

Designing High-Rises to Enhance Social Cohesion and Biodiversity in Urban Environments

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Abstract

Urban densification through high-rise developments frequently compromises social cohesion and biodiversity. This research explores design interventions in mixed-use residential towers at Zuidplein, Rotterdam, enhancing these essential urban qualities. The study identifies key factors influencing social cohesion—including transitional and communal spaces, resident characteristics, and socio-demographic diversity—and biodiversity, emphasizing natural habitats and ecological resilience. Communal gardens emerge as significant interventions, offering spaces for intercultural dialogue and ecological integration. These gardens not only foster strong community relationships but also enhance urban biodiversity through targeted planting supporting local fauna. The resulting framework guides architects in creating residential towers that promote connectedness among residents and harmony with nature, strengthening the urban ecosystem and improving residents' quality of life.

Keywords

Social cohesion, Biodiversity, Urban high-rise, Mixed-use, Communal gardens, Urban densification, Architectural design, Ecosystem services, Social sustainability, Ecological resilience

1 Introduction

1.1 Problem statement

Our cities are growing rapidly. Urban densification and high-rise development, as a product of urbanization, have transformed these environments into dense, concrete jungles, often at the expense of both social connections and biodiversity. Social cohesion and biodiversity are essential for the well-being of people and the planet, directly influencing the livability of urban residents (Huygen & De Meere, 2008, pp. 9–10).

Zuidplein, the heart of Rotterdam-Zuid, exemplifies a highly urbanized area where challenges related to social cohesion and biodiversity are particularly pressing. Within the redevelopment project *Hart van Zuid*, one of the main goals—alongside the creation of additional housing through high-rise developments—is to improve the living environment, with a specific focus on fostering social cohesion and biodiversity.

The objective of this study is to investigate the factors of urban biodiversity and social cohesion in places like Zuidplein and to discuss design interventions that could enhance these aspects. In the built environment, such interventions can serve as recommendations to architects and urban planners on how to design residential high-rise buildings that foster social cohesion and urban biodiversity.

1.2 Thematic research question

Main question:

What kind of interventions stimulate social cohesion and biodiversity in a mixed-use residential tower (+50 meter) in Zuidplein?

Sub-questions:

1. What do the terms 'social cohesion' and 'biodiversity' mean in the context of high-rise and urban residential environments?
2. What factors promote or hinder social cohesion and biodiversity in mixed-use residential environments within urban high-rise buildings?
3. What types of interventions and design elements have proven effective in enhancing biodiversity and social cohesion in similar urban residential projects?
4. How can communal spaces and green elements be integrated into a mixed-use residential tower to promote both biodiversity and social cohesion in Zuidplein?

2 Methodology

This thematic research follows a qualitative approach, based on a two-phase literature review. The aim was to gain insight into how social cohesion and biodiversity can be enhanced within residential high-rise buildings in urban contexts, and to formulate practical, scientifically grounded interventions.

In the first phase, the core concepts - social cohesion and biodiversity - were theoretically explored within the context of urban high-rise development, with a focus on Zuidplein in Rotterdam. The second phase examined the key influencing factors of both themes and identified possible solutions. All sources were academic to ensure the reliability and validity of the findings.

The research specifically focused on high-rise buildings in urban environments, limiting biodiversity to terrestrial flora and fauna. Aquatic biodiversity was excluded as it was deemed less relevant to the context. For each relevant factor, interventions were proposed, supported by literature and logical reasoning.

The findings were synthesized into a design framework that offers guidelines for integrating social and ecological values into urban high-rise living.

3 Defining social cohesion and biodiversity in urban high-rise environments

3.1 Social cohesion

Social cohesion refers to the degree of connectedness and solidarity within a group of people. In the context of residential high-rises in highly urbanized areas like Zuidplein, this means that residents are engaged with one another, trust and respect each other, and are willing to provide support when needed (Huygen & De Meere, 2008, p. 7). Simple actions, such as borrowing sugar from a neighbor or entrusting someone with a spare key, reflect this connection. A high level of social cohesion positively impacts neighborhood safety, reduces social isolation, and generally enhances individual well-being by stimulating meaningful social interactions (Huygen & De Meere, 2008, pp. 9–10). Furthermore, strong social cohesion fosters support for societal

transitions such as the energy transition, as it promotes trust, collaboration, and shared norms within a community (Gijsberts, Portegijs, De Bakker, Versantvoort & Broere, 2024). When people feel connected to each other, they are more likely to support common goals and undertake collective actions, such as adjusting their energy behavior or endorsing sustainable policies.

