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Urban Density-Dependent Effects of Neighborhood Park Spatial Features: Evidence from the Seoul Metropolitan Area

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Abstract

This study examines how users' preferences for spatial elements in neighborhood parks influence satisfaction and assesses the moderating role of urban density in this relationship. An online survey was conducted with 283 residents in the Seoul Metropolitan Area, and the study area was classified into high-, medium-, and low-density urban contexts. Exploratory factor analysis was employed to derive key spatial elements, and multiple regression and moderation analyses were conducted to empirically verify the relationship between the respondents' spatial preferences and satisfaction. The study finds that the spatial elements of neighborhood parks have significantly varying effects on user satisfaction based on urban density. Specifically, natural and community spaces were identified as core elements that consistently influenced satisfaction across all urban density levels. In contrast, multifunctional cultural spaces were the only significant predictors of the relationship between spatial preferences and satisfaction in high-density spaces and urban-landscape spaces only had a significant influence in medium-density areas. The findings suggest that the spatial elements of neighborhood parks do not operate universally; rather, their effects on user satisfaction are context-dependent and shaped by urban density.

Keywords: urban green infrastructure; cultural ecosystem services; urban density; spatial preferences; user satisfaction

1. Introduction

Rapid urbanization has introduced a number of complex challenges worldwide, including environmental stress, social fragmentation, and public health crises. Increasing attention has been directed toward nature-based solutions, with green infrastructure emerging as a promising alternative for gray infrastructure-oriented development [1–3]. Green infrastructure refers to multifunctional systems enhancing urban sustainability and residents' quality of life by integrating urban green spaces and ecosystem services [4,5].

Neighborhood parks represent a key practical implementation of green infrastructure, and they have been recognized as essential urban green spaces enabling residents to engage with nature, rest, and interact with others within their daily living environments. Besides performing ecological functions, such as regulating the microclimate and conserving biodiversity, they also provide social and psychological benefits that are closely associated with residents' quality of life [6–9]. Therefore, in contemporary discussions on urban sustainability, neighborhood parks are increasingly recognized as crucial everyday public spaces that contribute to environmental resilience, public health promotion, and community formation.

Recent studies have examined the social and psychological values of neighborhood parks systematically through the cultural ecosystem services (CES) framework. CES encom-

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pass the intangible benefits provided by these parks, such as leisure, recreation, psychological restoration, place attachment, and community-building, and have become a key means for understanding the relationship between residents and their living environment [10]. In this regard, a previous study indicates that neighborhood parks facilitate daily contact with nature, which contributes significantly to reducing stress, restoring mental health, and enhancing physical health [11]. Furthermore, neighborhood parks enable nature connectedness and place attachment to function as important psychological factors shaping residents' environmental attitudes and life satisfaction [12–14]. These findings demonstrate that the value of neighborhood parks is not only determined by their physical attributes or facilities but also mediated through users' perceptions and experiences.

From the perspective of urban design, neighborhood parks should be conceptualized as physical settings and everyday public spaces where daily life and social interactions are repeatedly accumulated [15]. Accordingly, users' evaluations of these parks are likely to depend more on their qualitative spatial characteristics, which shape user experience and satisfaction, than on quantitative indicators such as size or provision levels. Empirical studies have shown that user-perceived spatial elements—including facility composition, accessibility, and surrounding environmental characteristics—significantly influence satisfaction, highlighting the importance of perception-based approaches [16]. Users' perceptions of parks' spatial components and their spatial preferences serve as key determinants in the formation of satisfaction and are thus key predictors of these qualitative attributes. However, while previous studies have explored the effects of service areas and accessibility [17,18], usage patterns and satisfaction [8,19], and the equity and public health implications of green spaces [20], these studies have generally been confined to specific cities or homogeneous spatial contexts. In comparison, comparative analyses examining how the variance of spatial preferences and satisfaction formation across different urban contexts remain limited.

Neighborhood parks are located in highly distinct urban contexts. Disparities in population density, land-use structure, and the availability of surrounding natural environments lead to variations in these parks' functions and users' spatial preferences. For example, in high-density metropolitan areas, neighborhood parks are more likely to be perceived as spaces for psychological restoration, serving a compensatory role for residents' lack of everyday contact with nature [21]. Conversely, in relatively low-density areas, they function more prominently as social spaces that facilitate community interactions. However, despite the fact that such contextual differences can structurally influence spatial preferences and satisfaction, few studies have empirically investigated the effects of these variations.

To address this gap in the literature, this study empirically examines how users' preferences for spatial elements in neighborhood parks affect their satisfaction, focusing on the moderating role of urban density. Specifically, this study tests whether spatial preferences differ according to urban density (H1) and whether urban density moderates the relationship between spatial preferences and user satisfaction (H2).

H1. *Users' spatial preferences for neighborhood park elements differ significantly according to urban density levels.*

H2. *Urban density significantly moderates the relationship between spatial preferences for neighborhood park elements and user satisfaction.*

The Seoul Metropolitan Area, which exhibits a diversity of urban types ranging from highly dense metropolitan environments to low-density cities, was selected as the study area. Based on the findings, this study seeks to interpret the importance of the spatial elements of neighborhood parks from a design perspective, with urban density as a key

contextual variable, and derive theoretical implications that would contribute to developing context-sensitive planning and design strategies for neighborhood parks.

