Enhancing Social Cohesion and Biodiversity in Urban High-Rise Residential Towers: A Design Research for Zuidplein, Rotterdam

Research Plan

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Argumentations of choice of the studio: There is an increasing demand for a holistic approach in the construction sector. This field integrates design, technology and sustainability, which is essential in an era where the focus is on environmentally friendly and energy efficient buildings. By working from a multidisciplinary perspective, I can contribute to the creation of buildings that are both aesthetically pleasing and functional, sustainable and future-proof.

Keywords: Social Cohesion, Urban Biodiversity, High-Rise Residential Design, Urban Agriculture, Sustainable Urban Development

1 Introduction

In recent decades, high-rise buildings have become a symbol of urbanization, with the first skyscrapers emerging as a response to the rapid urbanization and technological advancements of the 19th century (Al-Kodmany, 2015). These structures embodied the drive for growth and space-saving, leading to iconic skylines in cities such as Ro;erdam. In Ro;erdam-South, specifically in the Zuidplein area as indicated in Figure 1, the 'Hart van Zuid' project plans a redevelopment with more housing and green spaces (Heijmans, 2024). Due to limited space, high-rise buildings are a logical choice (as shown in Figure 2), but this also brings new challenges related to social cohesion and sustainability.

Figure 1

Map showing the location of Zuidplein in Ro5erdam.

Note: From Google Earth.

Figure 2

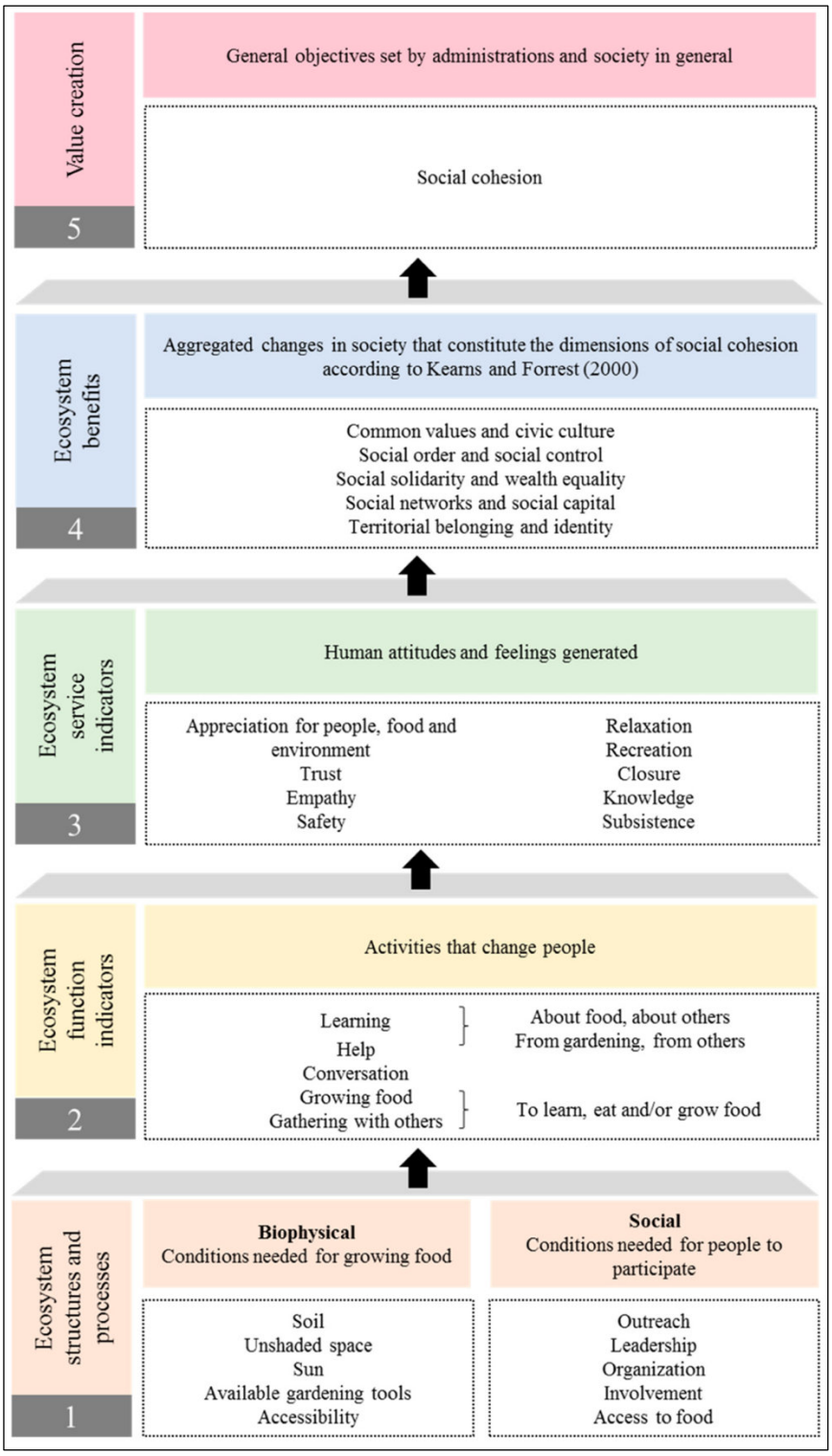
Aerial view of the future developmentsin Hart van Zuid, with a preview of more high-rise buildings.