Communities often exhibit high levels of social cohesion due to their shared social attributes, such as cultural background, political beliefs, or values (Green & Janmaat, 2011). Building a sense of community within high-rise buildings can significantly enhance social cohesion. To establish and sustain such communities, three conditions must be met (Spinks, n.d.):

1. The community aligns with individual identities;
2. Residents understand how to participate and are encouraged to do so;
3. Participation provides a reward, either intrinsic or extrinsic.

However, it is crucial to consider that tensions may arise when groups with different social attributes coexist. Building a cohesive community in a high-rise on Zuidplein can enhance neighborhood cohesion, but care must be taken to avoid significant identity conflicts between the high-rise community and surrounding residents. For instance, if a high-rise primarily houses young, highly educated expatriates with shared lifestyles and exclusive activities, while the surrounding neighborhood consists of lower-income residents from diverse cultural backgrounds, this disparity could lead to tensions. The high-rise residents might be perceived as an isolated, elitist group disconnected from the wider community (Dekker & Bolt, 2005).

3.2 Biodiversity

Biodiversity encompasses the variety of plant and animal species in a given region (Wageningen University & Research, 2021). In urban high-rise environments like Zuidplein, biodiversity refers to the presence of diverse flora and fauna in or around the building. This includes everything from humans and microorganisms to plants and insects. Biodiversity is essential for food security, the economy, health, and overall well-being (Jones-Walters, 2019). For example, pollinating insects such as bees contribute to the production of three-quarters of global crops, directly supporting food supply (European Parliament, 2019).

In fostering biodiversity, both flora and fauna play integral roles. These elements are interdependent; flora often forms the foundation of ecosystems. Without a diverse and healthy plant community, many animal species cannot thrive. Plants provide food and shelter for animals, while animals contribute to pollination, seed dispersal, and soil health maintenance (Ellison, 2014).

To encourage biodiversity in urban areas like Zuidplein, buildings—especially high-rises—must provide natural habitats through greenery that supports local fauna, creating a harmonious coexistence between humans and nature (Wildenberg, n.d.). Plants require three basic elements to thrive: water, light, and air (carbon dioxide) (Cohen, 2022). For animals, natural habitats must include nesting opportunities and food sources (Wildenberg, n.d.).

4 Factors affecting social cohesion and biodiversity in mixed-use residential towers

4.1 Factors affecting social cohesion

4.1.1 Building characteristics

Quality and use of transitional spaces

Transitional spaces such as hallways and elevators are key to fostering social cohesion. Well-designed and well-maintained spaces encourage informal interactions, such as greetings or short conversations, which strengthen community bonds. Poorly maintained or unsafe spaces, on the other hand, discourage these interactions (Noordenbos, 2023).

Presence of Social Spaces

Social spaces like communal gardens or rooftop terraces increase social cohesion, especially when they are accessible and frequently used. These spaces explicitly provide opportunities for residents to meet and interact, as opposed to relying solely on chance encounters (Noordenbos, 2023).

Number of Entrances

Fewer entrances and more shared spaces enhance cohesion by creating more opportunities for residents to encounter one another. Buildings with communal entrances and shared spaces foster interactions among residents (Noordenbos, 2023).

Safety

A sense of safety in both social and transitional spaces is essential for fostering social cohesion. Residents who feel unsafe are less likely to use communal areas, which limits interactions and reinforces isolation (Noordenbos, 2023).

4.1.2 Resident characteristics

Age

Older residents often experience higher levels of social cohesion. They tend to spend more time in their building and are more reliant on local contacts for social support, increasing the likelihood of interactions and community formation (Noordenbos, 2023).

Ownership and duration of residence

Homeowners generally exhibit stronger connections to their community due to their personal investment in their property and neighborhood. Similarly, longer residency allows more time for relationships to develop, further strengthening community ties (Noordenbos, 2023).

Mobility

Car ownership reduces dependency on local amenities, decreasing the likelihood of interactions with neighbors. In contrast, high-rises in urban areas with abundant public transit and amenities encourage local engagement and informal encounters (Noordenbos, 2023). Zuidplein has many facilities in the area where encounters can occur (see Figure 1)

