Overcoming Challenges in Municipal Decision-Making for Urban Greenery Implementation

A Study of Barriers, Enablers, and Mitigation Strategies

TUDelft

Master thesis
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Acknowledgements

What started as a hobby of a small vegetable garden on my rooftop terrace in Rotterdam, has turned into a master's thesis on implementing urban greenery. In the past few months, I have gained many interesting insights on this topic and had the chance to share my enthusiasm with many people. I believe this thesis is just the beginning of my journey towards making cities greener, and I hope that one day I can contribute to the implementation of more urban greenery in cities.

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Enjoy reading!

Anouk Slomp
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Executive summary

Introduction

The significant urbanization in cities is characterized by the increasing dense and concrete infrastructure, which presents important challenges for municipalities in implementing urban greenery into cities (Stobbelaar et al., 2022). The implementation of urban greenery is important for healthy and sustainable cities. Without sufficient greenery, cities face climate-related issues, such as increased temperatures, poor air quality, and reduced biodiversity. Moreover, the absence of urban greenery also negatively affects the quality of life, reducing the well-being among urban residents (Antoszewski et al., 2020; Pereira & Baró, 2022). Therefore, integrating urban greenery brings multiple benefits essential for creating healthy and sustainable cities.

This thesis addresses the challenges municipalities face in decision-making processes for implementing urban greenery. The study focusses on urban greenery in the context of dense, urbanized environments; therefore, it is limited to focusing on small to medium-sized greenery projects in already developed urban areas. The objective of this research is to identify the broad range of barriers and enablers that influence the decision-making process of municipalities in implementing urban greenery, and to provide practical guidance for municipalities to improve this implementation, contributing to climate change mitigation and urban sustainability. To address this problem and achieve the objective, the main research question is:

> *"HOW CAN MUNICIPALITIES EFFECTIVELY OVERCOME THE CHALLENGES ENCOUNTERED IN THE DECISION-MAKING PROCESS FOR IMPLEMENTING URBAN GREENERY?"*

Methodology

The research conducted a qualitative research approach. First, a literature review was conducted to understand the important background information on the benefits of urban greenery and the decision-making processes. After this, both a systematic literature review and semi-structured interviews were conducted, with the goal to identify the key barriers and enablers municipalities face when implementing urban greenery. A thematic analysis was employed to recognize patterns and to structure types of barriers and enablers into categories.

The systematic literature review identified barriers and enablers from 25 relevant articles obtained through a structured search on Scopus. These articles provided insights into theoretical challenges and opportunities in the decision-making on urban greenery. In addition to the literature review, 14 semi-structured interviews were conducted with municipal decision-makers from Amsterdam, Rotterdam, Den Haag, Utrecht, and Eindhoven. The interviews gathered practical insights from decision-makers directly involved in municipal urban greenery projects, providing insights in the barriers and enablers faced by these municipalities.

After that, the research explored the connections between barriers and enablers to provide a comprehensive understanding of how they interact. Based on these insights, possible mitigation strategies were developed by aligning barriers with enablers identified from the literature review and interviews. Additionally, a validation session with experts was conducted to validate the findings and ensure that the identified barriers, enablers, and suggested strategies are relevant and applicable in real-world municipal contexts.

Results

Barriers and enablers are identified across seven different categories: organizational, governance and regulatory, social and psychological, financial, research and knowledge, spatial, and participation. The thematical analysis structured the 182 identified barriers into 36 different types of barriers, and 110 enablers into 44 types. This highlights the range of factors influencing the

urban greenery implementation. The research identifies that the key barriers are Fragmentation in coordination and responsibilities, Lack of funding and Limited space allocation. On the other hand, Community engagement, Raising awareness and Car restraint policies are the three most identified enablers for successful implementation.

The barriers and enablers are highly interconnected, allowing the enablers to be applied in multiple ways to achieve different goals, making it difficult to formulate clear mitigation strategies. The results highlight that municipalities should adopt a flexible and context-specific approach to effectively address the challenges. The developed mitigation strategies offer examples of practical and adaptable guidance for municipalities to improve urban greenery implementation. To make well-informed decisions on the best approaches, it is crucial for municipalities to have a clear understanding of the barriers and enablers. Therefore, using an identification framework for barriers and enablers can improve awareness and support better decision-making.

Discussion
The results offer a comprehensive understanding of the multiple barriers and enablers experienced by municipal decision-makers. The semi-structured interviews provided new insights into the barriers and enablers by providing more context and background information. From the results became clear that the enablers are more flexible and variable than the barriers, which reflects the differences in strategies, policies, and resources from municipalities. Because of the flexibility of the enablers, they can be adapted to the specific needs and goals of municipalities.

