

EXPLORING KEY FACTORS INFLUENCING THE PLACEMENT OF OPEN SPACES IN RESIDENTIAL COMPLEXES TO ENHANCE QUALITY OF LIFE

Behrooz Khosrowjerdi*, Mahnaz Noshadi**

*) Department of Architecture, University of Hakim Sabzevari, Sabzevar, Iran

**) Department of Architecture, University of Islamic Azad Mashhad, Mashhad, Iran

e-mail: b.khosrowjerdi@gmail.com

ABSTRACT

Open spaces in residential complexes function as critical social infrastructure, yet evidence-based frameworks for their strategic placement remain underdeveloped. This study identifies and prioritizes twelve key factors influencing open space location decisions in high-density residential contexts using the Fuzzy Delphi Method. Grounded in Place Attachment Theory, Attention Restoration Theory, and WHO Quality of Life frameworks, a multidisciplinary expert panel evaluated the factors through linguistic scales converted to triangular fuzzy numbers. Defuzzification procedures (acceptance criteria: $A \geq 0.5$, $d < 0.2$) revealed a clear hierarchical structure. Social Interactions emerged as the primary driver ($A = 0.733$), validating open spaces as social infrastructure rather than merely physical amenities. Visual Quality ($A = 0.703$) and Long-term Sustainability ($A = 0.690$) ranked second and third, emphasizing aesthetic engagement and ethical imperatives. Supporting factors, including Privacy, Activities, Security, Spatial Continuity, Accessibility, Environmental Comfort, Multi-functionality, Cultural Context, and Permeability, demonstrated moderate importance as enabling conditions. The findings provide empirically validated design frameworks, challenging conventional planning paradigms that prioritize technical standards over human-centered outcomes.

Keywords: Open Spaces, Residential Complexes, Social Interactions, Permeability, Spatial Continuity

INTRODUCTION

Housing serves as the pivotal nexus between humanity and the material world, a tangible entity encapsulating emotions, affections, memories, attachments, and the reflection of culture. Martin Heidegger approaches housing qualitatively, asserting that the true housing crisis concerns humanity's quest for dwelling rather than scarcity (Sharr, 2007). In *Building Dwelling Thinking*, Heidegger portrays dwelling as an

essential mode of being-in-the-world, challenging purely functional or economic approaches to residential design.

Drawing from Heidegger's insights, Christian Norberg-Schulz (1980) posits that architecture's ultimate aim is to facilitate dwelling. He argues that humans truly dwell when they can adapt to and identify with an environment, achieving profound belonging. Thus, dwelling transcends mere shelter, implying spaces where life unfolds as genuine places. Dwelling expresses positioning and identity formation, establishing meaningful bonds between humans and environments arising from the pursuit of belonging. Consequently, individuals attain self-awareness only upon dwelling, affirming their existence in the world (Norberg-Schulz, 1980). This phenomenological approach underscores architecture's role in fostering existential connections between inhabitants and lived environments.

Contemporary housing analysis reveals that modern dwellings have increasingly transformed into vertical units, often failing to address societal needs adequately (Uzgören & Erdönmez, 2017). As responses to human requirements evolved, apartments gave way to residential complexes; however, open spaces interspersed among blocks still fall short of fulfilling contemporary demands. This deficiency manifests in social isolation despite high-density living, inadequate recreational and restorative provisions, limited community formation opportunities, and disconnection from natural elements essential for psychological well-being (Gehl, 2001; Marcus & Francis, 1997). The proliferation of residential complexes as dominant urban typology has paradoxically intensified the need for thoughtfully designed communal spaces while constraining available spatial resources (Newman & Kenworthy, 2015).

Open spaces within residential complexes function as critical intermediaries between private dwelling units and the broader urban fabric, serving simultaneously as social infrastructure, environmental amenities, and physical frameworks for activities that cannot occur in enclosed spaces (Bahador & Bavar, 2022; Carmona, 2021). These spaces encompass diverse typologies, courtyards, pedestrian pathways, green areas, children's play zones, social gathering places, each contributing distinctively to residents' quality of life. Research demonstrates that strategically located and well-designed open spaces correlate with enhanced social cohesion, reduced stress, improved physical health, and stronger place attachment (Hartig et al., 2014). Conversely, poorly conceived spaces characterized by inadequate accessibility, insufficient visual appeal, compromised security, or functional irrelevance remain underutilized, representing missed opportunities for community building (Whyte, 1980).

Despite extensive theoretical discourse on residential open spaces' importance, a critical gap persists between abstract design principles and operational guidance for practitioners. Existing literature addresses open space typologies, functions, and benefits comprehensively (Perloff, 2015; Tankel, 2011), yet provides limited empirical validation of which specific factors most significantly influence placement success. Design professionals face challenges prioritizing competing considerations, maximizing social interaction versus ensuring privacy, optimizing accessibility versus maintaining security, emphasizing visual quality versus achieving sustainability, without evidence-based guidance on relative importance. This methodological

vacuum results in inconsistent outcomes, where location decisions rely on individual intuition, regulatory requirements, or economic constraints rather than systematic evaluation frameworks grounded in professional consensus.

Furthermore, literature reveals fragmentation across disciplinary boundaries. Environmental psychology illuminates restorative potential and psychological mechanisms (Kaplan & Kaplan, 1989), while urban design emphasizes spatial configuration principles like permeability and connectivity (Carmona, 2021). Place attachment studies explore emotional bonds (Lewicka, 2011), and public health research documents environmental quality-wellbeing correlations (Abraham et al., 2010). However, these parallel knowledge streams rarely converge into integrated frameworks synthesizing psychological, social, environmental, and functional dimensions into actionable design criteria applicable to residential planning.

Addressing this gap, the present study seeks to empirically identify and validate critical factors influencing optimal open space placement within residential complexes, developing an evidence-based framework that enhances residents' quality of life. Specifically, this research pursues three interconnected objectives:

1. Synthesize multidisciplinary theoretical perspectives (environmental psychology, place attachment theory, quality of life frameworks) into a coherent conceptual model identifying potential factors affecting open space location decisions at the residential complex scale;
2. Employ the Fuzzy Delphi method to validate and prioritize twelve critical factors derived from theoretical synthesis and literature review, establishing expert consensus on their relative importance; and
3. Translate validated factors into a hierarchical framework providing designers, urban planners, and developers with systematic evaluation criteria for site selection, enabling prioritization of considerations most consequential for fostering social interaction, environmental quality, and community cohesion.

The research advances beyond descriptive accounts toward prescriptive guidance grounded in professional expertise. By operationalizing abstract principles through empirically validated factors ranked by importance, this study bridges the gap between theoretical knowledge and practical application. The Fuzzy Delphi methodology addresses inherent uncertainty and subjectivity in spatial quality judgments, enabling systematic aggregation of expert opinions while accommodating the nuanced, context-dependent nature of design decision-making (Siraj et al., 2019). Focusing on the intermediate scale between private units and public infrastructure, where open spaces function most directly as community-building assets, the investigation employs a single-round expert survey establishing hierarchical priorities among twelve factors: Privacy, Security, Activities, Social Interactions, Spatial Continuity, Accessibility, Environmental Comfort, Visual Quality, Multi-functionality, Long-term Sustainability, Cultural Context, and Permeability.