Local amenities in Zuidplein

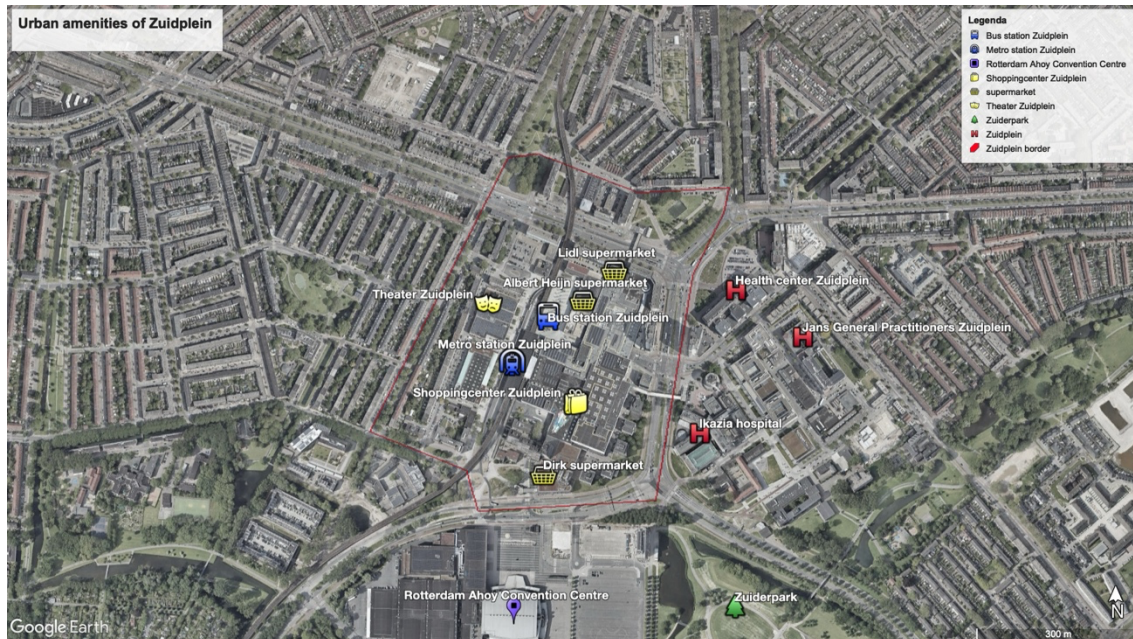


Figure 1. Map made by Google Earth. © Google.

Education level

Highly educated residents often have extensive external social networks, reducing their need to build relationships within the building (Noordenbos, 2023).

Maximum relationships

According to Dunbar's number, individuals can maintain stable social bonds with up to 150 people, emphasizing the cognitive limits of human social connections. This includes approximately 50 friends, 15 close companions, and 5 intimate relationships (Dunbar, 1998, p. 77). Considering this principle during building design can help ensure spaces facilitate sustainable social relationships.

4.1.3 Socio-demographic factors specific to Zuidplein

Research conducted in Rotterdam highlights two key socio-demographic factors—ethnic diversity and residential instability—that impact social cohesion in neighborhoods like Zuidplein (Meusen, n.d.).

Ethnic Diversity

Zuidplein is characterized by a highly diverse population with residents from a wide range of cultural backgrounds (CBS, 2024). While diversity can enrich a community, it can also pose challenges for social cohesion. Differences in cultural practices, languages, and social norms can make it harder for residents to identify common values and interests, reducing the likelihood of social interaction (Meusen, 2014). Addressing this requires thoughtful interventions that foster inclusivity and encourage cross-cultural exchanges within the building.

Residential Instability

Zuidplein experiences significant residential turnover, primarily due to the high percentage of

social housing (69%) and relatively affordable housing options that attract temporary residents (Meusen, 2014; CBS, 2024). Frequent moves and short-term stays weaken the formation of long-term social bonds, reducing overall social cohesion in the neighborhood.

4.2 Factors affecting biodiversity

4.2.1 Environmental Factors

Loss of Natural Areas

Urbanization has significantly diminished the extent of natural areas. Buildings and infrastructure have taken over spaces that once served as natural green habitats, making it difficult for wildlife to survive due to a lack of food and nesting opportunities (Wildenberg, 2023). Figure 2 shows that not much natural area remains in Rotterdam. The city's green infrastructure largely consists of semi-natural areas—natural spaces influenced by human activities, such as city parks.