Note: From ‘Hart van Zuid’ by Hart van Zuid, 2024. h@ps://nl.linkedin.com/posts/loes-van-der-weerd-10916490_winterfeestopzuid-activity-7137400823319257089-gGwg

Currently, Zuidplein scoreslow on social cohesion (GemeenteRo;erdam, 2024).The Municipality of Ro;erdam promotesurban agriculture, including community gardens, asa means to strengthen a senseof community, as research by Veen et al. (2015)demonstrated that communal gardens promote social interaction and cooperation. Petit-Boix and Apul (2018)delve deeper into the mechanisms and processesthat stimulate this social cohesion within the broader context of urban agriculture, asshown in Figure 3.

Figure 3

Diagram of social cohesion mechanisms within urban agriculture through biophysical and social factors.



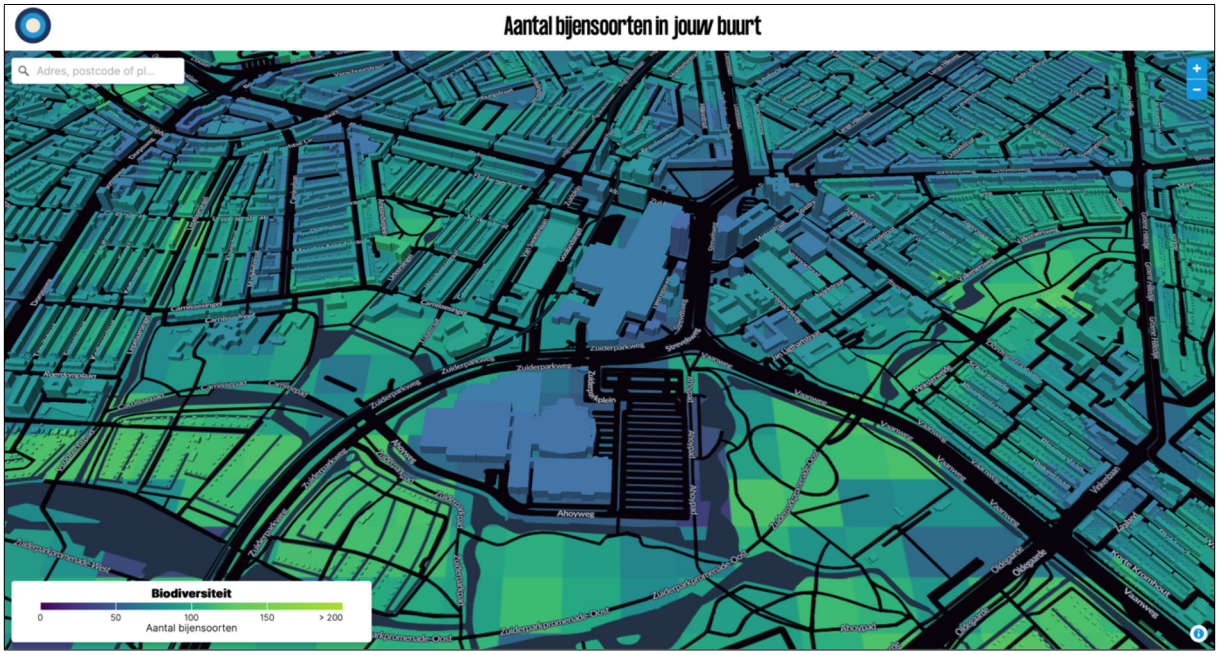
Note: From 'From Cascade to Bo@om-Up Ecosystem Services Model: How Does Social Cohesion Emerge from Urban Agriculture?' by Petit-Boix & Apul, 2018. h@ps://doi.org/10.3390/su10040998

It shows that it is necessaryto meet biophysical factors (the basic conditions for growing food) and social factors (the basic conditions for people to participate) to make urban agriculture work and stimulate social cohesion. There is a knowledge gap on how mixed-use high-rise buildings, the biophysical and social factors, can be translated into physical spaceto enhancesocial cohesion. A high-rise could offer a solution for the limited land availability by stacking communal gardens. However, the low biodiversity of pollinating insectsand the lack of natural habitatswith sufficient food (nectar and pollen) and nesting opportunities in urban areas—and thus in high-rises—presentsanother significant biophysical challenge for urban agriculture (Wildenberg, 2022;European Parliament, 2019). Additionally, weather conditions at great heights in high-rise buildings hinder insects, making pollination at such heights more difficult. Without pollinating insects, urban agriculture will be less effective, reducing its potential to enhancesocial cohesion.