2. Theoretical Background

2.1. CES of Neighborhood Parks and User Experience Perception

Neighborhood parks serve as urban green spaces that enable residents to engage with nature within their daily living environments, providing a wide range of CES, which encompass intangible benefits such as leisure, recreation, psychological restoration, place attachment, and social interactions [22]. Unlike other ecosystem services, the value of CES is primarily formed through users' subjective perceptions and experiences [23]. Thus, the value of neighborhood parks cannot be fully captured solely by physical provisions or functional efficiency. Previous studies have demonstrated that the psychological and emotional benefits of neighborhood parks, including emotional stability, stress reduction, and the quality of daily restorative experiences, are closely associated with user satisfaction [24–26]. These findings highlight the necessity of adopting an experience-centered approach to evaluate the functions and effects of neighborhood parks.

Beyond structured activities such as walking or exercising, user experiences in neighborhood parks encompass diverse forms of engagement, including personal relaxation and contemplation, interactions with pets, informal social encounters, and incidental use along daily movement. These experiences differ depending on users' life contexts and spatial perceptions; thus, neighborhood parks are positioned as multifunctional spaces where rest, social interaction, and psychological restoration overlap [6,27]. In particular, psychological restoration constitutes a core component of CES, with the restorative effects of natural environments being explained through attention restoration theory and stress recovery theory [28,29]. Restorative experiences serve as key pathways for user satisfaction, suggesting that the value of neighborhood parks is not unilaterally determined by physical accessibility or facility provision [30,31], but also by how users perceive and experience these spaces within their everyday lives.

This perspective aligns with Sustainable Development Goal 11 by extending the meaning of "safe, inclusive, and accessible green and public spaces" into an experiential dimension [32]. Similarly, recent studies argue that the value of urban green spaces should be understood as a multidimensional construct that encompasses actual use experiences, user perceptions, and perceived environmental quality, rather than being assessed solely through indicators of physical distribution or service provision [33–35]. In turn, policies for the development of sustainable urban green spaces should move beyond supply-oriented metrics and incorporate evaluation frameworks that reflect the quality of user experience and perception.

2.2. Context-Dependent Values of Neighborhood Park Spatial Elements

As mentioned previously, CES in neighborhood parks are formed through user experiences; the contents and quality of these experiences vary depending on urban context and the specific characteristics of spatial elements. From this perspective, CES can be understood as values that are grounded in users' subjective experiences [36–38], where the meaning and effects of spatial attributes differ based on how users perceive and interpret them [23].

In this context, the significance of the spatial elements of neighborhood parks lies not in their inherent physical properties but in their role in shaping CES through the user experience, which subsequently informs overall spatial evaluation. Spatial elements such as natural features, resting areas, landscape aesthetics, and spaces for social activities derive meaning through user experiences, including psychological restoration, emotional

stability, social interaction, and place attachment. These experiential processes ultimately constitute the key pathways for the formation of user satisfaction, highlighting the need to examine differentiated experiential structures associated with specific spatial elements of neighborhood parks.

However, existing research tends to conceptualize the relationship between spatial attributes and user satisfaction as a universal phenomenon that is largely independent of urban context. While variables such as green coverage, facility diversity, accessibility, and landscape quality have been repeatedly employed as key explanatory factors [39,40], these studies do not give enough attention to how these spatial elements operate differently across diverse urban environments through the lens of user experience [41,42]. As a result, the effects of spatial elements are often reduced to average relationships that fail to capture contextual variability.

The context dependency of spatial elements is particularly evident in relation to urban density. In high-density urban environments, which exhibit few opportunities for daily contact with nature, users often value neighborhood parks as spaces for psychological restoration and emotional buffering, with naturalness and restorative environmental qualities serving as key determinants of user experience [7,43]. In contrast, in low-density cities with relatively abundant access to natural environments, neighborhood parks serve as spaces for social interactions and daily community use [44,45]. In such contexts, elements that facilitate communal activities, open spatial configurations, and user interactions may play more significant roles in shaping user experience and satisfaction [46,47].

The existing literature remains focused on single cities or limited urban typologies, resulting in a lack of comparative empirical analysis of the effects of spatial elements on user satisfaction across varying levels of urban density. Furthermore, studies emphasizing external conditions such as park distribution or accessibility have failed to comprehensively explain the role of internal spatial elements in shaping experiences and satisfaction [7,20]. To address this gap, this study conceptualizes the relationships among spatial elements, user experience, and satisfaction as context-dependent structures shaped by urban environments and empirically examines these relationships. To this end, spatial preferences are operationalized as a form of spatial evaluation reflecting user experience.

3. Methods

3.1. Study Area and Context

To empirically examine differentiated design strategies for neighborhood parks across urban densities, this study selected the Seoul Metropolitan Area in the Republic of Korea. This region exhibits pronounced spatial heterogeneity. Comprising Seoul Metropolitan City and Gyeonggi Province, the Seoul Metropolitan Area is a mega-urban region characterized by a high-density environment that accommodates approximately 40% of the national population. It contains a spectrum of urban hierarchies that differ substantially in terms of population density, land-use intensity, and the availability of natural capital. These structural characteristics provide strong analytical validity for comparing variations in users' perceptions and preferences across different levels of urbanization.

To analyze differences in the perceived importance of the spatial elements of neighborhood parks, the study area was classified into three urban types based on population density and the availability of natural environments: (1) high density (Seoul); (2) medium density (*dong*-level districts in Gyeonggi Province); (3) low density (*eup*- and *myeon*-level districts in Gyeonggi Province).