The significance extends across multiple domains. Theoretically, it integrates fragmented perspectives into a unified framework, demonstrating how psychological restoration needs, social interaction imperatives, and sustainability concerns converge in residential design. Methodologically, it validates fuzzy set theory utility for architectural research, providing replicable approaches for establishing professional

consensus on complex design phenomena. Practically, it equips professionals with prioritized evaluation criteria enabling more systematic, evidence-informed site selection, potentially improving satisfaction outcomes and community well-being. Pedagogically, the framework offers educational value for training emerging practitioners in systematic environmental analysis and evidence-based design thinking.

By establishing evidence-based priorities for open space placement, this research contributes to residential complex design evolution from intuition-driven practice toward systematic, theoretically grounded, empirically validated approaches honoring Heidegger's vision of architecture facilitating authentic dwelling and Norberg-Schulz's understanding of place-making as identity formation.

THEORY / RESEARCH METHODS

Theoretical Framework

The investigation of open space placement in residential complexes necessitates a robust theoretical foundation integrating multiple disciplinary perspectives. This research draws upon three complementary frameworks that collectively provide a comprehensive basis for understanding how spatial configuration influences residential well-being and inform the selection of critical factors evaluated through the Fuzzy Delphi methodology.

Environmental Psychology and Attention Restoration Theory (Kaplan & Kaplan, 1989) provides fundamental insights into human-environment interactions, positing that exposure to natural environments enables cognitive restoration by reducing mental fatigue and enhancing directed attention capacity. Kaplan (1989) identifies four essential characteristics of restorative environments: being away, extent, fascination, and compatibility. In residential contexts, open spaces embodying these characteristics contribute significantly to stress reduction and mental health recovery (Ulrich et al., 1991). Recent empirical studies validate ART's relevance to urban residential environments, demonstrating that proximity to and visual access to green open spaces correlate with reduced stress levels, improved cognitive functioning, and enhanced emotional well-being among residents (Hartig et al., 2014). This theoretical foundation informs several critical factors examined in this research, including visual quality, environmental comfort, and accessibility.

Place Attachment Theory, rooted in environmental psychology and human geography, examines the emotional bonds individuals develop with specific locations (Altman, 1975). Scannell and Gifford (2010) conceptualize place attachment as a multidimensional construct encompassing person, psychological process, and place dimensions. Lewicka (2011) distinguishes between place identity and place dependence, both enhanced when residential open spaces support diverse activities, foster social interaction, and provide spatial continuity throughout the complex. Research demonstrates that stronger place attachment correlates with increased residential satisfaction, sense of community, and pro-environmental behaviors (Manzo & Devine-Wright, 2013). The spatial configuration and accessibility of open

spaces significantly influence place attachment formation, with spaces perceived as secure, private, and culturally appropriate facilitating deeper emotional bonds while accommodating multi-functional uses that strengthen collective attachment (Stedman, 2003). This framework informs factors such as security, privacy, social interaction opportunities, and cultural context.

The World Health Organization's Quality of Life Framework defines quality of life as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (The Whoqol, 1998). The framework encompasses six domains, with the environmental domain particularly relevant to residential design, including physical safety, home environment, opportunities for recreation and leisure, and access to health services. In residential settings, well-designed open spaces contribute to physical health through opportunities for activity and environmental comfort, support psychological health via restorative experiences and stress reduction, facilitate social relationships through interaction spaces, and enhance overall environmental quality (Abraham et al., 2010). The WHO framework emphasizes person-environment fit, suggesting that environmental features should align with residents' needs, preferences, and cultural values, informing consideration of factors such as multi-functionality, long-term sustainability, and cultural context.

These three theoretical frameworks converge to provide a comprehensive foundation for investigating open space placement. Environmental Psychology and ART illuminate psychological mechanisms through which spatial design influences well-being; Place Attachment Theory explains how spatial configuration fosters emotional bonds and community identity; and the WHO Quality of Life Framework offers a holistic lens for evaluating residential environmental quality. This integration supports a multi-dimensional approach to identifying critical factors: accessibility, visual quality, and environmental comfort relate to restorative experiences; security, privacy, and social interaction opportunities connect to place attachment formation; while multi-functionality, cultural context, and long-term sustainability align with comprehensive quality of life domains. This theoretical synthesis justifies the selection of twelve critical factors examined in this research and provides the conceptual foundation for employing the Fuzzy Delphi method to establish expert consensus on their relative importance.

Literature Review

Residential Complexes

Residential complexes emerge from the aggregation of multiple apartments (up to ten stories) within unified urban blocks designed as integrated wholes, featuring shared public spaces collectively utilized by residents (Carmona, 2021). This housing typology enables diverse unit types while providing enhanced facilities, green spaces, and parking provisions commensurate with site capacity. The design is highly sensitive, as errors in delineating private, public, and communal domains can result in uncontrolled spaces, potentially leading to significant social challenges (Paul & Terence, 2015), underscoring the importance of environmental strategies for mitigating crime and enhancing social cohesion in built environments.

Some Advantages of Residential Complexes

The positive attributes of residential complexes are multifaceted, addressing urban challenges while enhancing residents' quality of life. Table 1 summarizes the primary advantages identified in contemporary literature:

Table 1. Advantages of Residential Complexes

No.	Advantage	Description	Key References
1	Dense and Efficient Urban Configurations	Residential complexes partially address population growth and land scarcity by enabling higher-density housing developments that optimize urban land use while maintaining livability standards.	(Litman, 2015; Newman & Kenworthy, 2015)
2	Affordable Homeownership for Diverse Households	Midrise apartment buildings (typically 7-8 stories) facilitate homeownership among low-income groups and accommodate diverse household structures, including young couples, single-parent families, childless couples, and retirees. This typology bridges the gap between high-density apartments and single-family homes, promoting inclusive urban living.	(Montgomery, 2013)
3	Cost-Effective Service Delivery	By distributing municipal and maintenance costs across a larger number of households, residential complexes reduce per-capita expenses for both residents and municipalities. The moderate density and lack of advanced technology requirements make maintenance economically viable for broad social groups.	(Litman, 2015; Marcus & Francis, 1997)
4	Enhanced Amenities and Community Facilities	Residential complexes provide access to diverse amenities beyond individual units, including childcare centers, communal dining areas, housekeeping services, social/recreational spaces, children's play areas, sports fields, and green spaces. Vehicular movement is typically restricted to parking zones, reserving internal open spaces for pedestrian use and social interaction.	(Gehl, 2001)
5	Balance Between Community and Privacy	The design of residential complexes enables residents to enjoy communal living and social interactions while preserving private domains, fostering a sense of community without compromising individual privacy needs.	(Altman, 1975; Gehl, 2001)

Open Space

Open space refers to spaces situated between built surfaces, encompassing parks, recreational areas, public gathering places, and natural landscapes accessible to residents (Tang & Wong, 2008). These spaces function as subsystems comprising natural elements, artificial elements, or combinations thereof, serving as balancing

elements within the urban fabric that moderate building and human density while shaping urban experience (Carmona, 2021). The most important public open spaces in residential neighborhoods include green spaces, parks, pedestrian walkways, streets, and plazas, which reduce pollution, improve living environments, and facilitate social interaction, communication, relaxation, and circulation.