Ro;erdam is commi;ed to bee-friendly landscapes, including Zuidplein, where bee biodiversity is relatively low, as shown in Figure 4 (GemeenteRo;erdam, n.d.).

Figure 4

Map of Zuidplein showing the number of bee species in the area and surrounding environment.



Note: From 'Ruimteship Aarde: number of bee species in your neighborhood' by KRO-NCRV, n.d. h@ps://kro-ncrv.nl/ruimteschip-aarde-bodem

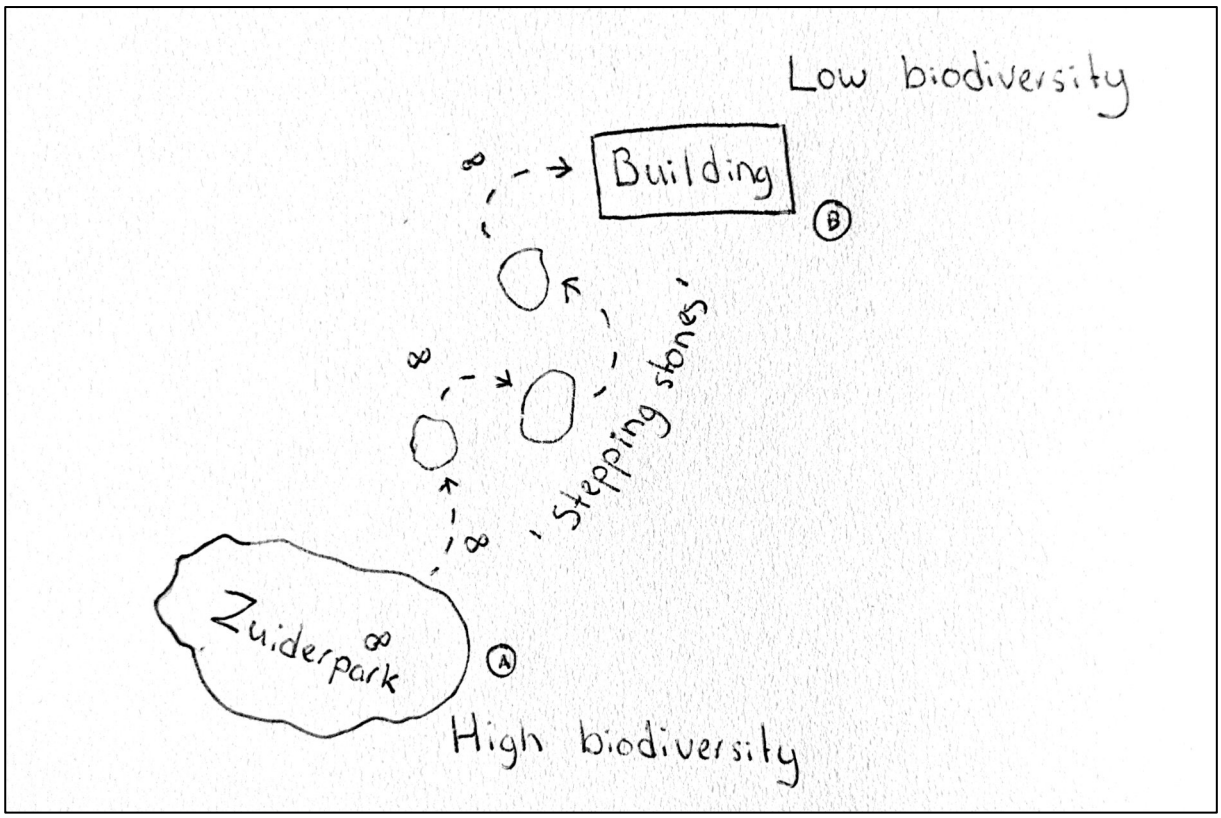
The focus is on various local bee species, such as the large leaf cu;er bee in Zuidplein, to promote successful pollination and biodiversity (Province of South Holland, n.d.; Steffan-Dewenter, Klein, Gaebele, Alfert & Tscharntke, 2006).