This classification was operationalized using population density and per capita urban park area (Figure 1). Seoul, representing the high-density category, exhibits an extremely high population density of 15,425 persons/km^2 along with a relatively low per capita urban

park area of 4.99 m^2. In comparison, medium-density areas demonstrate a population density of 3259 persons/km^2, which is lower than that of Seoul but reflects a considerable level of urban intensity, and a relatively higher per capita park area of 10.11 m^2. Finally, low-density areas exhibit a substantially lower population density of 294 persons/km^2 and the highest per capita park area at 10.53 m^2. Accordingly, the classification of urban types reflects not only administrative distinctions but also differences in spatial density and access to green space within everyday living environments (Table 1).

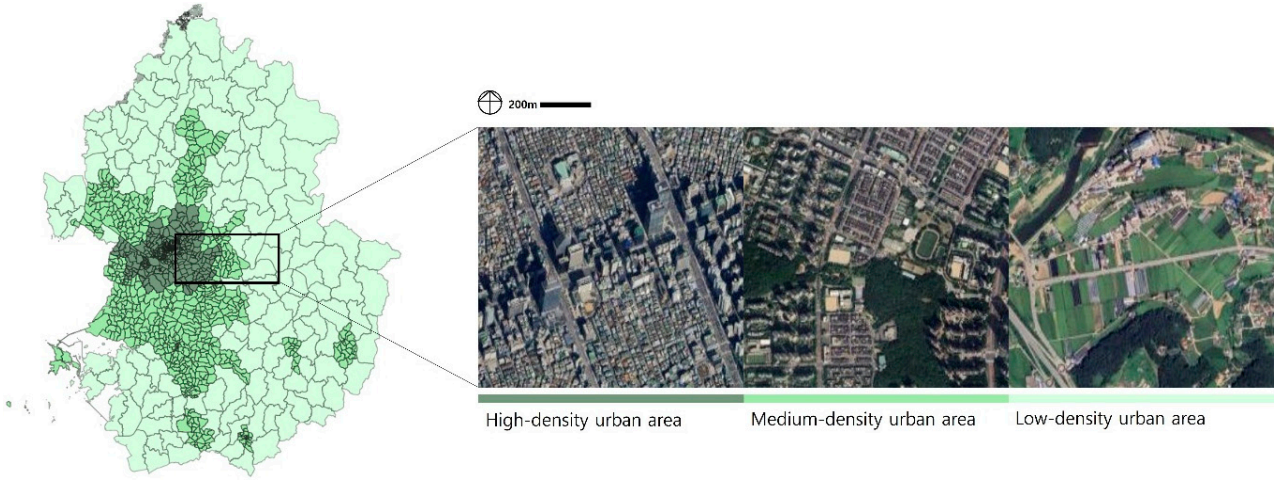


Figure 1. Study area. Sources: Google Maps (accessed on 16 February 2026, https://www.google.com/maps).

Table 1. Overview of study areas.

Area	Population (Persons, %)	Area (km^2)	Population Density (Persons/km^2)	Park Area (km^2)	Urban Park Area per Capita (m^2/Person)
National total	51,805,547 (100%)	100,378	516	605	11.68
High-density (Seoul)	9,335,444 (18.0%)	605	15,425	46.6	4.99
Medium-density (*dong*-level districts in Gyeonggi Province)	9,585,563 (18.5%)	2941	3259	96.9	10.11
Low-density (*eup*- and *myeon*-level districts in Gyeonggi Province)	2,041,659 (3.9%)	6956	294	21.5	10.53

Note: Data were adapted and summarized from population and urban park statistics provided by Statistics Korea (KOSIS) and the Korea Public Data Portal [48,49].

Seoul, representing the high-density type, exhibits a compact urban structure with an intense concentration of population within a limited land area. The accumulation of residential and commercial uses creates a scarcity of everyday green space; consequently, neighborhood parks primarily function as critical restorative environments and essential public goods that offer rare opportunities for contact with nature.

Medium-density areas function as satellite cities of Seoul, with lower floor-area ratios and relatively planned urban structures. These areas typically exhibit residential-centered land use, complemented by commercial and business functions. Neighborhood parks are integrated into urban infrastructure and serve as central public spaces for daily leisure and social interactions.

Low-density areas are characterized by low population density and high proximity to non-urban natural environments, such as agricultural land and forests. In these regions,

neighborhood parks primarily function as leisure nodes connected to extensive surrounding natural resources. Accordingly, patterns of use and user preferences in these areas are expected to diverge from those observed in high-density urban environments.

Table 1 presents detailed physical and demographic indicators of the study area. This multilayered classification enables comparative evaluations of neighborhood parks across diverse urban scales and densities, providing an empirical foundation for the development of context-sensitive design guidelines in future planning and practice.

3.2. Measurement Variables

The measurement variables are derived by reconstructing the multidimensional functions of CES in urban parks, as reviewed in Section 2, focusing on users' actual spatial experiences. For this purpose, prior studies addressing the multifaceted benefits provided by parks—such as health promotion, psychological restoration, social interaction, and landscape and cultural values—were comprehensively reviewed from a CES perspective [7,18,20,21,36,43,50–59].

Subsequently, park functions, which have traditionally been conceptualized from a provider-oriented perspective, were reinterpreted based on user experiences, and conceptually similar functions were integrated according to qualitative similarity. As a result, five spatial elements were identified: natural, rest and leisure, urban-landscape, community, and multifunctional cultural spaces. This approach shifts from cataloguing physical park attributes to constructing grounded in user experience and meaning.

As discussed in Section 2, each spatial element reflects distinct user experience characteristics from a CES perspective. Natural spaces correspond to psychological restoration and emotional stability; rest and leisure spaces to physical activity and everyday well-being; urban-landscape spaces to aesthetic experiences and place perception; community spaces to social interactions and a sense of belonging; and multifunctional cultural spaces to value formation and learning experiences. The prior studies underpinning the variable derivation and the corresponding relationships among spatial elements are presented in Table 2.

