from more diverse populations.

6.3 Retrospective Evaluation and Contributions

The study makes significant contributions to the understanding of neighborhood outdoor spaces and their impact on quality of life (QOL).

Empirical Validation: The study offers empirical validation by confirming prior research on the mediating roles of leisure activities and emotional experiences in linking environmental features to QOL.

Integrated Framework: The study presents an integrated framework that incorporates emotional and activity-based constructs, thereby bridging critical gaps in understanding how outdoor spaces influence the psychological and social dimensions of QOL.

Actionable Insights: The research provides actionable insights, offering evidence-based guidelines for urban planners and policymakers to design spaces that are not only functional but also emotionally restorative and socially inclusive.

6.4 Recommendations for Improving the Situation

To improve the effectiveness of neighborhood outdoor spaces, several key recommendations are proposed.

Inclusive Design Strategies:

Inclusive design strategies should be prioritized to ensure universal accessibility, incorporating features such as shaded seating, interactive elements, and barrier-free pathways that cater to diverse user needs.

Enhancing Green Infrastructure:

Enhancing green infrastructure by integrating vegetation and water features can amplify both psychological benefits and ecological sustainability.

Enhancing Green Infrastructure:

Community-centric design approaches should be adopted, actively engaging residents in the design process to align spaces with their specific needs and foster a sense of ownership.

Maintenance and Upkeep:

Regular maintenance and upkeep are essential to ensure safety, usability, and aesthetic appeal, thereby encouraging continuous engagement with these spaces.

6.5 New Directions for Future Research

Future research on neighborhood outdoor spaces and their impact on quality of life (QOL) can explore several promising directions. Longitudinal Studies: 1. Conducting longitudinal studies would allow researchers to evaluate the sustained impacts of outdoor spaces on QOL over time, offering deeper insights into long-term effects. 2. Cross-Cultural Comparisons: Cross-cultural comparisons across diverse cultural and urban contexts can help identify universal principles and context-specific dynamics. 3. Technological Integration: Integrating smart technologies, such as augmented reality or app-based feedback systems, could enhance both the functionality and appeal of these spaces. 4. Climate Adaptation: Investigating climate adaptation strategies would reveal how outdoor leisure spaces can

address climate resilience while maintaining their social and emotional benefits. 5. Qualitative Insights: Combining quantitative surveys with qualitative methods, such as interviews or participatory observations, would provide richer and more nuanced insights into user experiences. Together, these directions promise to deepen understanding and expand practical applications in urban design and planning.

In conclusion, this research provides a foundational understanding of how neighborhood outdoor leisure spaces impact QOL, offering actionable recommendations for urban design and future research directions. By addressing its limitations and leveraging new technologies and methodologies, further studies can refine and expand on these findings, creating more sustainable, inclusive, and enriching urban environments.

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