Nature map of Rotterdam

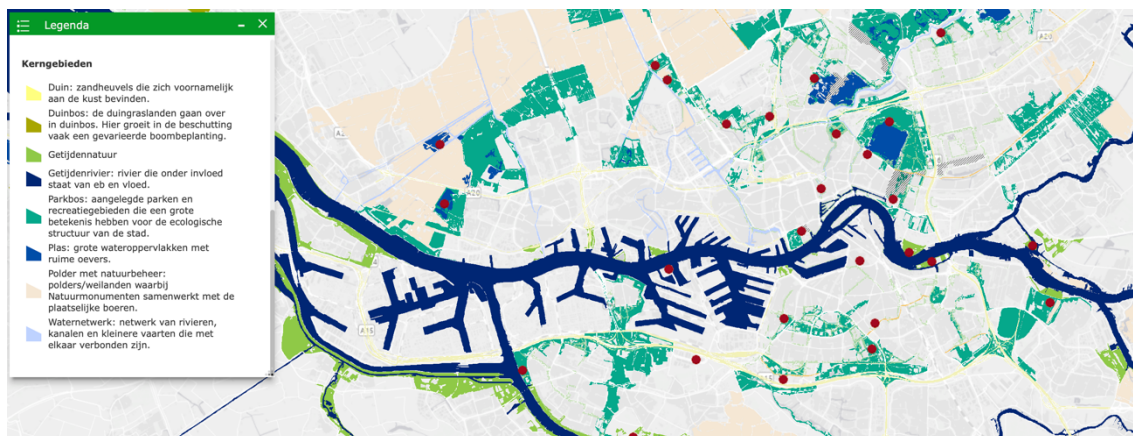


Figure 2. Note. Screenshot from *Natuurkaart Rotterdam*, by Gemeente Rotterdam, 2024. Retrieved May 8, 2025, from <https://rotterdam.maps.arcgis.com/apps/webappviewer/index.html?id=4d7b91c67b23464e88fbc543bf1434d0>

Around Zuidplein, the primary green area is Zuiderpark, as illustrated in Figure 3.

Nature map of Zuidplein



Figure 3. Note. Screenshot from *Natuurkaart Rotterdam*, by Gemeente Rotterdam, 2024. Retrieved May 8, 2025, from <https://rotterdam.maps.arcgis.com/apps/webappviewer/index.html?id=4d7b91c67b23464e88fbc543bf1434d0>

Fragmentation of Natural Areas

Urbanization has also caused fragmentation of natural areas, which negatively affects ecological resilience (Alberti & Marzluff, 2004). Ecological resilience refers to an ecosystem's ability to recover from disturbances. For example, a forest may recover after a storm through its remaining vegetation and seed bank, maintaining its ecological functions but potentially with different species (McDonald et al., 2008).

The lack of natural habitats and connectivity between natural areas results in low biodiversity, making ecosystems less capable of recovery and forcing them to rely on alternative species to maintain their functions (Turrini & Knop, 2015). Increasing the availability of natural habitats and connectivity between green areas enhances biodiversity and strengthens ecosystems (Simkin et al., 2022).

A distinction is made between functional diversity (different groups contributing to ecosystem functions, such as pollinators) and response diversity (how various species within a group react to disturbances, such as bees responding to disease or temperature changes) (Ibáñez-Álamo et al., 2017). This approach differs from the traditional focus on saving specific endangered species, emphasizing functionality in conservation and policy (McDonald, 2013). Rather than prioritizing a few species, it is more effective to promote a wide range of flora and fauna that fulfill specific ecosystem functions (Garrard et al., 2018).

In the coming years, the Municipality of Rotterdam aims to address the reduction and fragmentation of natural areas by creating green corridors throughout the city (Gemeente Rotterdam, n.d.). It is crucial for buildings to connect with these green areas to achieve ecological resilience. In Zuidplein, this means the residential tower must be linked to the nearby Zuiderpark.

5 Design framework for enhancing social cohesion and biodiversity in Zuidplein

From the factors influencing social cohesion and biodiversity, interventions for designing high-rise buildings were examined and compiled into a design framework (see Appendix 1).

5.1 Communal gardens: synergy between social cohesion and biodiversity

Communal gardens constitute a powerful design intervention that connects social cohesion and ecological sustainability within urban high-rise buildings (Gemeente Rotterdam, 2012). As shared spaces for food production, they stimulate encounters, collaboration, and intercultural dialogue. Joint gardening activities foster long-term interactions among residents. Vegetables and fruits from diverse cultures prompt conversations about heritage and traditions, thereby enhancing ethnic understanding and inclusion. Inclusivity is an essential aspect of social cohesion, especially in a diverse city like Rotterdam. An inclusive society creates broader support for societal transitions, such as the energy transition.