Besides that, the interconnectedness of the barriers and enablers make it challenging for municipalities to determine where to begin with addressing the barriers. There is no general approach, as each municipality's context and specific challenges require tailored solutions. However, the findings suggest that starting with improving the fragmented structure of municipalities could be an effective first step. Additionally, the enabler Raising awareness is highlighted as a multifunctional enabler, as it can positively influence all the barriers municipalities experience, which can be an effective starting point to impact many barriers.

Recommendations
The key recommendations for future research include exploring the applicability of the results for smaller, less urbanized cities and cities outside Europe, to assess whether the identified barriers and enablers are relevant in different contexts. Another important area for further research is exploring the potential of increasing urban greenery on private land through collaborations between municipalities and private stakeholders. Additionally, future research can include perspectives from different stakeholders besides municipal employees, to capture a broader understanding of the challenges. Finally, research can focus on addressing the key barrier of fragmentation in coordination and responsibilities by developing specific strategies or validating the effectiveness of the identification framework proposed in this research.

Conclusion
The research concludes that municipalities experience unique and complex challenges when implementing urban greenery, and there is no one-size-fits-all solution for addressing these challenges. Municipalities need to enhance collaboration between departments and stakeholders and should adopt tailored strategies for urban greenery projects. By using an identification framework for barriers and enablers, municipalities are better prepared for the challenges of implementing urban greenery, ensuring that future greening projects are more successful and sustainable.

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1. Introduction

In this chapter, the research will be introduced by first outlining the context of the research and identifying the relevant knowledge gaps. After that, section 1.2. provides the research objective and the research questions that this thesis aims to answer. Finally, section 1.3. provides the details of the scope in which this research takes place.

1.1. Research context

The world is experiencing a significant trend towards urbanisation, leading to several urgent challenges. In 2018, 55% of the world's total population is living in urban areas, and it is expected that by 2050 this number will increase to 68% (United Nations, 2019). A major challenge faced by the increasing urbanisation is that it comes at the expense of green areas in cities. Because the urban population continues to grow, cities become more compact and denser, characterized by an increase in concrete structures and a loss of urban green areas (Stobbelaar et al., 2022). This loss causes significant negative effects on climate change, biodiversity and quality of life in cities, such as increased urban heat, loss of species and reduced mental well-being (Antoszewski et al., 2020; Pereira & Baró, 2022). Therefore, the availability of urban green areas is not only desirable for developing attractive environments, but also brings multiple benefits essential for mitigating urbanization problems and creating healthy and sustainable cities (Bush et al., 2021).

In response to these growing urbanization challenges, the European Commission introduced in 2019 the "European Green Deal" (Fetting, 2020), this deal highlights the importance of implementing greenery in urban areas to protect the environment and biodiversity (Costadone & Vierikko, 2023; Pereira & Baró, 2022). For this deal the European Commission formulated 16 targets, target 14 states: *"Cities with at least 20,000 inhabitants have an ambitious Urban Greening Plan"* (European Commission, 2022). The study by Costadone & Vierikko (2023) evaluated the progress of these urban greening plans in 15 European cities. According to their findings, even though many cities have developed greening plans, crucial decision-making processes are still lacking to ensure the successful implementation of urban greenery.

Cities in the Netherlands are also responding to the urbanization challenges, especially in the major cities and their surrounding municipalities rapid urbanization is experienced (de Jong et al., 2022). The urban growth leads to densely built cities and increasing pressure on public spaces, which makes it difficult for local municipalities to implement urban greenery (Bruinsma & Koomen, 2023). Similar to many other European cities, some Dutch municipalities introduced their own greening plans to overcome the climate change problems. Den Haag aims to add 23 hectares of green spaces (Gemeente Den Haag, 2024) and Rotterdam set the goal to increase the greenery with 20 hectares in the coming years (Gemeente Rotterdam, 2019). However, despite these efforts, municipalities face significant challenges in effectively implementing the plans urban greenery plans into their cities (Stobbelaar et al., 2022).