The Term Open Space

The term open space was first used in England in 1833. However, the initial definitions of open space can be traced to the 20th century, originating from the conceptualization of space as a void or whatever can be conceived from the remnants of filled volumes (Mozaffar & Asadpour, 2012). Following this, the perspectives of various thinkers on open space are presented:

Table 2. Concepts Related to Urban Open Spaces

No.	Concepts Related to Urban Open Spaces		
1	Lynch	Urban open space is a freely accessible area that serves as the venue for the realization of spontaneous activities, movements, or visual explorations by a large number of the city's inhabitants.	(Lynch, 1964)
2	Tankel	He divides urban open spaces into two categories: 1. Utilized open spaces, which have three functions including usability, visual landscape, and fulfilling human emotions. 2. City-shaping open spaces, which have two functions: providing urban services and assisting in the formation of urban development patterns.	(Tankel, 2011)
3	Perloff	Open spaces are geographical and social locations within or adjacent to the city, publicly owned, and not occupied by buildings or structures.	(Perloff, 2015)
4	Tang & Wong	Open spaces have three functional dimensions: supplying (parks and recreational areas), protecting (ecosystem values and biodiversity), and shaping (urban morphology and development patterns). These dimensions interact within residential neighborhoods to enhance social, ecological, and structural functions.	(Tang & Wong, 2008)
5	Song	In defining open space, they refer to enclosure or non-enclosure and believe that open space lacks buildings or that its built-up area is no more than one-twentieth of the free space. The entire space is used for recreational and public purposes or remains unused.	(Song et al., 2020)

Table 2 perspectives converge on three functional categories (Figure 1). Supplying Open Spaces provide recreation, social gathering, and aesthetics fulfilling residents' physical and psychological needs, as emphasized by Lynch's (1964) spontaneous activities concept and Tankel's (2011) utilized spaces. Protecting Open Spaces preserve ecosystems, biodiversity, and natural landscapes, aligning with Perloff's (2015) non-built public zones and environmental functions documented by Tang and Wong (2008). Shaping Open Spaces influence urban morphology and

development patterns, reflected in Tanel's (2011) city-shaping category and Song et al.'s (2020) spatial structure analysis. This framework integrates classical definitions with contemporary research on ecosystem services, social sustainability, and urban form (Tang & Wong, 2008).

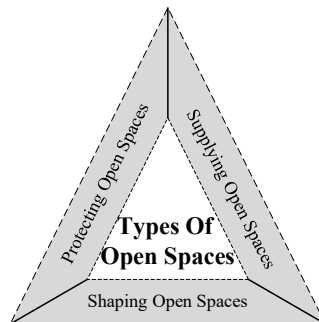


Figure 1. Conceptual Framework of Open Space Typology

Source: Developed by Authors Synthesizing Perspectives from Table 2, with Particular Reference to Tang & Wong (2017); Tanel (2011); Perloff (2015)

Open Space in Residential Complexes

A residential complex comprises open and enclosed spaces, with open spaces defined as collectively managed areas available to all residents, including pedestrian pathways, green areas, social zones, parking, and wayfinding elements (Carmona, 2021; Gehl, 2001). Their primary role is moderating building and population densities while facilitating outdoor activities (Lynch, 1964; Song et al., 2020). Despite their critical importance (Perloff, 2015), these spaces are often neglected due to high land costs and speculative development (Behzadfar & Ghazizadeh, 2011), though strategic design of intermediary zones can enhance social sustainability by bridging privacy with communal interaction (Bahador & Bavar, 2022).

Beyond environmental aspects like sunlight and ventilation, open spaces shape cultural and social qualities (Kaplan & Kaplan, 1989), strengthening neighborhood social relations (Francis et al., 2012) and ensuring spatial continuity (Gehl, 2001). Research demonstrates that exposure to natural elements reduces stress, improves cognitive function, and enhances mental health through restorative processes (Hartig et al., 2014), while also mitigating pollution, urban heat islands, and air quality issues.

Human presence remains fundamental to creating quality places. Historically, neighborhood open spaces served as communal hearts where social interactions fostered collective identity and belonging (Altman, 1975; Whyte, 1980). These shared spaces cultivate membership, mutual influence, and emotional connections that bind residents, embodying the essence of communal living in dense urban contexts (Bahador & Bavar, 2022).

Factors Affecting the Location of Open Spaces

The design quality of residential open spaces emerges from multiple interacting scales of spatial organization. In categorizing the factors influencing the physical design of residential complexes, Einifar (2000) identifies three primary scales (Figure 2). The

first pertains to the external connections of residential complexes with adjacent urban environments, including transportation networks, service infrastructure, and neighborhood integration. The second scale encompasses internal relationships within complexes and interactions outside individual residential units, the communal and semi-public realm that forms the heart of residential community life. The third scale addresses the relationships and proportions of internal spaces within residential units, ensuring harmony with residents' cultural and traditional living patterns.

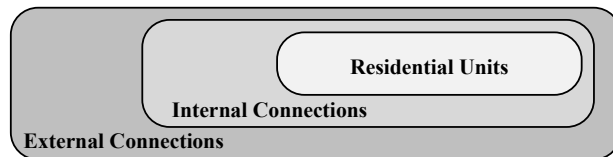


Figure 2. Three Primary Scales of Residential Complexes
Source: Einifar (2000)

Given that the emphasis of this research is on open spaces in residential complexes, the second scale, internal relationships within complexes and interactions outside residential units, constitutes the primary analytical focus.

Contemporary scholarship on sustainable urban design has expanded this framework by emphasizing multiple dimensions of open space quality. Research demonstrates the importance of functional diversity in open space planning (Song et al., 2020; Tang & Wong, 2008), the role of spatial configuration in fostering social sustainability (Bahador & Bavar, 2022; Mazumdar et al., 2018; Woodcraft, 2012), the restorative functions of natural elements and visual quality (Hartig et al., 2014; Kaplan & Kaplan, 1989; Ulrich et al., 1991), and the critical role of accessibility, comfort, and activities in creating vibrant public spaces (Gehl, 2001; Jalaladdini & Oktay, 2012; Uzgören & Erdönmez, 2017; Whyte, 1980). Theoretical frameworks addressing place attachment (Lewicka, 2011) territorial behavior (Ardrey, 1966; Lang, 1987), permeability and spatial networks (Karimi, 2023; Mazumdar et al., 2018), and crime prevention through environmental design (Paul & Terence, 2015) further contribute to understanding the complex relationships between physical design and resident well-being. Integrating these diverse perspectives with the theoretical foundations (Attention Restoration Theory, Place Attachment Theory, and the WHO Quality of Life framework), twelve key factors emerge as critical determinants of open space quality in residential complexes (Figure 3).