This research focuses on interventions that can promote social cohesion and biodiversity, important biophysical requirements for urban agriculture. Bees, for example, can be a;racted from areas with high bee biodiversity, such as the Zuiderpark in Ro;erdam-South, to high-rises with lower bee biodiversity through 'stepping stones' that serve as a connection route for bees, as illustrated in Figure 5 (Parmetier, 2024). This concept can also be applied vertically within high-rises by using 'stepping stones' such as facades, roofs, balconies, indoor gardens, vertical corridors, and by designing stacked communal gardens to provide a livable habitat for diverse local bee species, which also create space for social interaction and

cohesion (see Figure 6) (Wildenberg, 2022). Wildenberg's (2022) research "Nature Inclusive Design in High-Density Urban Development to Support Urban Biodiversity" can help, as it offers solutions for food supply and nesting opportunities for insects in high-density urban areas. By creating livable habitat steps that protect against environmental factors like wind at high altitudes, tailored to specific bee species and integrated with the environment and communal gardens, bees can be encouraged to se;le at higher levels in high-rise buildings, enabling pollination on higher floors.

Figure 5

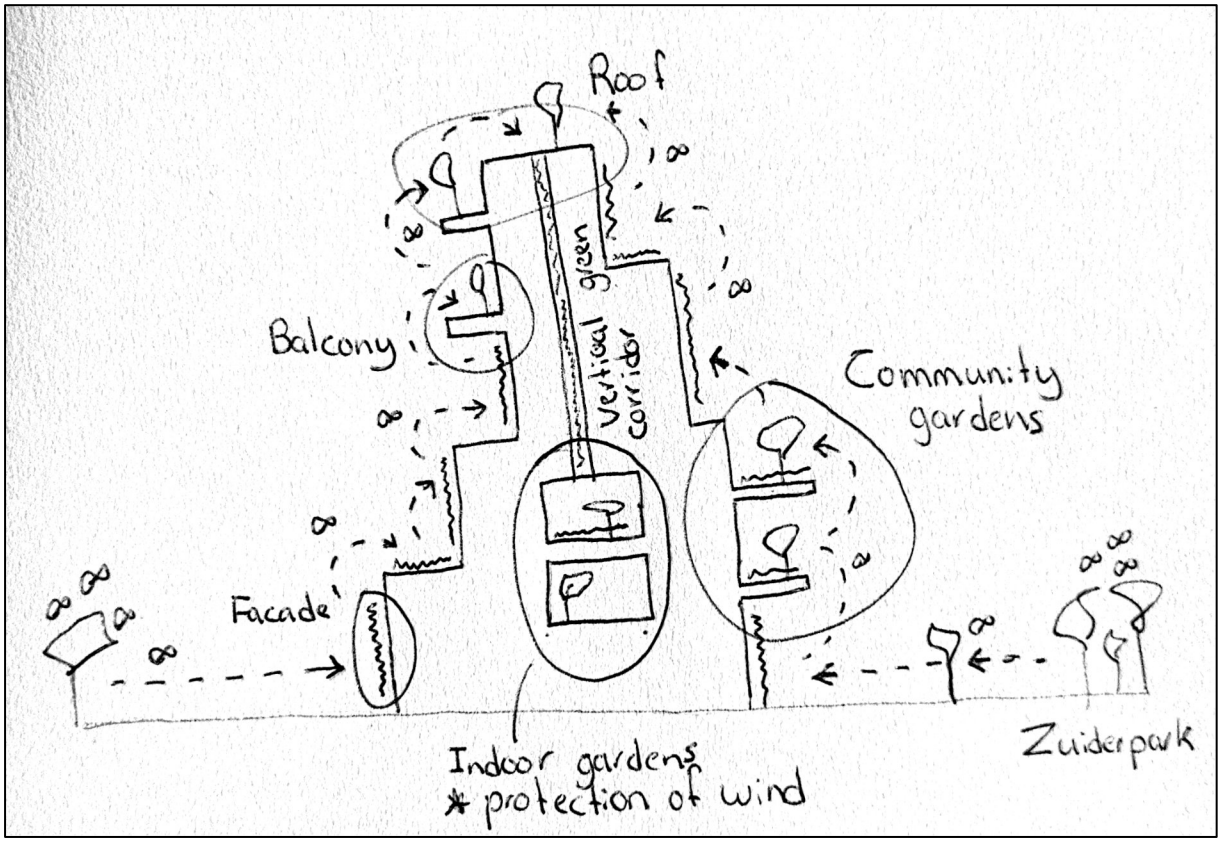
Sketch of stepping stones as a connection between areas with low biodiversity and places with high biodiversity.