In addition to these experienced challenges, the literature also confirms that the transition towards greener cities remains a complex process. They emphasize the critical role of municipalities in the implementation of greenery and highlight their lagging implementation efforts (Emeis & Fallmann, 2022; Panagopoulos et al., 2018; Stobbelaar et al., 2022). Many different challenges, including lack of active stakeholder involvement, reluctance to implement greening policies, and insufficient collaboration with other key stakeholders hinder the success of the overall greenery implementation (Boulton et al., 2018). These challenges faced by municipalities highlight the urgency to address these barriers effectively to ensure more successful implementation of urban greenery. By overcoming the barriers, cities will not only become greener but also improve the overall sustainability and livability.

1.1.1. Knowledge gap and problem statement

While literature often agrees on the importance of integrating urban greenery, to overcome climate change and urbanization problems, the availability and implementation of greenery in many urban areas is still insufficient. Two key knowledge gaps contribute to this limited implementation of urban greenery.

First, the knowledge gap lies in the fragmented and specific nature of literature on the benefits of urban greenery. The existing literature often addresses urban greenery benefits separately, by focusing on specific aspects such as urban heat mitigation (Santamouris et al., 2018), flood mitigation (Li et al., 2020b), or human well-being (Kraemer & Kabisch, 2021). However, comprehensive studies that integrate all the different benefits are limited. The research of Kumar et al. (2024) reviewed 202 articles, the majority (69.8%) of these articles did not report other benefits besides mitigating and adapting to urban heat. For stakeholders involved in urban greenery implementation, having a complete and comprehensive overview of the benefits can create a better understanding and support informed decision-making. Therefore, the fragmented information in the literature hinders effective decision-making on urban greenery.

The second knowledge gap relates to the fragmented understanding of barriers and enablers in the decision-making processes for urban greenery implementation, with a particular lack of focus on how to overcome these barriers. Because urban greenery is a highly multidisciplinary field, involving urban planning and development, environmental science, governance, and other related disciplines, integrating this fragmented knowledge becomes essential (Lähde & Di Marino, 2019). While significant research has been conducted on the barriers faced by municipalities (for example: Buffam et al., 2022; Hoang & Fenner, 2016; Voskamp et al., 2021; Williams et al., 2019), research on enablers remains limited. When enablers are discussed, they are often analyzed without connecting them to broader strategies or to the barriers they could potentially address (Grunewald et al., 2021; Li et al., 2020c), resulting in an incomplete academic understanding of the factors that facilitate successful urban greenery initiatives. This gap results in valuable knowledge spread across multiple disciplinary fields, lacking a clear understanding of how enablers can be effectively used to address barriers (Lähde & Di Marino, 2019). Bridging this gap is crucial to bring together the fragmented knowledge, offering both practical guidance for municipalities and a stronger theoretical foundation for understanding urban greenery implementation.

Despite the increasing awareness of the importance of urban greenery for sustainable urban development, these knowledge gaps result in the following *problem statement* for this research: The knowledge gap leads to the problem that research on urban greenery is characterized by a fragmented and incomplete academic understanding, as research on the benefits, barriers, and enablers are spread across multiple disciplines. This fragmentation in knowledge makes it difficult to connect these concepts and explain how to overcome the barriers effectively. As a result, this academic gap results into practical challenges for decision-makers. Municipalities lack clear guidance to inform urban greenery strategies, leading to difficulties in implementing successful greenery initiatives. Bridging this academic-practical gap is essential to create effective urban greenery solutions that align with urban planning and development.

1.2. Research objective

This research addresses the limited implementation of urban greenery, resulting from the knowledge gaps on benefits, barriers and enablers that municipalities face. The objective of this research is to bring together the fragmented and multidisciplinary knowledge on these important aspects of urban greenery implementation. By providing a comprehensive overview of urban greenery benefits, identifying key barriers and enablers, and exploring ways to address these

barriers, this research aims to offer a comprehensive understanding that can support both theoretical insights and provide practical guidance for more informed and effective decision-making in urban greenery implementation. This integrated approach will help municipalities to mitigate the complex challenges arising from climate change and urbanization, ensuring that urban greenery is implemented successfully.

1.2.1. Research questions

While urban greenery is recognized as an effective solution to overcome the urgent climate change and urbanization problems, municipalities still experience many challenges in the decision-making for successful implementation of urban greenery. Therefore, to achieve the research objective this master thesis will try to answer the following MAIN RESEARCH QUESTION:

HOW CAN MUNICIPALITIES EFFECTIVELY OVERCOME THE CHALLENGES ENCOUNTERED IN THE DECISION-MAKING PROCESS FOR IMPLEMENTING URBAN GREENERY?

In order to provide an answer to this question, the main research question is divided into the following research questions.