Table 2. Conceptual framework and variable operation.

Park Function	Conceptualization of Space	Spatial Elements	User Experience	Measurement Items (5-Point Likert Scale)
Environmental/ Ecological Function	Spaces where natural elements shape users' emotional and sensory experiences	Natural ecological space	Psychological restoration, emotional stability, sense of connection to nature	Preference for natural spaces
Leisure and Rest Function	Spaces where movement and rest overlap, forming everyday use experiences	Leisure and recreation space	Rest, stress relief, everyday recovery	Preference for leisure and rest spaces
Landscape and Aesthetic Function	Spaces that shape visual experiences and place image	Urban landscape space	Aesthetic experience, place attachment, place identity	Preference for urban landscape spaces
Social and Cultural Function	Spaces where social interaction and local identity are realized	Community space	Social relations, sense of belonging, collective memory	Preference for community spaces
Educational Function	Spaces that induce cognitive transformation through experience and learning	Multi-functional cultural space	Value formation, learning experiences	Preference for multifunctional cultural spaces

Spatial preference was conceptualized as a form of spatial evaluation reflecting user experience and was measured using a five-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"), for each spatial element. The construct validity of the derived variables was assessed using exploratory factor analysis (EFA). The analysis identi-

fied five distinct factors, each with an eigenvalue greater than 1.0. The cumulative variance explained by the factor structure reached 67.435%, indicating an adequate explanatory capacity for spatial preferences. In addition, the Cronbach's α exceeded 0.7 for all factors, confirming satisfactory internal consistency and reliability. The single factor used to measure user satisfaction demonstrated a variance of 73.502% and a reliability coefficient of 0.873, further validating the stability of the measurement results. Final factor names and statistical indicators are presented in Table 3.

Table 3. Results of exploratory factor analysis.

Category	Factor	Factor Loadings	Eigenvalue	Variance Explained (%)	Cronbach's α
Spatial preferences	Natural space	N1 (0.856), N2 (0.777), N3 (0.757), N4 (0.764)	3.096	15.481	0.864
	Leisure and rest space	L1 (0.721), L2 (0.707), L3 (0.661), L4 (0.592)	2.464	12.318	0.768
	Urban-landscape space	U1 (0.626), U2 (0.666), U3 (0.563), U4 (0.558)	2.594	12.969	0.744
	Community space	C1 (0.696), C2 (0.737), C3 (0.764)	1.890	9.448	0.767
	Multifunctional cultural space	M1 (0.594), M2 (0.719), M3 (0.773), M4 (0.836), M5 (0.816)	3.444	17.219	0.868
Park satisfaction	User satisfaction	S1 (0.900), S2 (0.865), S3 (0.786), S4 (0.873)	2.940	73.502	0.873

Note: Detailed descriptions of factors and measurement items are provided in the Supplementary Materials.

3.3. Research Model

To examine the differential effects of spatial preferences on user satisfaction across varying levels of urban density, this study established a research model illustrated in Figure 2. The independent variables comprise five spatial elements derived and validated through EFA, and the dependent variable is overall user satisfaction. Urban density, classified as high, medium, and low density, was incorporated as a moderating variable. Through this model, the study empirically investigates how the relationships between the spatial elements of neighborhood parks and user satisfaction vary according to urban density.

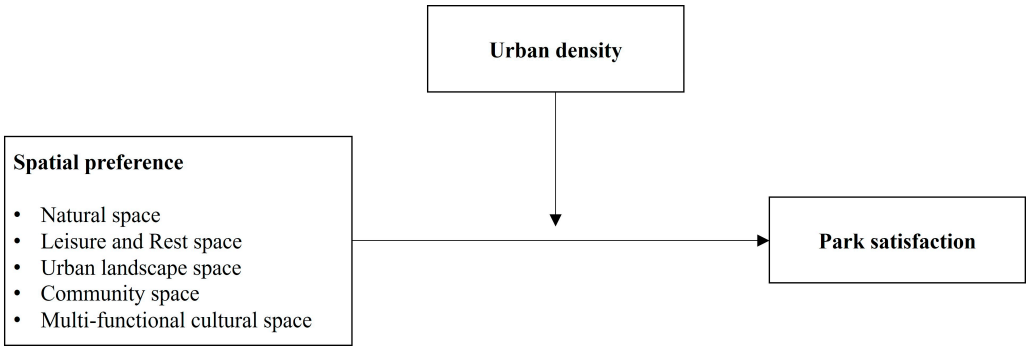


Figure 2. Research model.

3.4. Data Collection

Data were collected through an online survey administered through a professional research firm's panel between 29 January and 4 February 2026. The survey targeted adults with prior experience of using neighborhood parks near their residences. A stratified

sampling strategy based on place of residence was employed, focusing on Seoul, *dong*-level districts in Gyeonggi Province, and *eup–myeon* districts in Gyeonggi Province.

A total of 300 questionnaires were distributed. Following a rigorous screening process to exclude insincere or logically inconsistent responses, 283 questionnaires were retained for analysis, yielding an effective response rate of 94.3%. To assess the adequacy of the sample size, an a priori power analysis was conducted using G*Power version 3.1.9.7. The analysis employed an F-test for multiple regression with five predictors, assuming a medium effect size ($f^2 = 0.15$), a significance level of $\alpha = 0.05$, and statistical power of $1 - \beta = 0.80$. The results indicated a minimum required sample size of 92 respondents. Accordingly, the final valid sample (N = 283) was deemed sufficient to ensure adequate statistical power for the analyses. Moreover, each analytical subgroup (Seoul, *dong*-level districts in Gyeonggi Province, and *eup*- and *myeon*-level districts in Gyeonggi Province) included more than 92 valid responses. This distribution provided sufficient statistical power to conduct independent regression analyses and comparative analyses across urban contexts.