Note: Image by the author.

Figure 6

Concept sketch of potential interventions in high-rise buildings to promote social cohesion and biodiversity.



Note: Image by the author.

A diagram of the research and planning is included in Appendices 1 and 2.

2 General problem statement

This research focuses on bridging the knowledge gap on how biophysical and social factors can be integrated into the design of mixed-use residential towers over 50 meters to both strengthen social cohesion and promote the biodiversity of local pollinating insects, in the Zuidplein district, where space constraints, low social cohesion, and biodiversity pose challenges.

3 Overall design objective

The design goal of this graduation project is to develop a mixed-use residential tower of more than 50 meters high in the Zuidplein area of Ro;erdam, with a focus on promoting social cohesion and biodiversity through urban agriculture. The aim is to integrate both social and biophysical factors, such as encouraging bee-friendly habitats and designing communal gardens. These interventions will encourage social interaction and cooperation while simultaneously creating habitats for local bee species to contribute to biodiversity. The design should be functional for residents and serve as an example for high-density urban development projects facing limited space, with sustainability and community building at the core.

4 Overall Design Question

How can a mixed-use residential tower of more than 50 meters be designed to enhance social cohesion in Zuidplein through urban agriculture, integrating both social and biophysical factors, such as promoting biodiversity?

5 Reflection on the relevance

The design goal addresses the urgent need for urban densification combined with strengthening social cohesion in neighborhoods with low community ties, such as Zuidplein. By integrating green and biodiverse spaces within high-rise buildings, this project offers a sustainable and spatially efficient solution. Residents benefit from these living environments, while the city of Ro;erdam gains new knowledge for similar redevelopment projects. The project holds societal value by promoting local

biodiversity and social interaction, making it relevant for both urban development and the creation of connected communities.

6 Thematic Research Objective

The thematic goal of this research is to identify effective interventions that can stimulate social cohesion and biodiversity within a mixed-use residential tower of more than 50 meters high. The focus is on urban agriculture as a means to promote community building and develop habitats for local bee species. By analyzing literature and case studies of similar high-rise projects, the research investigates which design strategies work best to achieve these objectives within a limited urban space. The findings will serve as the foundation for the iterative design process and concrete design decisions within the Zuidplein case.

7 Thematic Research Question

Main thematic researchquestion:

What kind of interventions stimulate social cohesionand biodiversity in a mixed-use residential tower (+50meter) 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 cohesionand 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 cohesionin similar urban residential projects?
4. How can communal spacesand green elements be integrated into a mixed-use residential tower to promote both biodiversity and social cohesion?

8 Reflection on the relevance

The thematic researchgoal is both socially and scientifically relevant. It provides insight into how high-rise buildings can contribute to local biodiversity and social cohesion—topicsclosely aligned with Ro;erdam's sustainability goals. This knowledge can be widely applied in other urban areasfacing similar challenges. Residents benefit from more inclusive and green communal spaces,while architects, urban planners, and policymakers receive guidelines for future, sustainable urban densification projects.

9 Thematic research methodology

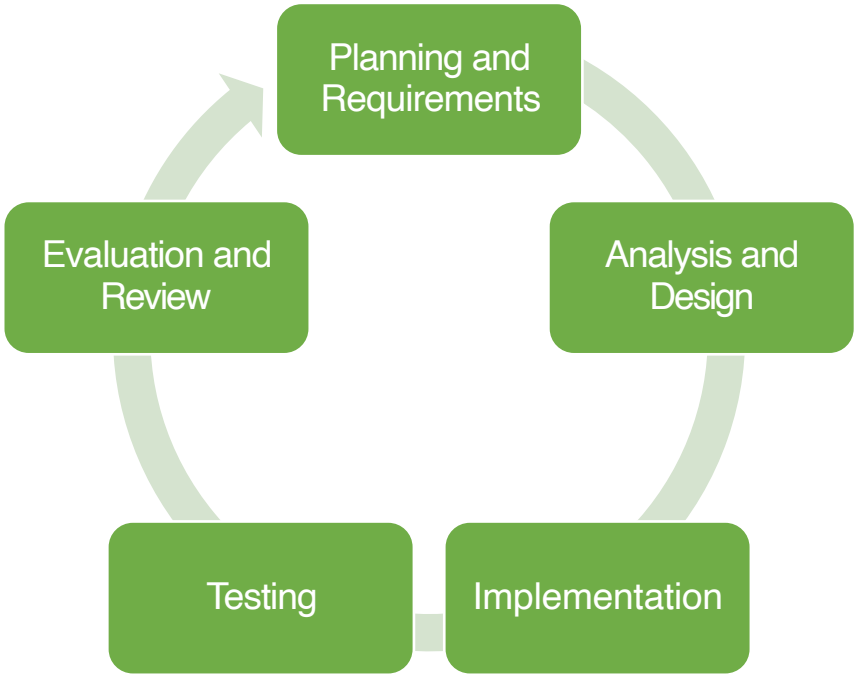
For this qualitative researchon interventions that stimulate social cohesion and biodiversity in mixed-use residential buildings, desk researchis employed. This includes researchby design, where literature review and casestudy analysis inform the iterative design process.