RESEARCH QUESTION 1:
What are the benefits of urban greenery, and why is its implementation considered challenging for achieving these benefits?

Conducting a literature review provides an overview of the benefits of urban greenery, including a visual representation, to increase knowledge transfer for stakeholders involved in the implementation. Additionally, it identifies and analyzes the main challenges that hinder the achievement of the benefits of urban greenery.

RESEARCH QUESTION 2:
What is the role of urban planning and decision-making processes in the effective implementation of urban greenery?

A second literature review is conducted to develop a comprehensive understanding of how urban planning and decision-making processes influence the implementation of urban greenery. This review will provide details on these processes in the context of the Netherlands.

RESEARCH QUESTION 3:
Which barriers and enablers influence the decision-making process of municipalities for implementing urban greenery, according to scientific literature and decision-makers?

This question explores the barriers and enablers that influence the decision-making process of municipalities related to implementing urban greenery. For answering this research question a systematic literature review is performed and 14 semi-structured interviews are conducted.

RESEARCH QUESTION 4:
How can the enablers be strategically matched with barriers to support municipalities in overcoming challenges related to urban greenery implementation?

Finally, this question explores how barriers and enablers can be strategically matched to offer guidance to municipalities. By identifying connections between barriers and enablers, based on both theoretical insights and practical experiences, the research focusses on adaptable strategies to improve decision-making for effective urban greenery implementation.

Figure 1 shows how the research questions are related, and which methodology was applied to answer each research question. More details on the methodology will be provided in Chapter 3.

RQ 1

What are the benefits of urban greenery, and why is its implementation considered challenging for achieving these benefits?

Literature review (background)

RQ 2

What is the role of urban planning and decision-making processes in the effective implementation of urban greenery?

RQ 3

Which barriers and enablers influence the decision-making process of municipalities for implementing urban greenery, according to scientific literature and decision-makers?

Thematic analysis

Systematic literature review

Interviews

RQ 4

How can the enablers be strategically matched with barriers to support municipalities in overcoming challenges related to urban greenery implementation?

Results RQ3 matching

Main research question

HOW CAN MUNICIPALITIES EFFECTIVELY OVERCOME THE CHALLENGES ENCOUNTERED IN THE DECISION-MAKING PROCESS FOR IMPLEMENTING URBAN GREENERY?

Figure 1. Research design

1.3. Scope

In this section, the specific scope of the research is outlined. The scope is defined by analysing VOSviewer results and by developing a detailed scope table. This specific scope provides a foundational framework for the direction and focus of the research.