Diagram of relation between social cohesion and biodiversity by communal gardens

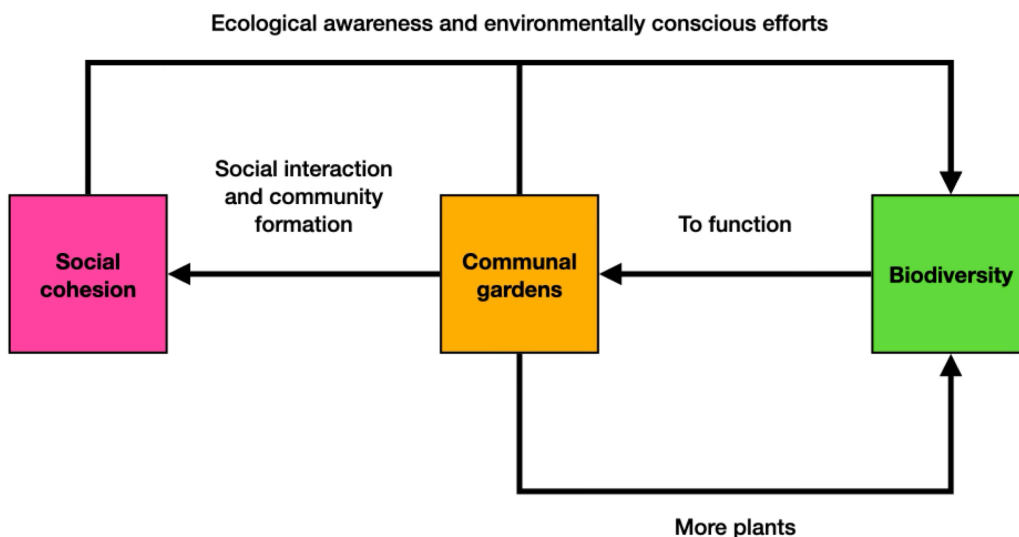


Figure 4. Own work.

The intrinsic motivation lies in collectively growing fresh food, strengthening community bonds, and connecting with nature. Extrinsically, it offers cost savings and access to organic produce—particularly relevant in the context of rising housing costs, where growing one's vegetables and fruits can generally lower living expenses. The popularity of allotment gardens in Rotterdam already demonstrates strong interest in collective food production (Gemeente Rotterdam, n.d.).

Simultaneously, these gardens contribute to biodiversity. Selected crops can serve as habitats for pollinators. Additionally, reducing CO₂ emissions from imported food contributes to climate adaptation and indirectly enhances biodiversity on a larger scale.

A residential community can form around the shared activity of gardening and food cultivation as a socially relevant common interest. Residents sharing a passion for gardening live together, promoting social interaction. Moreover, the identity of these residents will not conflict with that of other residents from the Zuidplein area, thereby preventing potential friction. On the contrary, residents from diverse cultural backgrounds often cultivate crops native to their countries of origin, sparking conversations about food and associated cultural traditions. This can foster ethnic acceptance and mutual understanding.

Communal gardens can bridge humans and nature while simultaneously promoting aspects like inclusivity, social interaction, and ecological sustainability.

6 Conclusion

This study demonstrates that targeted design interventions effectively enhance social cohesion and biodiversity in urban high-rise buildings. Using Zuidplein as a case study, factors influencing social cohesion and biodiversity were identified, including the design of communal spaces, residential characteristics, and residents' socio-demographic contexts. Socio-economic diversity and residential instability present specific challenges for Zuidplein. Designing shared spaces such as accessible communal gardens and shared entrances proved crucial in strengthening interactions and combating social isolation.

Communal gardens are especially suitable for achieving both social and ecological goals. They stimulate intercultural interactions, create strong social bonds through joint activities, and contribute to biodiversity by providing habitats for pollinators and other urban wildlife. Additionally, these gardens support climate adaptation by reducing emissions through local food production. The research emphasizes the importance of integrative design approaches, addressing social and ecological aspects together, as this leads to more sustainable and resilient urban communities.

The proposed design strategies are empirically and theoretically supported and offer guidelines directly applicable to architects and urban planners. This research thus contributes to improved urban livability, in which residents are more closely connected to each other and the natural environment, setting an example for future sustainable and inclusive urban development.

7 Discussion and Recommendations

This research provided a coherent framework for improving social cohesion and biodiversity, specifically targeting high-rise projects in urban environments like Zuidplein. Although interventions are extensively supported theoretically, practical validation through pilot projects

is recommended. Implementing these interventions in actual projects would provide valuable empirical data and refinement of the proposed framework.

Additionally, it remains crucial to consider potential tensions between different resident groups, caused by varying socio-cultural backgrounds and residential stability. The research suggests active management and continuous dialogue as important factors to minimize conflicts and encourage community formation.

A significant opportunity exists in extending the research to other aspects of biodiversity, such as aquatic systems and broader ecosystem services not explicitly covered in this study. Future research could also focus on quantitative evaluations of social cohesion and biodiversity, providing an even stronger evidence base for design interventions.