For researchby design, an iterative design processis applied with the following steps, as shown in Figure 7 (Eby, 2019):

1. Planning and Requirements: Project goals and requirements are defined for social cohesion and biodiversity.
2. Analysis and Design: Design conceptsbasedon literature study and case study analysis are developed and analyzed, focusing on social and ecological functions such as meeting spacesand green zones.
3. Implementation: The design conceptis developed into a model, including technical details for social and ecological amenities, using environmentally friendly materials and construction techniques.
4. Testing: The model is tested at Zuidplein to evaluate the effectivenessof social and ecological elements.
5. Evaluation and Review: The design is evaluated and improved basedon test results and feedback from the design and researchtutor, as well as experts in social cohesion and biodiversity.

Figure 7

Illustration of the cycle of the iterative design process.



Note: Image own work

The steps/iterations are repeated until the goal of designing a mixed-use residential building that stimulates social cohesion and biodiversity is achieved.

For the literature review, research from the TU Delft repository, Google Scholar, and ResearchGate is used as much as possible, focusing on design strategies that stimulate social cohesion and biodiversity.

For the casestudy analysis, the following buildings, known for their design aimed at promoting social cohesion and biodiversity, will be analyzed:

- Social Cohesion:
    - Kleiburg Flat (Amsterdam, Netherlands) (see Figure 8)
    - Bosco Verticale (Milan, Italy) (see Figure 9)
- Biodiversity:
    - Trudo Tower (Eindhoven, Netherlands) (see Figure 10)
    - Wonderwoods (Utrecht, Netherlands) (see Figure 11)

Figure 8

Image of Kleiburg Flat in Amsterdam.

Note: From 'Kleiburg: the old and new ideal of living' by Stijn Poelstra, 2017 h@ps://architectenweb.nl/nieuws/artikel.aspx?id=40516

Figure 9

Image of BoscoVerticale in Milan.

Note: From 'Vertical Forest Milan' by Stefano Boeri Archite@i, n.d.

h@ps://www.stefanoboeriarchite@i.net/en/project/vertical-forest/

Figure 10

Image of Trudo Tower in Eindhoven.

Note: From ‘Ecology and a forest tower’ by Biotope-City, n.d. h@ps://biotope-city.net/en/ecology-and-a-forest-tower/

Figure 11

Image of Wonderwoods in Utrecht.

Note: From ‘Wonderwoods: A green island in an urban environment’ by MSVA, n.d. h@ps://mvsa-architects.com/en/projects/wonderwoods/

The data collection and data analysis methods for each sub-question are presented in Table 1.

Table 1

Data collection and data analysis methods for each sub-question.

Sub-question	Data collection	Data analysis methods
What do the terms 'social cohesion' and 'biodiversity' mean in the context of high-rise and urban residential environments?	Literature review	Conceptual analysis to derive definitions and key conceptsfrom the literature.
What factors promote or hinder social cohesion and biodiversity in mixed-use residential environments within urban high-rise buildings?	Literature review	Thematic analysis to identify common factors and paBerns influencing social cohesion and biodiversity.
What types of interventions and design elements have proven effective in enhancing biodiversity and social cohesion in similar urban residential projects?	Casestudy analysis	Comparative analysis of selected casestudies to identify successful interventions and design principles.
How can communal spacesand green elements be integrated into a mixed-use residential tower to promote both biodiversity and social cohesion?	Researchby design	Iterative evaluation of design propositions with feedback cycles, assessing the success of integrating green and communal elements based on established criteria for social cohesion and biodiversity.

Note: Table own work

A limitation of this researchis that no quantitative data will be collected, as the improvement of social cohesion and biodiversity can only be accurately measured in practice, for example, through surveys of residents and insect speciescounts. Therefore, the research focuses on qualitative analyses and concept development,

with quantitative effectsoutside the scope.Only future researchafter actual implementation can demonstrate these effects.