These factors, Privacy, Safety and Security, Activities, Social Interactions, Permeability, Spatial Continuity, Accessibility and Proximity, Environmental Comfort, Visual Quality, Multi-functionality, Cultural Context, and Long-term Sustainability, collectively address the physical, social, psychological, and cultural dimensions necessary for creating livable residential environments. The selection of these factors was informed by a comprehensive review of international literature spanning urban design theory (Carmona, 2021; Lynch, 1964), environmental psychology (Hartig et al., 2014; Ulrich et al., 1991), social sustainability (Francis et al., 2012; Woodcraft, 2012), configurational analysis (Karimi, 2023; Karrholm,

2016), and sustainable urbanism (Litman, 2015; Perloff, 2015). The following subsections present a detailed literature review of each factor, establishing the theoretical and empirical foundation for their subsequent evaluation through the Fuzzy Delphi expert consensus method and validation through empirical analysis.

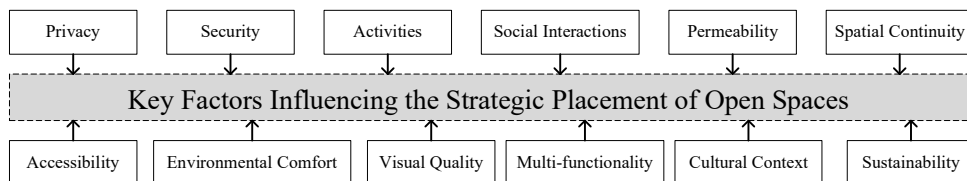


Figure 3. Key Factors Influencing the Strategic Placement of Open Spaces

Privacy

In residential design, privacy and social interaction represent opposing concepts requiring careful balance (Lang, 1987). Studies indicate greater privacy is achieved through individuals' control over personal environments and autonomy in social encounters (Bahador & Bavar, 2022). At the residential complex scale, privacy control involves establishing hierarchies of public, semi-public, semi-private, and private open spaces (Madanipour, 2014), preventing unwanted intrusions while providing intermediary zones. Research demonstrates that spaces lacking clear territorial designation offer less control over social interactions, diminishing engagement opportunities (Ardrey, 1966). In clearly bounded environments, residents exhibit higher interaction levels than scenarios where privacy relies solely on contact avoidance (Lang, 1987), with hierarchical spatial organization fostering place attachment through legible, predictable environments (Lewicka, 2011).

Safety and Security

Perceived security in residential environments is influenced by sociocultural characteristics, physical accessibility for intruders, boundary definition and control, and surveillance over access paths (Einifar, 2000). Crime Prevention Through Environmental Design (CPTED) principles emphasize natural surveillance, territorial reinforcement, and access control in creating safer environments (Paul & Terence, 2015). Research demonstrates that well-designed open spaces with clear sight lines, adequate lighting, and defined boundaries significantly reduce crime opportunities while enhancing residents' sense of security (Newman & Kenworthy, 2015).

Activities

Activities in residential open spaces classify into essential, optional, and social categories (Gehl, 2001). Essential activities maintain stable quality across varying environments, while improved environmental quality significantly increases optional activities, resulting in greater social interactions (Whyte, 1980). Whyte's (1980) research demonstrated that movable seating, food vendors, and engaging microclimates substantially increase activity duration and diversity. In residential complexes, elements such as pedestrian pathways, green areas, and children's play

spaces represent key design principles (Jalaladdini & Oktay, 2012), with research emphasizing that activity diversity contributes to neighborhood vitality, social cohesion, and long-term sustainability (Litman, 2015).

Social Interactions

Social interactions are fundamental to community building and resident satisfaction (Francis et al., 2012). Open space design significantly influences encounter frequency and quality, ranging from passive observation to active engagement. Gehl (2001) identifies three interaction levels: necessary activities (functional encounters), optional activities (recreational socialization), and resultant social activities (spontaneous interactions). Spatial configuration plays a critical role in facilitating these interactions (Francis et al., 2012), with Woodcraft's (2012) social sustainability framework emphasizing that communal spaces provide opportunities for neighborly exchange, foster shared identity, and build social capital. Studies in Indonesian contexts show systematic visual aesthetic criteria, coordinated furniture, consistent colors, unified design elements, significantly enhance residential perceptual quality (Rahman et al., n.d.). Mazumdar et al. (2018) demonstrate that culturally responsive design accommodating diverse social practices enhances shared space inclusivity, while seating arrangements, shade structures, and activity nodes encourage lingering and interaction, transforming spaces into vibrant social settings (Uzgören & Erdönmez, 2017).

Permeability

Permeability refers to the degree an urban environment allows movement through different routes (Karimi, 2023). In residential complexes, permeability influences accessibility, wayfinding, and integration of open spaces into daily patterns. High permeability creates multiple pathways, offering navigation choices and fostering spatial freedom (Karimi, 2023). Lynch's (1964) "legibility" concept emphasizes that well-connected, permeable environments enhance cognitive mapping and spatial orientation, contributing to residents' sense of control and belonging. Space syntax research demonstrates that spatial configuration, particularly integration and connectivity, directly impacts movement flows, social encounters, and open space vitality (Karrholm, 2016). Conversely, low permeability creates isolated pockets, reducing accessibility and discouraging communal space use (Madanipour, 2014). Strategic design of permeable networks ensures open spaces function as integrated components of daily routines rather than isolated amenities.

Spatial Continuity

Spatial continuity refers to seamless flow and connection between areas within residential complexes, creating cohesive spatial experiences (Tang & Wong, 2008). This encompasses physical continuity (uninterrupted pathways, visual connections) and experiential continuity (unified sense of place through design elements) (Carmona, 2021). Lynch's (1964) principles emphasize edges, paths, and districts in creating coherent spatial structures residents can navigate and comprehend. Research demonstrates spatial continuity enhances wayfinding, encourages exploration, and reinforces territorial identity (Karrholm, 2016). In residential settings, continuous

open space networks linking recreational areas, pathways, and community facilities promote physical activity, social interaction, and environmental awareness (Tang & Wong, 2008), with Song et al. (2020) demonstrating green space continuity specifically contributes to ecological connectivity and nature access. Discontinuous spaces create movement barriers and reduce functional effectiveness (Madanipour, 2014).

Accessibility and Proximity

Accessibility and proximity are fundamental determinants of open space utilization (Litman, 2015). Research demonstrates use frequency declines significantly as distance increases, with most residents unwilling to walk more than 5–10 minutes to access communal spaces (Gehl, 2001). Litman's (2015) work emphasizes walkable access to amenities constitutes a core livable neighborhood principle, reducing automobile dependence and enhancing cohesion. Universal design principles emphasize accessibility must accommodate diverse users, including children, elderly, and individuals with mobility limitations (Jalaladdini & Oktay, 2012), requiring barrier-free pathways, appropriate surfaces, gentle slopes, and strategic seating placement. Jalaladdini and Oktay (2012) demonstrate pedestrian-friendly features (continuous sidewalks, visual interest, safety measures) significantly enhance perceived and actual accessibility. Proximity alone is insufficient; physical and psychological barriers must be minimized to ensure equitable access (Carmona, 2021).