It is recommended that future projects align with urban policy initiatives, such as the green corridors planned by the municipality of Rotterdam, to strengthen ecological connectivity on a larger scale. This can systematically embed the integration of socio-ecological design principles in high-rise developments into spatial planning policies.

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9 Appendix

Design framework for the intergration of social cohesion and biodiversity in residential high-rise

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Goal: Creating a residential high-rise that enhances both social cohesion and biodiversity
User: Residents, visitors

Aspect	Factor	Nr.	Intervention	Source
Social cohesion <i>Building properties</i>	Quality and use of transitional spaces	1.	Comfortable and interactive spatial design: the goal is to enhance both comfort and interaction within transitional spaces by adding amenities like newsstands and charging stations and incorporating movable furniture that allows residents to customize their space as needed.	Dash, S. P., & Shetty, A. (2023). Transitional Spaces as an Integrated design approach Enhancing social Cohesion in High-Rise Dwellings. In <i>Springer eBooks</i> (pp. 1–18). https://doi.org/10.1007/978-3-030-91262-8_96-1
		2.	Floor-level activity spaces: the objective is to foster social interaction by creating communal spaces between corridors and lobbies at the floor level, encouraging engagement among residents.	
		3.	Integration of open and built spaces: to promote community-building, the design incorporates courtyards and semi-open spaces with seating, landscaping, and paths, ensuring ample daylight and a pleasant atmosphere.	
		4.	Roof utilization for social spaces: the goal is to transform roofs into sky courts or rooftop gardens with plants, seating, and viewing platforms, and use sky bridges to strengthen connections between buildings.	
		5.	Privacy and security measures: ensuring residents' safety and privacy through the strategic placement of plants and security cameras, creating a safe and private living environment.	
		6.	Visual openness for interaction: the aim is to encourage social interaction by ensuring a degree of visual openness that allows residents to see one another.	
		7.	Enhancing space quality: the intervention focuses on using colors, textures, and gardens to make spaces visually appealing and calming, while ensuring adequate lighting and ventilation.	
		8.	Personalization of transitional spaces: to create a sense of connection, transitional spaces will be designed to allow personalization, such as space for resident portraits or movable furniture.	
		9.	Acoustic control in lobbies: the objective is to reduce noise levels in lobbies by using acoustic panels or tiles, ensuring a pleasant and quiet environment.	
		10.	Landscaping in transitional spaces: the design encourages communal gardening activities by providing space for planting or vertical greenery in transitional areas.	
		11.	Flexible space design: the aim is to create multifunctional spaces that can serve both as areas for interaction and circulation, providing residents with the flexibility to adapt the space.	
		12.	Aesthetic and decorative enhancement: this intervention focuses on using innovative lighting, cultural designs, and a variety of materials to make spaces inviting and visually attractive.	
		13.	Increased circulation routes: by designing multiple circulation routes, the goal is to promote spontaneous encounters and provide variation in movement within the building.	
	Presence of social spaces	14.	Accessible shared spaces: the aim is to create easily accessible shared amenities, such as rooftop gardens and community spaces, that encourage frequent interactions and foster a sense of community.	Verhage, S. (2021). The impact of the living environment on the local social life of high-rise residents: Effects of the physical environment of high-rise residential buildings on social cohesion and interaction at both building and neighborhood level as perceived by high-rise residents [Eindhoven University of Technology, Thesis]. In <i>Eindhoven University of Technology</i> . https://pure.tue.nl/ws/portals/portal/183239714/Verhage_0855472_USRE_Kemperman.pdf
		15.	Green meeting points: integrating terraces, vertical gardens, and landscaped courtyards into the building to provide central social spots that enhance social cohesion among residents.	1. Nguyen, L., Van Den Berg, P., Kemperman, A., & Mohammadi, M. (2020). Where do people interact in high-rise apartment buildings?: Exploring the influence of personal and neighborhood characteristics. <i>International Journal of Environmental Research and Public Health</i> , 17(13), 4619. https://doi.org/10.3390/ijerph17134619 2. Tony, I. (2020). Urban Living with Nature: Design for Human-nature Interactions in Communal Green Spaces at Residential High-rises. <i>IOP Conference Series Earth and Environmental Science</i> , 589(5), 052002. https://doi.org/10.1088/1755-1315/589/5/052002