1.3.1. VOSviewer

First, a bibliometric analysis is performed using the VOSviewer software. This type of analysis helps researchers to find relevant literature and identifies the connection between their most frequently used keywords. For this research, the analysis is conducted to explore the exact focus of the research, to improve the relevance and quality. For the analysis a search in Scopus was performed with the following keywords: *"urban" "cities" "greenery" "process"*. Figure 2 presents the results from the Scopus data analysed in VOSviewer.
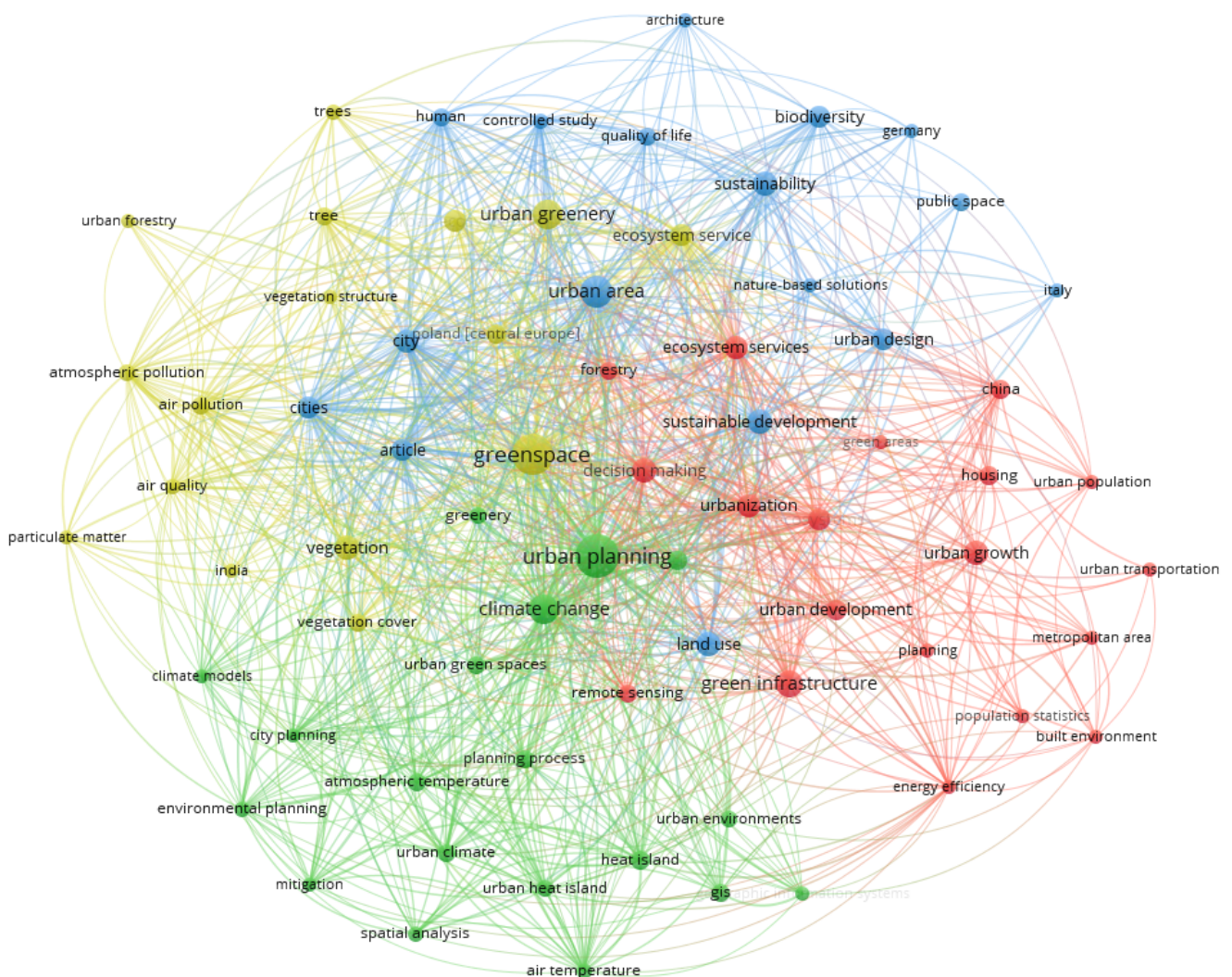
Figure 2. VOSviewer result

In this figure four different clusters of keywords are identified: The green cluster focusses mostly on the climate change aspects in urban planning. The yellow cluster is dedicated to trees and air quality. The blue cluster focuses on the biodiversity and human aspects related to urban areas in cities. Finally, the red cluster emphasizes terms related to urbanization and the built environment. These four disciplines are all interconnected. The keywords in the center of the figure are the most

significant terms because of their dense connections with other terms. These central terms identify the key concepts in the field of research and play an important role in forming the focus of this research.