10 Expected resultsof thematic research and design implementation

The thematic researchwill result in a setof design strategiesfor creating biodiverse, communal spaceswithin high-rise buildings. Expectedoutcomesinclude recommendations for designing habitats on higher floors, such asvertical gardens and balcony landscapesthat promote social cohesion and a;ract pollinators. Success will be measured basedon qualitative criteria, such asthe potential a;ractiveness for local beespeciesand the expected social interaction within communal spaces.These insights will be concretelyapplied to the design for Zuidplein, with the ultimate goal of creating a model for sustainable, socially connectedurban residential environments.

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12 Appendices

12.1 Research diagram

General Problem Statement

This research focuses on bridging the knowledge gap on how biophysical and social factors can be integrated into the design of mixed-use residential towers over 50 meters to both strengthen social cohesion and promote the biodiversity of local pollinating insects, in the Zuidplein district, where space constraints, low social cohesion, and biodiversity pose challenges.

Overall Design Objective

The goal of this graduation project is to design a mixed-use residential tower over 50 meters high in Rotterdam's Zuidplein area, focusing on social cohesion and biodiversity through urban agriculture. By integrating social and environmental elements—like bee-friendly habitats and communal gardens—the design will foster interaction and cooperation among residents while supporting local bee species and biodiversity. This project aims to be both functional and a model for sustainable, high-density urban development, balancing limited space with a strong emphasis on community and environmental stewardship.

Overall Design Question

How can a mixed-use residential tower of more than 50 meters be designed to enhance social cohesion in Zuidplein through urban agriculture, integrating both social and biophysical factors, such as promoting biodiversity?

Thematic Research Objective

This research aims to identify effective interventions for enhancing social cohesion and biodiversity in a mixed-use residential tower over 50 meters high, focusing on urban agriculture to foster community and support local bee habitats. Through literature review and case study analysis of similar projects, the study will determine optimal design strategies for these goals in limited urban space. The findings will inform the iterative design process and decisions for the Zuidplein project.

Stacked unshaded community gardens
Watering
Space for space for gardening tools shop
…

Biofysica factors

Soil
Unshaded space
Sun
Available gardening tools
Accessibility

Social factors

Outreach
Leadership
Organisation
Involvement
Access to food

Space for:
Education/workshops
Meeting places
Social events
…

Vertical habitat for pollinating insects:
- Food (nectar and pollen)
- Nesting places
- Protection from strong winds
- Protection from temperature differences

…

Thematic Research Question

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

What do the terms 'social cohesion' and 'biodiversity' mean in the context of high-rise and urban residential environments?

What factors promote or hinder social cohesion and biodiversity in mixed-use residential environments within urban high-rise buildings?

What types of interventions and design elements have proven effective in enhancing biodiversity and social cohesion in similar urban residential projects?

How can communal spaces and green elements be integrated into a mixed-use residential tower to promote both biodiversity and social cohesion?

Data collection - Methodology

Literature review

Literature review

Case study analysis

Research by design

Data analysis methods - Methodology

Conceptual analysis to derive definitions and key concepts from the literature.

Thematic analysis to identify common factors and patterns influencing social cohesion and biodiversity.

Comparative analysis of selected case studies to identify successful interventions and design principles.

Iterative evaluation of design propositions with feedback cycles, assessing the success of integrating green and communal elements based on established criteria for social cohesion and biodiversity.