3.5. Analytical Methods

Multiple regression and moderation analyses were conducted using IBM SPSS Statistics (Version 24). Separate regression models were estimated for high-, medium-, and low-density urban areas to compare the relative effects of spatial elements on user satisfaction. Stepwise multiple regression analysis was employed as an exploratory approach to identify the relative influence of multiple spatial variables and select key predictors with statistically significant explanatory power. Through this process, a parsimonious model was derived by retaining only those variables that made significant contributions to explaining the dependent variable.

Model fit was assessed using the adjusted coefficient of determination (adjusted R^2), and the overall statistical significance of each regression model was assessed using F-tests. Residual autocorrelation was examined using Durbin–Watson statistics. Standardized regression coefficients (β) were reported to facilitate comparison of effect sizes and the relative importance of independent variables, with statistical significance set at $p < 0.05$. Variance inflation factor values for all predictors remained below the recommended threshold, indicating that multicollinearity was not a concern.

To examine the moderating effect of urban density, moderated regression analyses were conducted using PROCESS Macro version 4.2 developed by Hayes. PROCESS Model 1 was applied, with urban density specified as the moderating variable, to assess whether the relationship between spatial preferences and user satisfaction varied across different urban density contexts. Urban density was operationalized as a dummy-coded variable. The statistical significance of moderation effects was evaluated based on regression coefficients, t-values, and *p*-values. Confidence intervals were estimated at the 95% level using a bootstrapping procedure with 5000 iterations. Moderation effects were considered statistically significant when the confidence intervals did not include zero.

4. Results

4.1. Respondent Characteristics

Table 4 presents the respondents' demographic characteristics. The respondents' gender distribution was relatively balanced, with males accounting for 48.1% and females for 51.9%. Regarding age, respondents in their 40s constituted the largest cohort (26.5%), followed by those in their 30s (20.1%) and 60s (17.7%). With respect to place of residence, the sample was evenly distributed across the three urban density levels, with 32.5% residing in high-density areas, 33.9% in medium-density areas, and 33.6% in low-density areas.

Table 4. Demographic characteristics of respondents (N = 283).

Category	Item	N	%
Gender	Male	136	48.1
	Female	147	51.9
Age	20s	31	11.0
	30s	57	20.1
	40s	75	26.5
	50s	41	14.5
	60s	50	17.7
	70 and over	29	10.2
Place of residence	High-density urban area	92	32.5
	Medium-density urban area	96	33.9
	Low-density urban area	95	33.6

4.2. Results of Regression Analysis

To examine the effects of spatial preferences for neighborhood park elements on user satisfaction across urban density levels, multiple regression analyses were conducted, classifying areas into high-, medium-, and low-density categories (Table 5). The results indicate that the spatial preference factors influencing satisfaction and their relative importance vary according to urban density.

Table 5. Results of multiple regression analysis (dependent variable: user satisfaction).

Variables	Model 1 (High-Density Urban Area)	Model 2 (Medium-Density Urban Area)	Model 3 (Low-Density Urban Area)
	β	*β*	*β*
Natural space	0.454 **	0.261 **	0.198 *
Leisure and rest space	–	0.240 **	0.196 *
Urban-landscape space	–	0.392 **	–
Community space	0.194 *	0.267 **	0.234 **
Multifunctional cultural space	0.228 *	–	–
Adjusted R^2	0.291	0.325	0.135
F-value	13.462 **	12.419 **	5.890 **
Durbin–Watson statistic	2.101	2.084	1.950

Note: * $p < 0.05$, ** $p < 0.01$.

In high-density urban areas, natural ($\beta = 0.454$, $p < 0.01$), multifunctional cultural ($\beta = 0.228$, $p < 0.05$), and community ($\beta = 0.194$, $p < 0.05$) spaces had significant positive effects on user satisfaction. Thus, in high-density environments, neighborhood parks enhance satisfaction through natural elements and spatial characteristics that facilitate educational, cultural, and social activities. The high-density model showed moderate explanatory power (Adj. $R^2 = 0.291$) and was statistically significant ($F = 13.462$, $p < 0.01$).

Meanwhile, in medium-density urban areas, urban-landscape ($\beta = 0.392$, $p < 0.01$), natural ($\beta = 0.261$, $p < 0.01$), community ($\beta = 0.267$, $p < 0.01$), and leisure and rest ($\beta = 0.240$, $p < 0.01$) spaces were all positively associated with user satisfaction. Notably, urban-landscape space emerged as the strongest predictor, highlighting the importance of visual comfort and spatial image in shaping satisfaction in medium-density urban areas. The medium-density model demonstrated relatively high explanatory power (Adj. $R^2 = 0.325$), and the F-test results supported the overall model fit ($F = 12.419$, $p < 0.01$).

Finally, in low-density urban areas, community ($\beta = 0.234$, $p < 0.01$), natural ($\beta = 0.198$, $p < 0.05$), and leisure and rest ($\beta = 0.196$, $p < 0.05$) spaces were identified as significant positive predictors of user satisfaction, whereas multifunctional cultural and urban-landscape

spaces did not have a statistically significant effect. This result suggests that, in low-density contexts, functional spatial characteristics that support everyday use and interpersonal interaction have a stronger influence on satisfaction than symbolic or visually oriented elements. Although the explanatory power of the low-density model was lower (Adj. $R^2 = 0.135$) than the other models, it remained statistically significant ($F = 5.890$, $p < 0.01$).