Environmental Comfort

Environmental comfort encompasses microclimatic conditions (temperature, humidity, wind, solar exposure) influencing open space usability and appeal (Hartig et al., 2014). Environmental psychology research demonstrates thermal comfort is a primary outdoor space utilization determinant, with extreme temperatures significantly reducing occupancy duration (Hartig et al., 2014). Strategic interventions, shade structures, vegetation cooling, windbreaks, solar orientation, substantially enhance comfort (Gehl, 2001). The biophilic design framework emphasizes restorative benefits of natural elements (vegetation, water features, natural materials) in creating comfortable, stress-reducing environments (Ulrich et al., 1991). Carmona (2021) identifies environmental comfort as critical to urban design quality, noting multi-sensory experiences (sounds, scents, textures) contribute to perceived comfort. In residential complexes, diverse microclimates allow residents to choose spaces suited to seasonal conditions, personal preferences, and planned activities, maximizing year-round utilization (Gehl, 2001; Ulrich et al., 1991).

Visual Quality

Visual quality encompasses the aesthetic characteristics and scenic attributes of open spaces, significantly influencing residents' psychological well-being and attachment to place (Kaplan & Kaplan, 1989; Lewicka, 2011). The Kaplans' Preference Framework identifies four key predictors of landscape preference: coherence (organizational structure), legibility (ease of wayfinding), complexity (visual richness), and mystery (promise of new information). Lewicka's (2011) research on

place attachment demonstrates that aesthetically pleasing environments foster emotional bonds, increasing residents' sense of belonging and community commitment. Ulrich's (1991) psycho-evolutionary theory posits that exposure to natural scenes triggers restorative responses, reducing stress and enhancing mood. This theory has been extensively validated in residential contexts, where views of vegetation, water, and natural landscapes correlate with improved mental health outcomes (Hartig et al., 2014). Lynch's (1964) concept of "imageability", the quality that makes spaces memorable and distinctive, further emphasizes the importance of visual character in creating meaningful places. In residential complexes, visual quality extends beyond natural elements to include architectural harmony, landscape diversity, public art, and maintenance standards (Carmona, 2021; Tang & Wong, 2008).

Multi-functionality

Multi-functionality denotes open space capacity to accommodate diverse activities and user groups simultaneously or at different times (Tang & Wong, 2008). Perloff's (2015) framework emphasizes successful spaces fulfill recreational, social, ecological, and aesthetic functions to maximize community benefit in dense contexts. Flexible design, adaptable surfaces, movable furniture, programmable zones, enables uses from children's play to organized events (Gehl, 2001). Whyte (1980) observed that spaces supporting simultaneous activities (eating, socializing, watching) attract more users than single-purpose designs. In residential complexes, multi-functional spaces must balance children's play, adult social zones, exercise facilities, and quiet areas (Tang & Wong, 2008), with such diversity ensuring long-term relevance as community demographics evolve (Litman, 2015).

Cultural Context

Cultural context reflects how values, traditions, and social norms shape residents' perceptions and use of open spaces (Lewicka, 2011). Mazumdar et al. (Mazumdar et al., 2018) demonstrate that culturally responsive design accommodates diverse practices, privacy preferences, gender-segregated zones, and symbolic elements, directly influencing place attachment and community cohesion (Lewicka, 2011). In residential complexes, spaces must support communal gatherings, religious observances, and traditional celebrations (Mazumdar et al., 2018). Woodcraft's (2012) social sustainability framework emphasizes participatory design processes ensuring spaces reflect residents' cultural aspirations, while Lynch (1964) noted that incorporating local landmarks and design languages strengthens community identity. Ignoring cultural context results in underutilized spaces despite technical adequacy (Carmona, 2021).

Long-term Sustainability

Long-term sustainability concerns the environmental durability and adaptive capacity of open spaces (Beatley, 2011). Sustainable layouts optimize ecological services, shade, storm-water control, and biodiversity, while reducing maintenance demand (Song et al., 2020). Energy-efficient materials, native planting, and flexible infrastructure ensure longevity and lower carbon impact (Carmona, 2021).

Kaplan & Kaplan (1989) link exposure to well-maintained natural settings with restorative health benefits, tying environmental performance to quality of life. Embedding sustainable management and community stewardship extends functional lifespan and nurtures shared responsibility (Woodcraft, 2012), making sustainability both an environmental and social imperative.

Research Methodology

This research employs the Fuzzy Delphi Method (FDM) to establish expert consensus on critical factors influencing open space placement in residential complexes. The methodology integrates fuzzy set theory with the traditional Delphi technique to accommodate the inherent uncertainty and subjectivity in expert judgments regarding environmental design parameters. This section explicates the methodological rationale, theoretical foundations of fuzzy logic, expert panel composition, data collection procedures, and analytical framework employed in this investigation.

The Fuzzy Delphi Method represents an advancement over conventional Delphi techniques by addressing limitations associated with crisp numerical assessments and iterative survey rounds (Hsu & Sandford, 2007). The application of systematic methodologies for evaluating architectural and environmental design factors has gained prominence in recent Indonesian scholarship (Rosiani et al., 2012), further supporting the use of structured expert consensus approaches in residential design research. Traditional Delphi methods, while effective in aggregating expert opinions, often require multiple iterations to achieve consensus, resulting in expert fatigue, increased dropout rates, and extended research timelines. Furthermore, conventional approaches assume precise expert judgments that may not adequately capture the ambiguity and vagueness inherent in evaluating complex environmental design factors (Ishikawa et al., 1993).

The FDM addresses these limitations through three principal advantages relevant to this research context. First, it employs fuzzy linguistic variables and triangular fuzzy numbers to represent expert opinions, thereby accommodating the uncertainty and imprecision characteristic of subjective assessments in architectural and urban design domains (Chang et al., 2000). Second, the method enables consensus achievement through a single survey round by utilizing fuzzy set operations to aggregate expert judgments, significantly reducing research duration while maintaining methodological rigor (Cheng & Lin, 2002). Third, FDM provides quantitative measures of both group consensus (defuzzification value) and expert agreement level (threshold distance), facilitating transparent and replicable decision-making processes (Hsu & Sandford, 2007).

Given the exploratory nature of this research and the necessity of synthesizing diverse expert perspectives on multi-dimensional environmental quality factors, the Fuzzy Delphi Method constitutes an appropriate methodological choice. The approach is particularly suited to situations where: (1) the problem requires expert judgment rather than precise quantitative data, (2) heterogeneity exists among expert perspectives, (3) the research aims to establish consensus on relative importance of multiple factors, and (4) linguistic assessments better capture the phenomenon under investigation than precise numerical ratings (Noorderhaven, 1995).