		16.	Vertical social pockets: the design creates open, connected spaces at various levels, such as multi-level lobbies, to encourage interaction in high-rise buildings and break up monotonous architectural designs.	Bee, A. S., & Im, L. P. (2016). The provision of vertical social pockets for better social interaction in High-Rise living. <i>Planning Malaysia</i> , 14(4). https://doi.org/10.21837/pmjournals.v14.i4.156
		17.	Semi-public transitional zones: these lounges or shared balconies, positioned between private and public areas, facilitate informal encounters among residents.	Muhuri, S., & Basu, S. (2017). Developing Residential Social Cohesion Index for High-Rise Group Housing Complexes in India. <i>Social Indicators Research</i> , 137(3), 923–947. https://doi.org/10.1007/s11205-017-1633-1
		18.	Culturally sensitive design: adapting the building design to reflect local cultures and lifestyles, such as incorporating traditional layouts, to increase community acceptance.	Ahmed, K. G. (2012). A 'Fareej-in-the-Sky': towards a Community-Oriented design for High-Rise Residential Buildings in the UAE. <i>Open House International</i> , 37(1), 48–70. https://doi.org/10.1108/ohi-01-2012-b0006
		19.	Flexible common spaces: multifunctional common spaces are designed to accommodate various activities, such as neighborhood meetings or parties, supporting diverse usage.	Dwijendra, N. K. A., Akhmadeev, R., Tumanov, D., Kosov, M., Shoar, S., & Banaitis, A. (2021). Modeling Social Impacts of High-Rise Residential Buildings during the Post-Occupancy Phase Using DEMATEL Method: A Case Study. <i>Buildings</i> , 11(11), 504. https://doi.org/10.3390/buildings11110504
		20.	Inclusive amenities for all income groups: by connecting different income groups through shared amenities, the design fosters inclusivity and reduces social segregation.	Wu, W., & Xin, J. G. (2020). Communal Space Design of High-Rise Apartments: A Literature Review. <i>Journal of Design and Built Environment</i> , 20(1), 35–49. https://doi.org/10.22452/jdbe.vol20no1.4
		21.	Aesthetic and lighting design: the objective is to ensure the use of natural light and attractive design elements in common spaces to make them inviting and pleasant for residents.	Stojiljkovic, B. (2022). Social Cohesion and Neighbor Interactions within Multifamily Apartment Buildings: Challenges of COVID-19 and Directions of Action. <i>Sustainability</i> , 14(2), 738. https://doi.org/10.3390/su14020738
Amount of entrances	22.	Limiting entrances for community interaction: limiting the number of entrances and creating open spaces encourages interaction between residents and enhances the building's sense of community.		
Safety	23.	Clear separation of public, semi-public, and private spaces: this intervention defines distinct boundaries between different types of spaces, ensuring privacy and protection from unwanted access, while maintaining comfort.		
Age	24.	Diverse housing for all ages: integrating different types of housing for various age groups, such as studios and family homes, encourages interaction and fosters a vibrant, multigenerational community.		
<i>Resident characteristics</i>	Homeownership and length of stay	25.	Mixed housing tenure (rental and ownership): by combining rental and ownership apartments, the design supports a diverse and stable community where homeowners offer long-term stability, and renters bring dynamism and flexibility.	
	Mobility	26.	Eliminating car parking to encourage interaction: excluding car parking from the building encourages residents to interact more with their surroundings, fostering community ties and encouraging use of local amenities.	
	Education level	27.	Accessible public transport connection: the building's design includes accessible routes to public transport, facilitating residents' use of sustainable transportation and encouraging interaction with the surrounding neighborhood.	
<i>Socio-demographic factors specific to Zuidplein</i>	Maximum relationships	28.	Dedicated spaces for highly educated residents: creating multifunctional common spaces that cater to the needs of highly educated residents, with workspaces and areas for lectures, to encourage interaction and collaboration.	
	Ethnic diversity	29.	Creating small living groups: based on dunbar's theory, small vertical living clusters are formed by limiting the number of homes per group, ensuring stable social connections within the building.	Dunbar, R. I. M. (1996). <i>Grooming, gossip, and the evolution of language</i> . Harvard University Press.
Residential instability	30.	Cultural and educational public spaces: the design includes cultural and educational spaces, such as worship areas and markets, to bring together residents from diverse backgrounds, promoting understanding and reducing prejudice.		
			See intervention 25.	
Biodiversity				