Overall, the results indicate that the effects of spatial preferences on user satisfaction in neighborhood parks vary by urban density. Natural and multifunctional cultural spaces are most influential in high-density areas; urban-landscape and leisure-related spaces play crucial roles in medium-density areas, and community spaces are central in low-density areas. These findings highlight the need for differentiated spatial strategies reflecting user characteristics and contextual demands in planning and designing neighborhood parks.

4.3. Moderating Effects of Urban Density

To determine whether urban density moderates the relationship between spatial preferences for neighborhood parks and user satisfaction, moderation regression analyses were conducted using PROCESS Macro (Model 1) (Figure 3). Urban density was specified as the moderating variable. The results of simple slope analyses indicate that the effects of spatial elements on user satisfaction are indeed dependent on urban density.

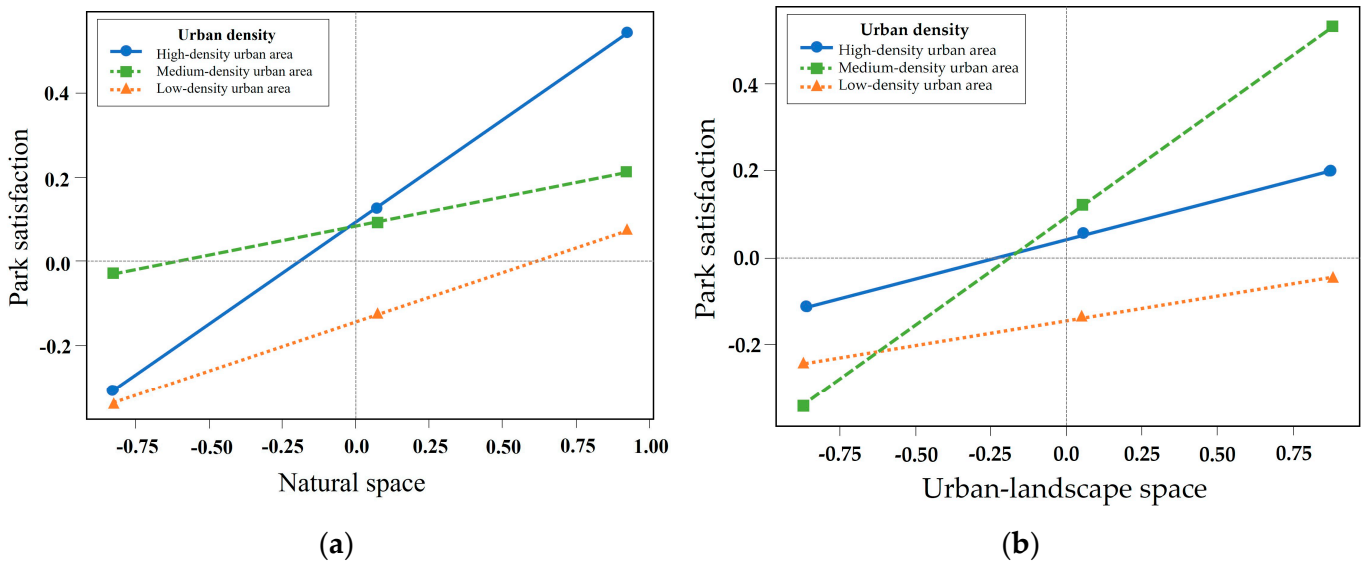


Figure 3. Simple slope plots illustrating the interaction effects between spatial preference and urban density on park satisfaction: (**a**) interaction between natural space preference and urban density; (**b**) interaction between urban-landscape space preference and urban density.

The moderating effects of urban density were statistically significant only for natural and urban-landscape spaces (Table 6). First, natural space exhibited a significant positive effect on user satisfaction in high-density urban areas ($B = 0.486$, $p < 0.001$, 95% CI [0.2937, 0.6791]). A statistically significant, albeit smaller, positive effect was also observed in low-density urban areas ($B = 0.235$, $p = 0.028$, 95% CI [0.0255, 0.4463]). In contrast, the effect of natural spaces did not reach statistical significance in medium-density urban areas.

Second, urban-landscape space showed a strong positive effect on user satisfaction exclusively in medium-density urban areas ($B = 0.496$, $p < 0.001$, 95% CI [0.2929, 0.6994]), with no significant effects detected in high- or low-density areas (Table 7). These findings suggest that spatial elements influence user satisfaction in a density-dependent manner. Certain elements only exert pronounced effects under specific urban density conditions, whereas others—such as community spaces—exhibit relatively consistent effects across contexts.

Table 6. Moderating effects of urban density on the relationship between spatial preferences and user satisfaction.