Fuzzy Set Theory and Triangular Fuzzy Numbers

Fuzzy set theory provides a mathematical framework for representing and manipulating imprecise information. Unlike classical set theory, which employs binary membership (an element either belongs or does not belong to a set), fuzzy set theory permits partial membership through membership functions ranging from 0 to 1. This characteristic enables representation of linguistic variables, such as “very important,” “moderately important,” or “slightly important”, through mathematical constructs that preserve their inherent vagueness.

Triangular fuzzy numbers (TFNs) constitute the most commonly employed fuzzy number representation in decision-making applications due to their computational simplicity and intuitive interpretation (Siraj et al., 2019). A triangular fuzzy number $\tilde{A}$ is defined by a triplet (l, m, u) , where l represents the minimum possible value (lower bound), m denotes the most likely value (modal value), and u indicates the maximum possible value (upper bound), with $l \leq m \leq u$. The membership function $\mu_{\tilde{A}}(x)$ for a triangular fuzzy number is expressed as:

$$\mu_{\tilde{A}}(x) = \begin{cases} 0 & x < l \\ \frac{x-l}{m-l} & l \leq x \leq m \\ \frac{u-x}{u-m} & m \leq x \leq u \\ 0 & x > u \end{cases} \quad (1)$$

In this research, expert assessments on a 7-point Likert scale are converted to triangular fuzzy numbers following the linguistic variable scale developed and validated by Saedah Siraj et al. (2019). This conversion framework, presented in Table 3, establishes correspondence between ordinal linguistic ratings and their fuzzy triangular representations, enabling mathematical operations on qualitative judgments while preserving their semantic meaning.

Table 3. Linguistic Variables and Fuzzy Triangular Number Scale

Linguistic Variable	Likert Scale Rating	Triangular Fuzzy Number (l,m,u)
Not Important	1	(0.0, 0.0, 0.1)
Very Low Importance	2	(0.0, 0.1, 0.3)
Low Importance	3	(0.1, 0.3, 0.5)
Moderate Importance	4	(0.3, 0.5, 0.7)
High Importance	5	(0.5, 0.7, 0.9)
Very High Importance	6	(0.7, 0.9, 1.0)
Extremely Important	7	(0.9, 1.0, 1.0)

Source: Adapted from Saedah Siraj et al. (2021)

The fuzzy scale normalization to the interval $[0, 1]$ facilitates standardized comparison across factors and enables computation of defuzzified values representing group consensus. This transformation maintains the proportional relationships among

linguistic categories while providing a continuous measurement scale suitable for fuzzy arithmetic operations (Cheng & Lin, 2002).

Consensus Measurement: Defuzzification and Threshold Distance

The Fuzzy Delphi Method employs two primary metrics to evaluate expert consensus: the defuzzified score (A) representing the aggregate importance level, and the threshold distance (d) measuring the degree of expert agreement (Ishikawa et al., 1993).

Defuzzification (Crisp Score): For each factor evaluated by n experts, individual triangular fuzzy numbers $\tilde{A}_i = (l_i, m_i, u_i)$ are aggregated to obtain the average fuzzy number $\widetilde{A_{avg}} = (\bar{l}, \bar{m}, \bar{u})$, where:

$$\bar{l} = \frac{1}{n} \sum_{i=1}^n l_i, \quad \bar{m} = \frac{1}{n} \sum_{i=1}^n m_i, \quad \bar{u} = \frac{1}{n} \sum_{i=1}^n u_i \quad (2)$$

The defuzzified value A is then calculated using the centroid method (also known as the center of gravity method), which represents the crisp value equivalent of the fuzzy number:

$$A = \frac{\bar{l} + 4\bar{m} + \bar{u}}{6} \quad (3)$$

This formula, derived from the weighted average of the triangular fuzzy number with emphasis on the modal value, provides a single representative value indicating the factor's importance level as assessed by the expert panel. Threshold Distance (Consensus Indicator): The threshold distance d quantifies the spread or dispersion among expert opinions, serving as a consensus indicator. It is calculated as:

$$d = \frac{\bar{u} - \bar{l}}{2} \quad (4)$$

A smaller threshold distance indicates higher consensus among experts, as it reflects a narrower range of assessments. Following established conventions in FDM applications, factors are considered to have achieved acceptable consensus when $d < 0.2$ (Cheng & Lin, 2002). This threshold ensures that the range of expert opinions remains within 40% of the normalized scale, indicating substantial agreement on the factor's importance level.

Acceptance Criteria: For a factor to be accepted as critical, it must satisfy two conditions: (1) $A \geq 0.5$, indicating at least moderate importance in the normalized scale, and (2) $d < 0.2$, demonstrating adequate expert consensus. Factors meeting both criteria are retained for further analysis, while those failing to meet these thresholds may require additional expert consultation or methodological refinement.

Expert Panel Selection and Composition

Fuzzy Delphi validity depends on expert panel expertise, diversity, and representativeness (Okoli & Pawlowski, 2004). This research employed purposive sampling with criteria: (1) minimum three years professional experience in residential design/urban planning, (2) bachelor's degree or higher in architecture, urban planning, landscape architecture, or related fields, and (3) demonstrated expertise through publications, portfolios, or professional recognition.

The final panel comprised 20 participants: 12 architecture professionals (60%), 6 urban planning specialists (30%), and 2 landscape architects (10%). Educational backgrounds included bachelor's (50%, $n=10$), master's (40%, $n=8$), and doctoral candidates (10%, $n=2$). Professional experience ranged from 3–15 years (mean = 7.2 years), with project involvement spanning small-scale developments (50–100 units) to large urban districts (500+ units). This size aligns with FDM literature recommending 10–30 experts for balancing perspectives and analytical tractability, with heterogeneity enhancing consensus robustness.

Data Collection Procedure and Instrument Design

Data collection occurred through a structured questionnaire administered during October 2025. The instrument was designed in three sections: (1) demographic information capturing professional background and expertise credentials, (2) instructional content explaining fuzzy linguistic scales and response procedures, and (3) evaluation matrix requiring experts to assess each of the 12 factors using the 7-point Likert scale presented in Table 3.

Prior to full deployment, the questionnaire underwent pilot testing with three experts not included in the final sample to ensure clarity of instructions, appropriateness of linguistic scale descriptions, and functionality of the online platform. Minor refinements to factor definitions and scale explanations were implemented based on pilot feedback.

The questionnaire presented each factor with a concise operational definition derived from the literature review to ensure consistent interpretation across respondents. Experts were instructed to evaluate each factor's importance for open space placement in residential complexes considering its impact on residents' quality of life. The 7-point Likert scale, ranging from "Not Important" (1) to "Extremely Important" (7), provided sufficient granularity to capture varying degrees of importance while remaining cognitively manageable for respondents (Siraj et al., 2019).

Response rate monitoring occurred throughout the five-days data collection period, with personalized follow-up communications sent to non-respondents after two days. The final response rate of 100% (20 of 20 invited experts) exceeded typical Delphi study participation rates, likely attributable to the single-round design, reasonable questionnaire length (approximately 10-15 minutes completion time), and researcher accessibility for clarification requests.