<i>Environment</i>	Reduction of natural Areas	31.	Nature-inclusive design: the integration of nature-inclusive elements, such as nesting stones and nectar-rich plants, in facades and roofs aims to support a healthy ecology and provide food and shelter for local species.	Wildenberg, E. M. (n.d.). <i>Nature Inclusive Design In High-Density Urban Development To Support Urban Biodiversity</i> . Delft University of Technology.
		32.	Plant needs and ecological value: the design takes into account the specific needs of plants, such as light, soil type, and irrigation, to promote healthy growth and maximize ecological value.	
		33.	Green connections to natural areas: creating green corridors between the building and surrounding natural spaces promotes ecological resilience and supports the maintenance of ecosystem functions.	Hilty, J., Worboys, G. L., Keeley, A., Woodley, S., Lausche, B. J., Locke, H., Carr, M., Pulsford, I., Pittock, J., White, J. W., Theobald, D. M., Levine, J., Reuling, M., Watson, J. E., Ament, R., & Tabor, G. M. (2020). Guidelines for conserving connectivity through ecological networks and corridors. https://doi.org/10.2305/ucn.ch.2020.pag.30.en
	Connecting with natural areas	34.	Diverse plant selection for ecological resilience: the selection of plants is based on their ecological functions, stimulating biodiversity and attracting species that contribute to the environment's resilience.	Wildenberg, E. M. (n.d.). <i>Nature Inclusive Design In High-Density Urban Development To Support Urban Biodiversity</i> . Delft University of Technology.
		35.	Energy-efficient building design: the intervention incorporates energy-efficient practices, such as solar panels, energy-efficient lighting, and low-carbon materials, to reduce energy consumption, improve air quality, and help combat climate change.	1. Lam, E. W., Chan, A. P., Olawumi, T. O., Wong, I., & Kazeeem, K. O. (2023). Sustainability concepts in global high-rise residential buildings: a scientometric and systematic review. <i>Smart and Sustainable Built Environment</i> . https://doi.org/10.1108/ssbe-04-2023-0094 2. Liu, Y., Chen, D., Wang, J., & Dai, M. (2023). Energy-Saving and ecological renovation of existing urban buildings in severe cold areas: a case study. <i>Sustainability</i> , 15(17), 12985. https://doi.org/10.3390/su151712985
	Climate change, urban heat island effect and pollution	36.	Noise-reducing facade design: facades are designed with noise- and air-pollution-reducing materials, such as green facades, to mitigate urban environmental issues and improve living conditions.	Prieto, A., & Pastén, M. (2024). What is your building doing for the city? Systematic Literature Review on the Potential of facade design for the mitigation of urban environmental Problems. <i>Sustainability</i> , 16(17), 7855. https://doi.org/10.3390/su16177855
		37.	Green roofs and walls for urban cooling: green roofs and walls are integrated to reduce the urban heat island effect, limit greenhouse gas emissions, and promote biodiversity, creating a cooler and healthier environment.	Barriuso, F., & Urbano, B. (2021). Green Roofs and Walls Design Intended to Mitigate Climate Change in Urban Areas across All Continents. <i>Sustainability</i> , 13(4), 2245. https://doi.org/10.3390/su13042245
		38.	Urban greening for pollution reduction: urban greening efforts, including forested areas, are incorporated into planning to reduce noise pollution and improve air quality, promoting a healthier urban environment.	Yuan, M., Yin, C., Sun, Y., & Chen, W. (2019). Examining the associations between urban built environment and noise pollution in high-density high-rise urban areas: A case study in Wuhan, China. <i>Sustainable Cities and Society</i> , 50, 101678. https://doi.org/10.1016/j.scs.2019.101678
		39.	Building layout for noise control: the spatial layout of buildings is adapted to reduce noise levels by strategically designing massing and complexity to contribute to a quieter environment.	Yuan, M., Yin, C., Sun, Y., & Chen, W. (2019). Examining the associations between urban built environment and noise pollution in high-density high-rise urban areas: A case study in Wuhan, China. <i>Sustainable Cities and Society</i> , 50, 101678. https://doi.org/10.1016/j.scs.2019.101678
Intersection social cohesion and biodiversity		40.	Communal gardens for biodiversity and social cohesion: the integration of communal gardens and it's biophysical and social needs within the building promotes biodiversity and encourages social interaction, strengthening community ties.	1. Gemeente Rotterdam. (2012). <i>Stimuleren van stadslandbouw in en om Rotterdam</i> . In Gemeente Rotterdam. https://foodsystemsplanning.ap.buffalo.edu/wp-content/uploads/sites/68/2019/05/Urban-Agriculture-Strategy-2012-City-of-Rotterdam-The-Netherlands-Dutch.pdf 2. Petit-Boix, A., & Apui, D. (2018). From Cascade to Bottom-Up Ecosystem Services Model: How Does Social Cohesion Emerge from Urban Agriculture? <i>Sustainability</i> , 10(4), 998. https://doi.org/10.3390/su10040998