Variables	Model 1 (Natural Space)	Model 2 (Community Space)	Model 3 (Leisure and Rest Space)	Model 4 (Urban-Landscape Space)	Model 5 (Multifunctional Cultural Space)
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Constant	0.0975 (0.0998)	0.0618 (0.1005)	0.0048 (0.1034)	0.0457 (0.0998)	0.0419 (0.1037)
X (Spatial preference)	0.4864 ** (0.0979)	0.3224 * (0.1101)	0.2248 * (0.0983)	0.1773 (0.0934)	0.2395 * (0.1039)
W1 (High-density urban area)	−0.0127 (0.1394)	−0.0031 (0.1410)	0.0754 (0.1440)	0.0537 (0.1396)	0.0518 (0.1454)
W2 (Low-density urban area)	−0.2417 (0.1396)	−0.1834 (0.1410)	−0.1092 (0.1459)	−0.1859 (0.1400)	−0.1805 (0.1459)
X × W1	−0.3496 * (0.1344)	−0.0219 (0.1464)	0.0413 (0.1455)	0.3189 * (0.1392)	−0.2572 (0.1415)
X × W2	−0.2505 (0.1449)	−0.0815 (0.1449)	−0.0752 (0.1419)	−0.0639 (0.1370)	−0.2195 (0.1515)
Model fit					
R^2	0.1118	0.0913	0.0560	0.1007	0.0288
ΔR^2 (X × W)	0.0225	0.0012	0.0022	0.0264	0.0129
F	6.9715 **	5.5689 **	3.2893 *	6.2064 **	1.6421
ΔF (X × W)	3.5152 *	0.1801	0.3218	4.0714 *	1.8413

Note: N = 283. The dependent variable (Y) is user satisfaction with neighborhood parks. Urban density was dummy-coded, with medium-density urban areas as the reference group (W1 = 0, W2 = 0). * $p < 0.05$, ** $p < 0.01$.

Table 7. Conditional effects of spatial preferences on user satisfaction at different levels of urban density.

Model	Moderator (W: Urban Density)	B	SE	t	*p*	95% CI (LB)	95% CI (UB)
Natural space	High-density urban area	0.486	0.097	4.968	0.000 **	0.2937	0.6791
	Medium-density urban area	0.136	0.092	1.485	0.138	−0.0445	0.3181
	Low-density urban area	0.235	0.106	2.206	0.028 *	0.0255	0.4463
Urban landscape space	High-density urban area	0.177	0.093	1.897	0.058	−0.0066	0.3611
	Medium-density urban area	0.496	0.103	4.805	0.000 **	0.2929	0.6994
	Low-density urban area	0.113	0.100	1.130	0.289	−0.0841	0.3108

Note: * $p < 0.05$, ** $p < 0.01$.

5. Discussion

This study demonstrates that the effects of the spatial elements of neighborhood parks on user satisfaction are context-dependent and vary with urban density. This finding addresses a key limitation of previous studies, which largely focus on the average effects of individual spatial elements, and explicitly positions urban density as a critical moderating variable in the formation of satisfaction. Furthermore, these results offer empirical support for the development of differentiated park planning and design strategies that are tailored to varying levels of urban density.

5.1. Universal Spatial Elements and Threshold Effects

Natural and community spaces were identified as fundamental spatial elements that neighborhood parks should provide across all urban density levels. Therefore, naturalness and social interactions constitute core functions of neighborhood parks that operate consistently across urban density contexts. This finding aligns with previous studies demonstrating that urban green spaces facilitate social interaction and cohesion, thereby enhancing psychological well-being [45,60]. Accordingly, natural and community spaces can be understood as universal spatial elements that realize CES across urban contexts.

However, the results of moderation analysis reveal that even these universal elements exhibit nonlinear variations depending on urban density. In particular, natural spaces show the strongest effects in high-density cities and remain significant in low-density cities, whereas no significant effects are observed in medium-density contexts. Thus, the effectiveness of natural spaces is context-sensitive and varies according to the scarcity and substitutability of nature within the urban environment [61]. In high-density cities, where access to nature is limited, neighborhood parks perform restorative and compensatory functions, thereby substantially amplifying user satisfaction. Meanwhile, in low-density cities, which feature relatively abundant access to nature, the marginal utility of additional natural elements appears to diminish but remains significant. The lack of significance in medium-density areas suggests the presence of a threshold condition, in which natural spaces function as a basic prerequisite but do not differentiate user satisfaction. This pattern aligns with discussions on threshold effects and diminishing marginal utility, wherein the impact of environmental resources changes nonlinearly once a certain level of provision is exceeded [62,63].

In contrast, community spaces were consistently significant across urban contexts, with no moderating effects observed, indicating that they function as a non-moderated universal element that are effective irrespective of urban density. This result demonstrates that beyond providing green spaces, neighborhood parks play a crucial roles as social infrastructure that facilitates social connections across urban environments [33,64].

5.2. Context-Specific Spatial Elements

This study finds that the spatial elements explaining satisfaction with neighborhood parks operate differently depending on urban density. In particular, urban-landscape spaces emerge as a significant driver in medium-density cities, whereas multifunctional cultural spaces are primary determinants in high-density cities. These findings indicate that the elements serving as key determinants of satisfaction formation vary according to urban density.

First, urban-landscape spaces significantly affect satisfaction only in medium-density cities, with no statistically significant effects observed in high- or low-density contexts. The moderation analysis further confirms a significant interaction with urban density, indicating that urban-landscape spaces function as context-specific elements that become particularly salient in medium-density environments. In such contexts, neighborhood parks may function not only as spaces for rest but also as landscape-based mechanisms that shape urban image and place identity [41].

In contrast, multifunctional cultural spaces emerge as context-specific factors in high-density cities. This pattern is closely associated with the characteristics of high-density urban environments, where limited public space must accommodate diverse activities and functions. Thus, neighborhood parks need to operate as multifunctional spaces integrating cultural, educational, and recreational functions [65]. This functional complexity appears to be a key determinant of user satisfaction in high-density urban areas.