Data Analysis Framework and Statistical Procedures

Data analysis proceeded through four sequential stages: (1) Likert scale conversion to triangular fuzzy numbers, (2) computation of average fuzzy numbers for each factor,

(3) calculation of defuzzified scores and threshold distances, and (4) factor ranking and acceptance determination.

1. Stage 1: Fuzzy Number Conversion

Each expert's Likert rating for each factor was converted to its corresponding triangular fuzzy number (l, m, u) using the scale in Table 3. This transformation generated a dataset of 240 triangular fuzzy numbers (20 experts $\times$ 12 factors), preserving the linguistic meaning of assessments while enabling mathematical operations.

2. Stage 2: Aggregation of Expert Opinions

For each factor, the 20 individual fuzzy numbers were aggregated to compute the average triangular fuzzy number $(\bar{l}, \bar{m}, \bar{u})$ representing the collective expert assessment. This aggregation employed arithmetic means for each component (lower bound, modal value, upper bound) of the triangular fuzzy numbers.

3. Stage 3: Consensus Metrics Calculation

Defuzzified scores (A) and threshold distances (d) were computed for each factor using the formulas presented in Section 2.3.3. These metrics enabled quantitative evaluation of both importance levels and consensus degrees across the expert panel.

4. Stage 4: Factor Evaluation and Ranking

Factors were evaluated against the acceptance criteria ($A \geq 0.5$ and $d < 0.2$) and ranked in descending order based on defuzzified scores. This ranking identifies the relative importance hierarchy among factors, informing design priorities for open space placement in residential complexes.

All computational procedures were executed using Microsoft Excel. Data validation procedures included verification of conversion accuracy, examination of extreme values, and assessment of missing data patterns. The final validated dataset, comprising fuzzy triangular numbers for all 20 participants across 12 factors, provided the basis for results presented in result and discussion section.

RESULTS AND DISCUSSION

Results

Fuzzy Delphi Analysis Outcomes

The Fuzzy Delphi method was employed to validate the significance of the twelve identified factors influencing the strategic placement of open spaces in residential complexes. A panel of 20 experts, comprising architects, urban planners, and urban designers with professional experience in residential complex design, participated in a single-round evaluation. Each factor was assessed using a 7-point Likert scale, subsequently converted to triangular fuzzy numbers to accommodate the inherent uncertainty and subjectivity in expert judgments. The defuzzification process yielded crisp values (A) representing the relative importance of each factor, while the threshold distance (d) indicated the degree of consensus among experts.

Overall Factor Validation

The analysis confirmed that all twelve factors are statistically significant and relevant to the location of open spaces in residential complexes, as evidenced by threshold distance values below the acceptance criterion of 0.2. This unanimous validation underscores the multifaceted nature of open space planning, necessitating consideration of environmental, functional, perceptual, and social dimensions. The factors demonstrated varying degrees of importance and consensus, reflecting diverse expert perspectives shaped by disciplinary backgrounds and practical experiences in residential design.

Table 4 presents the comprehensive results of the Fuzzy Delphi analysis, including the average fuzzy triangular numbers ($\bar{l}$, $\bar{m}$, $\bar{u}$), defuzzified importance scores (A), threshold distances (d), and acceptance status for all twelve factors.

Table 4. Fuzzy Delphi Analysis Results for Factors Influencing Open Space Location

Rank	Factor	$\bar{l}$	$\bar{m}$	$\bar{u}$	A (Defuzzified)	d (Consensus)	Accepted
1	Social Interactions	0.570	0.750	0.880	0.733	0.182	Accepted
2	Visual Quality	0.520	0.715	0.875	0.703	0.132	Accepted
3	Long-term Sustainability	0.490	0.690	0.890	0.690	0.019	Accepted
4	Privacy	0.515	0.695	0.845	0.685	0.177	Accepted
5	Activities	0.450	0.650	0.840	0.647	0.103	Accepted
6	Security	0.400	0.600	0.800	0.600	0.100	Accepted
7	Spatial Continuity	0.355	0.545	0.730	0.543	0.186	Accepted
8	Accessibility & Proximity	0.320	0.520	0.720	0.520	0.036	Accepted
9	Environmental Comfort	0.320	0.520	0.720	0.520	0.036	Accepted
10	Multi-functionality	0.290	0.490	0.690	0.490	0.019	Accepted
11	Cultural Context	0.270	0.470	0.670	0.470	0.068	Accepted
12	Permeability	0.235	0.420	0.615	0.423	0.162	Accepted

Note: $\bar{l}$ = average lower bound; $\bar{m}$ = average middle value; $\bar{u}$ = average upper bound; A = defuzzified importance score; d = threshold distance; Acceptance criterion: $d < 0.2$.

Hierarchy of Factor Importance

Social Interactions achieved the highest importance rating ($A = 0.733$), reflecting expert consensus that open space placement should prioritize opportunities for community building and interpersonal connection. The factor's threshold distance ($d = 0.182$), while within the acceptance criterion, suggests some variance in expert perspectives regarding optimal strategies for facilitating social engagement, likely reflecting tensions between centralized gathering spaces versus distributed intimate settings for diverse social preferences.

Visual Quality ranked second ($A = 0.703$) with notably stronger consensus ($d = 0.132$), indicating broad professional agreement on the critical role of aesthetic

appeal in determining space utilization. This finding validates environmental psychology research emphasizing that visual attractiveness functions as a prerequisite for engagement, with spaces lacking aesthetic appeal remaining underutilized regardless of functional adequacy.

Long-term Sustainability secured third position ($A = 0.690$) while achieving the strongest consensus across all factors ($d = 0.019$). This exceptional agreement, virtually unanimous among experts, suggests that sustainability is perceived not merely as one design objective among many, but as an ethical foundation underlying all placement decisions. The factor's multidimensional nature encompasses environmental stewardship (ecological services, climate adaptation), social viability (inclusive design, long-term community resilience), and economic feasibility (lifecycle costs, maintenance sustainability).

The remaining nine factors, Privacy ($A = 0.685$), Activities ($A = 0.647$), Security ($A = 0.600$), Spatial Continuity ($A = 0.543$), Accessibility & Proximity ($A = 0.520$), Environmental Comfort ($A = 0.520$), Multi-functionality ($A = 0.490$), Cultural Context ($A = 0.470$), and Permeability ($A = 0.423$), all achieved consensus while demonstrating substantially lower defuzzified scores. These findings suggest a design hierarchy where social, aesthetic, and sustainability considerations constitute primary drivers, while functional, technical, and contextual factors serve as supporting conditions that enable the realization of higher-order objectives.

Discussion

The Fuzzy Delphi analysis reveals a clear hierarchical structure with Social Interactions, Visual Quality, and Long-term Sustainability emerging as primary drivers superseding functional considerations. This section interprets findings through established theoretical frameworks and examines implications for design practice.