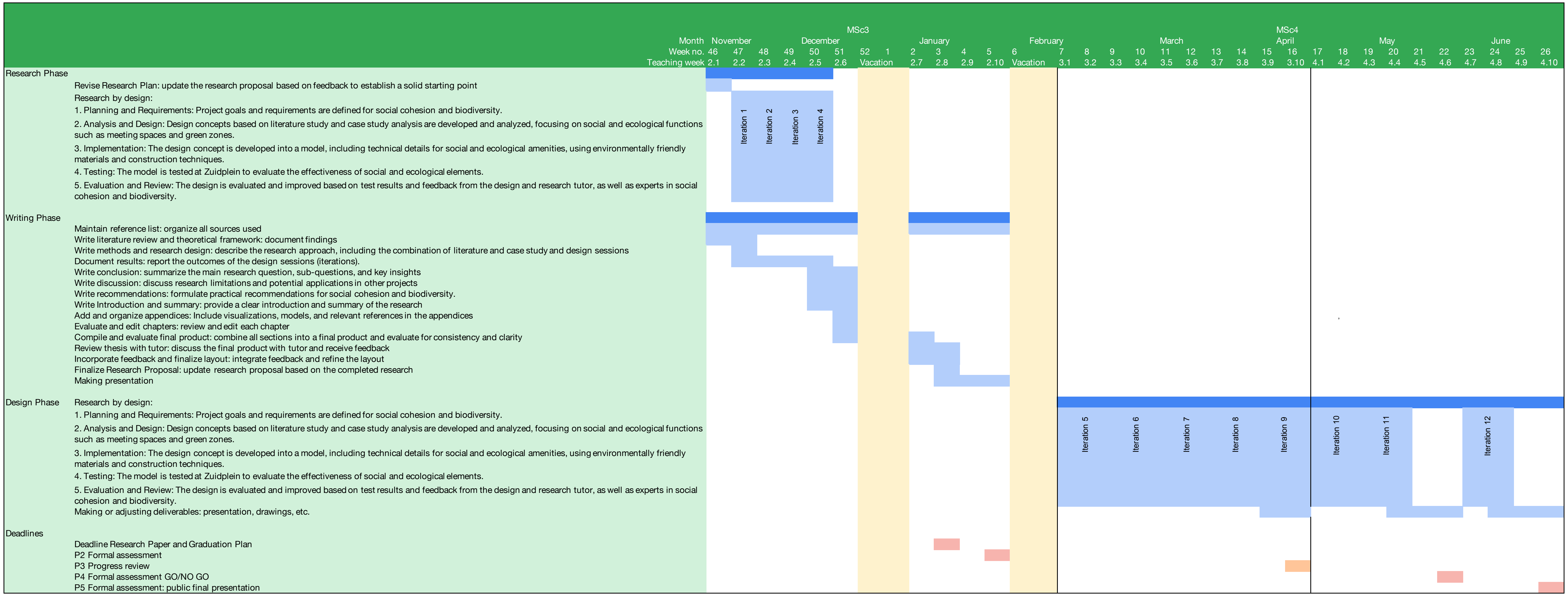
Expected results

This research will produce design strategies for biodiverse, communal spaces in high-rise buildings. Outcomes include recommendations for creating pollinator-friendly habitats on higher floors, like vertical gardens and balcony landscapes that foster social cohesion.

Conclusion & Recommendations

Design concepts and strategies for developing a building that creates a habitat for local bees and fosters social cohesion

12.2 Planning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Research Phase
Revise Research Plan: update the research proposal based on feedback to establish a solid starting point
Research by design:
1. Planning and Requirements: Project goals and requirements are defined for social cohesion and biodiversity.
2. Analysis and Design: Design concepts based on literature study and case study analysis are developed and analyzed, focusing on social and ecological functions such as meeting spaces and green zones.
3. Implementation: The design concept is developed into a model, including technical details for social and ecological amenities, using environmentally friendly materials and construction techniques.
4. Testing: The model is tested at Zuidplein to evaluate the effectiveness of social and ecological elements.
5. Evaluation and Review: The design is evaluated and improved based on test results and feedback from the design and research tutor, as well as experts in social cohesion and biodiversity.
Iteration 1
Iteration 2
Iteration 3
Iteration 4
Writing Phase
Maintain reference list: organize all sources used
Write literature review and theoretical framework: document findings
Write methods and research design: describe the research approach, including the combination of literature and case study and design sessions
Document results: report the outcomes of the design sessions (iterations).
Write conclusion: summarize the main research question, sub-questions, and key insights
Write discussion: discuss research limitations and potential applications in other projects
Write recommendations: formulate practical recommendations for social cohesion and biodiversity.
Write Introduction and summary: provide a clear introduction and summary of the research
Add and organize appendices: Include visualizations, models, and relevant references in the appendices
Evaluate and edit chapters: review and edit each chapter
Compile and evaluate final product: combine all sections into a final product and evaluate for consistency and clarity
Review thesis with tutor: discuss the final product with tutor and receive feedback
Incorporate feedback and finalize layout: integrate feedback and refine the layout
Finalize Research Proposal: update research proposal based on the completed research
Making presentation
Design Phase
Research by design:
1. Planning and Requirements: Project goals and requirements are defined for social cohesion and biodiversity.
2. Analysis and Design: Design concepts based on literature study and case study analysis are developed and analyzed, focusing on social and ecological functions such as meeting spaces and green zones.
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4. Testing: The model is tested at Zuidplein to evaluate the effectiveness of social and ecological elements.
5. Evaluation and Review: The design is evaluated and improved based on test results and feedback from the design and research tutor, as well as experts in social cohesion and biodiversity.
Making or adjusting deliverables: presentation, drawings, etc.
Iteration 5
Iteration 6
Iteration 7
Iteration 8
Iteration 9
Iteration 10
Iteration 11
Iteration 12
Deadlines
Deadline Research Paper and Graduation Plan
P2 Formal assessment
P3 Progress review
P4 Formal assessment GO/NO GO
P5 Formal assessment: public final presentation