Taken together, these findings indicate that the spatial elements of neighborhood parks do not operate uniformly across urban contexts. Rather, the key elements shaping user satisfaction vary depending on urban density. Notably, even when neighborhood parks share similar spatial configurations, their core functions and meanings are structurally reconfigured in response to the surrounding context. Therefore, park planning and design should move beyond a focus on uniformly enhancing all spatial elements and adopt context-sensitive approaches that prioritize the functions most relevant to the level of urban density.

5.3. Limited Explanatory Power in Low-Density Cities and Exogenous Factors

The relatively low explanatory power of the low-density model suggests that in these areas, user satisfaction cannot be sufficiently explained by internal park attributes. Exogenous environmental factors, such as park accessibility, the quality of surrounding natural environments, facility maintenance, and level of community cohesion, may play additional roles in shaping satisfaction. This finding aligns with previous studies observing that satisfaction is influenced by physical spatial characteristics as well as broader social contexts and living environment conditions [35,66]. Accordingly, satisfaction formation in low-density contexts should be understood from a perspective that extends beyond internal park features.

Furthermore, in low-density areas, natural environments are already abundant in residential surroundings; therefore, internal park spatial configurations may only contribute marginally to satisfaction. This observation aligns with prior research suggesting that the relationship between green exposure and mental health or satisfaction follows a nonlinear pattern, in which effects plateau or even diminish beyond a certain threshold [61,67,68]. Therefore, park planning in low-density areas should prioritize connectivity with surrounding environments and the social conditions of use, rather than focusing on the additional provision of internal facilities.

5.4. Urban Density-Based Park Design Strategies

The findings of this study suggest that policies and planning and design strategies for neighborhood parks should adopt differentiated strategies that are tailored to urban density. The uniform application of identical design standards across urban areas is unlikely to adequately reflect context-specific user needs and usage patterns. Thus, design strategies should incorporate urban density as a key planning variable.

Specifically, in high-density cities, where restoration and multifunctionality are key to satisfaction, park design should enhance ecological quality while integrating cultural and recreational functions. Meanwhile, in medium-density cities, where urban-landscape spaces emerge as significant factors, design strategies should emphasize visual amenities and landscape coherence. Finally, in low-density cities, given the limited explanatory power of internal spatial elements, design strategies should prioritize flexible spatial configurations that facilitate social interactions and prolonged use, as well as stronger connections with the surrounding environment.

5.5. Limitations and Future Research

This study has several limitations. First, it relies on perception-based survey data collected from neighborhood park users in the Seoul Metropolitan Area. While user perceptions capture the respondents' subjective evaluations, they do not provide objective measurements of physical spatial attributes or actual usage behaviors. Therefore, these findings reflect patterns in user-perceived spatial elements rather than direct causal links between physical characteristics and satisfaction. Future research would benefit from employing mixed-method approaches that integrate on-site observations or geographic information system-based spatial analyses.

Second, although the classification of urban areas based on density offers a useful analytical framework, it does not fully capture cultural, spatial, and institutional differences. Variations in provision systems, land-use regulations, and public space use cultures may occur even among areas with similar density levels. As such, applying the proposed urban density-based spatial strategies to other contexts may yield different outcomes. Careful interpretation is required when generalizing these findings, with due consideration given to the specific contextual conditions of each city.

Third, the relatively low explanatory power in low-density contexts suggests that park satisfaction may be influenced by additional variables beyond those included in this study. In particular, factors such as physical accessibility, level of facility maintenance, and variations in local social capital may play important roles in shaping satisfaction, regardless of density type. Future research should incorporate these variables into more comprehensive analytical models.

Finally, the sample size for each urban density subgroup (approximately 92–96 respondents) may limit the statistical power of the moderation analysis. Although bootstrapping was applied to estimate confidence intervals, caution is warranted when interpreting some interaction effects. Future studies should utilize larger sample sizes to enhance the robustness of the identified moderation effects and further extend the generalizability of the findings. Furthermore, future research should strengthen external validity by engaging with expert-based validation methods, such as Delphi surveys or consultations with practitioners and scholars.

6. Conclusions

This study examined the variance in the effects of spatial elements of neighborhood parks on user satisfaction across urban density levels. Based on regression and moderation analyses of neighborhood park users in the Seoul Metropolitan Area, the findings reveal a clear distinction between universal and context-specific spatial elements. These results address a critical gap in the literature, which tends to implicitly assume that parks' spatial elements operate uniformly.

The main findings can be summarized as follows. First, natural and community spaces have significant roles across all urban contexts; however, the effects of natural spaces exhibit a nonlinear pattern based on urban density while community spaces are consistently significant regardless of urban density. Second, urban-landscape spaces are significant only in medium-density cities, and multifunctional cultural spaces are significant only in high-density cities, indicating that the core functions of neighborhood parks are selectively reconfigured according to urban density. Third, the relatively low explanatory power in low-density contexts suggests that park satisfaction is influenced not only by internal spatial elements but also by exogenous factors, such as accessibility, surrounding environmental conditions, and the broader social context.

These findings suggest that neighborhood park planning and design should shift from a "one-size-fits-all" approach toward differentiated strategies that are tailored to urban density. In high-density cities, integrating ecological quality with multifunctional cultural uses should be prioritized; in medium-density cities, enhancing landscape aesthetics and place identity should be emphasized; and in low-density cities, strengthening community functions and everyday usability should be considered as the primary strategic focus.

In summary, neighborhood parks should be understood not as spaces that function uniformly across cities but as context-sensitive environments in which core functions are selectively activated depending on urban density. While the study's analytical framework may serve as a comparative reference for diverse international contexts, its application to other cities requires careful consideration of specific contextual factors such as park provision systems, land-use regulations, and cultural patterns of space use.

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