Interpretation of Priority Factors

Social Interactions as the highest-priority factor ($A = 0.733$) validates Place Attachment Theory's emphasis on social dimensions in residential quality (Scannell & Gifford, 2010). Open spaces function as social infrastructure enabling community formation, collective identity, and interpersonal connections essential for residential satisfaction (Manzo & Devine-Wright, 2013). The moderate consensus ($d = 0.182$) reflects recognition of design complexity in accommodating diverse social preferences, from centralized gathering spaces to intimate settings (Francis et al., 2012). This finding challenges functionalist approaches prioritizing physical accessibility over social facilitation, suggesting spatial configurations should be evaluated primarily on their capacity to enable meaningful encounters (Whyte, 1980). Visual Quality's second-place ranking ($A = 0.703$) with strong consensus ($d = 0.132$) aligns with Attention Restoration Theory's premise that aesthetics constitute fundamental restorative components (Kaplan & Kaplan, 1989). Spaces lacking visual appeal remain underutilized regardless of functional adequacy, as aesthetic quality serves as the primary engagement determinant. Research demonstrates consistent cross-cultural landscape preferences encompassing complexity, coherence, legibility, and mystery (Kaplan & Kaplan, 1989), with residential visual quality integrating

naturalistic beauty, spatial definition, and built-natural element synthesis. This validates investment in high-quality materials and skilled landscape architecture as essential rather than optional, challenging cost-minimization approaches that sacrifice aesthetics for short-term savings.

Long-term Sustainability's third position ($A = 0.690$) with exceptional consensus ($d = 0.019$) reveals near-unanimous recognition that sustainability considerations underpin all decisions, extending beyond environmental concerns to encompass ecological integrity, social equity, and economic viability. This reflects professional perception of sustainability not as one objective among many but as an ethical imperative elevated by climate change, resource constraints, and intergenerational equity concerns (Beatley, 2011). In residential contexts, this encompasses ecological services (stormwater management, heat island mitigation, biodiversity), social resilience (inclusive design, climate adaptation), and economic sustainability (lifecycle costing, maintenance feasibility). Strong consensus reflects recognition that sustainable strategies generate co-benefits: native plantings reduce maintenance while enhancing biodiversity and visual quality; permeable surfaces manage stormwater while accommodating activities; community gardens foster interaction while providing ecosystem services.

Supporting Factors

The remaining nine factors demonstrate substantially lower scores ($A = 0.423$ to $A = 0.685$), suggesting they function as enabling conditions rather than primary drivers. These group into three functional categories: Functional Enablers (Privacy, Security, Accessibility, Environmental Comfort) constitute baseline requirements ensuring spaces are physically accessible, perceptually safe, and climatically comfortable, essential but not differentiating features (Gehl, 2001). Activity Supporters (Activities, Multi-functionality, Permeability) facilitate diverse uses, with mid-range scores indicating that social interaction capacity and aesthetic appeal take precedence, aligning with research showing usage diversity emerges naturally from well-designed social spaces (Francis et al., 2012). Contextual Integrators (Spatial Continuity, Cultural Context) ensure coherent physical-social integration, with lower ranking reflecting that core principles, social, aesthetic, sustainable, apply universally, with contextual factors serving as localization mechanisms.

CONCLUSION

This study employed the Fuzzy Delphi method to empirically validate twelve critical factors influencing open space placement in residential complexes, establishing an evidence-based hierarchy beyond theoretical propositions. While all factors achieved consensus validation ($d < 0.2$), three emerged as paramount: Social Interactions ($A = 0.733$), Visual Quality ($A = 0.703$), and Long-term Sustainability ($A = 0.690$). This hierarchical structure provides actionable guidance for systematic site evaluation, ensuring decisions reflect professional consensus on effective spatial planning at the residential complex scale.

Social Interactions' highest ranking validates open spaces as critical social infrastructure rather than residual voids, demonstrating that contemporary practice recognizes them as essential for community cohesion. Successful location must prioritize sites with high residential visibility, strategic positioning along pedestrian convergence points, and characteristics conducive to spontaneous encounters (Gehl, 2001). These challenges approach relying solely on functional or aesthetic criteria, requiring explicit assessment of social interaction potential.

The strong consensus on Visual Quality ($d = 0.132$) and Long-term Sustainability ($d = 0.019$) reveals two additional foundational pillars. Visual Quality's second-place ranking confirms aesthetic appeal as a gateway to utilization, residents must first be attracted before benefiting from functional attributes (Kaplan & Kaplan, 1989). These challenges treating visual considerations as secondary, demonstrating that sight lines, landscape composition, and architectural integration constitute essential determinants of usage patterns. Long-term Sustainability's exceptional consensus indicates environmental responsibility has transitioned from specialized concern to mainstream standard, necessitating early integration of ecological services, resource efficiency, and climate resilience into site selection rather than post-design mitigation (Beatley, 2011).

Supporting factors, particularly Privacy (rank 4, $A = 0.685$), Activities (rank 5, $A = 0.647$), and Security (rank 6, $A = 0.600$), confirm the necessity of multidimensional analysis balancing social activation with territorial definition. While Social Interactions ranks highest, its realization depends on simultaneous privacy and security provisions enabling voluntary communal participation. The framework advocates achieving productive tensions between complementary dimensions: openness balanced with enclosure, accessibility tempered by territorial control, and visual transparency moderated by privacy.

Practical implications emerge directly from the hierarchy. The study advocates tiered evaluation wherein potential locations are first screened for social facilitation capacity, visual appeal, and sustainability support. Sites failing threshold levels for these critical dimensions should be deprioritized, as deficiencies are difficult to remediate through subsequent intervention. Sites passing first-tier screening are then evaluated for privacy, activity accommodation, and security, followed by refinement based on remaining factors. This structured approach enables efficient evaluation while ensuring consequential factors receive appropriate emphasis.

The research contributes to urban design theory by empirically operationalizing Einifar's (2000) second-scale considerations, internal relationships within complexes, through validated, ranked factors. By translating abstract principles into concrete evaluation criteria supported by professional consensus, this study equips practitioners with tools to create residential environments fostering community cohesion, enhancing well-being, and enduring as valuable assets across generations (Figure 4). Integration of these factors in early design stages represents a pathway toward more livable, socially cohesive, and environmentally responsible residential developments.

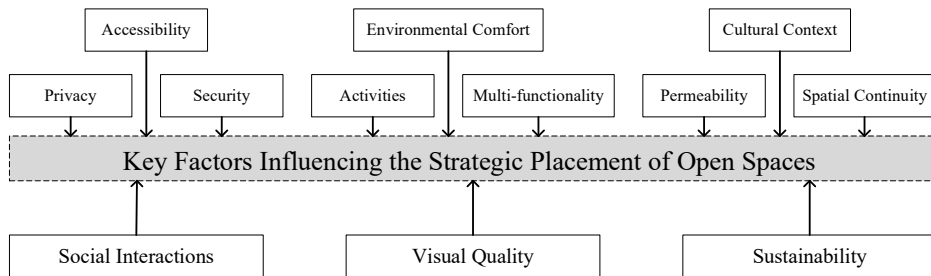


Figure 4. Key Factors Influencing the Strategic Placement of Open Spaces

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