The keyword "decision-making" is one of the significant terms in this research field, because of the central position in the network and the multiple connections. Figure 3 shows the detailed VOSviewer of this keyword. It is connected to a wide range of terms from every cluster, including other central terms like urban planning, greenspace, climate change, and urbanization. This indicates that decision-making occurs within a highly multidisciplinary field and is interconnected with important aspects of urban greenery.
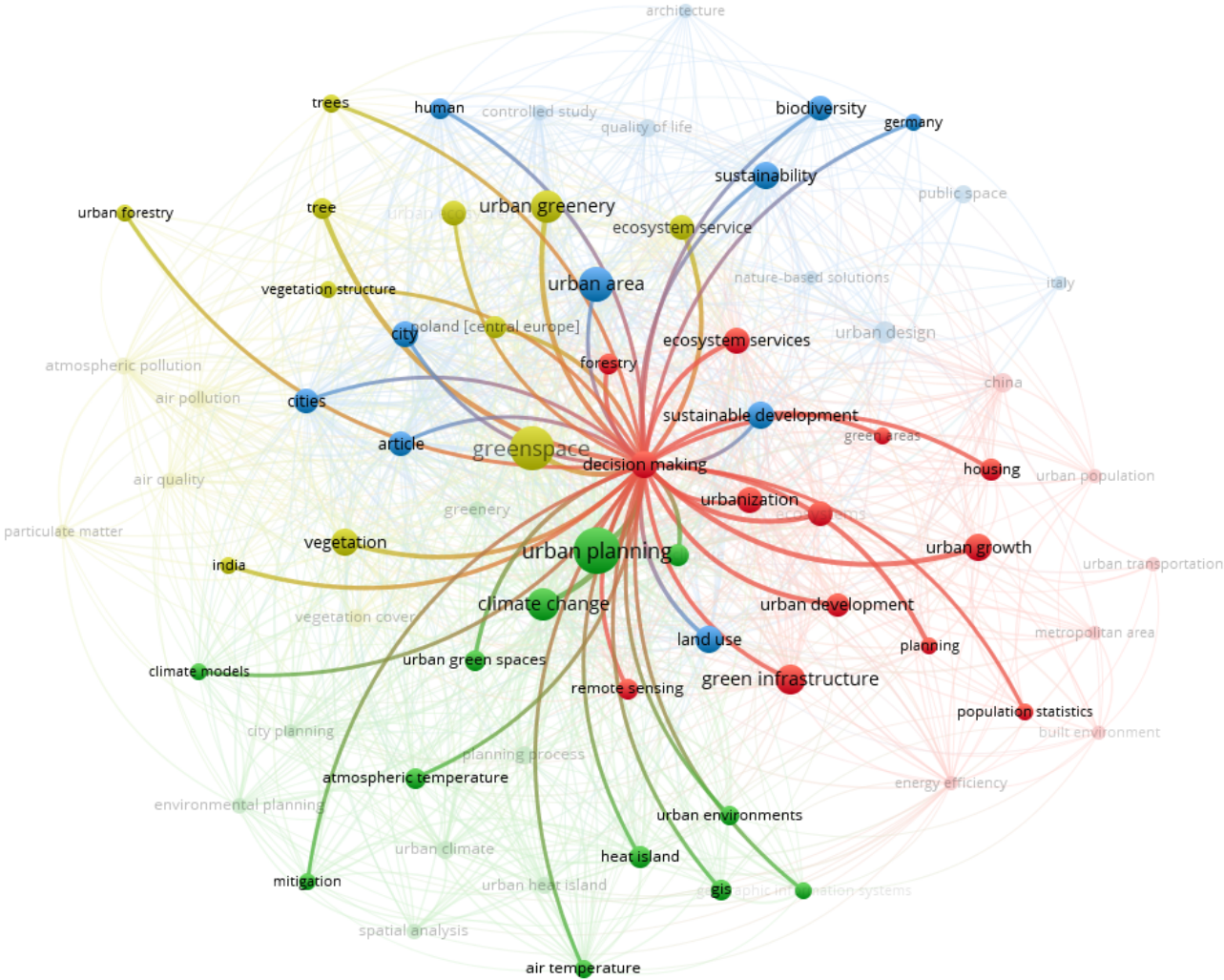
Figure 3. VOSviewer result, 'decision making'

However, this analysis also shows a gap in this research field, which presents the added focus for this research: while decision-making is linked to multiple broad terms, there is a clear lack of specific terms related to barriers, challenges, enablers, drivers, and strategies. These are important factors for the understanding of decision-making processes for urban greenery implementation. The lack of these terms suggests that there is insufficient focus and knowledge around how decision-making in urban greenery is influenced by these factors. Therefore, focusing on decision-making in this research is important. Despite its central role in the network, there is still a need for better understanding on how municipalities can navigate the challenges of urban greenery implementation.

1.3.2.   Scope table

To ensure that the research will give valuable results, it is essential to define the scope to determine which aspects will be included and excluded. Table 1 outlines the aspects that will and will not be addressed in this research.

	Include	Exclude
Researched country	The Netherlands	All other countries
Source of literature	European research	Research outside Europe
Initiating actors	Greening initiatives from Dutch municipalities	The focus will not be on initiatives from other actors *For example: Initiatives from citizens*
Municipalities	The 5 largest municipalities: Amsterdam, Rotterdam, Utrecht, Den Haag and Eindhoven	The other (smaller) municipalities in the Netherlands
Areas	Already developed areas in cities, focusing on the public open spaces	Undeveloped areas: open spaces in cities, suburban areas, undeveloped plots
Size of projects	Small and medium-size projects *For example: Greening individual streets and small squares, in city centres and densely built neighbourhoods.*	Large-scale (new) projects *For example: Rijnhavenpark development (Rotterdam)*
Greenery typologies	Micro and meso greenery solutions: Greenery typologies that can be implemented in already densely developed urban areas *For example: Street trees, street planters, grass, pocket parks*	Macro greenery solutions: Greenery typologies that cannot be implemented in already developed urban areas *For example: Forest parks*
Sustainable environment focus	Studies concerning implementing more greenery in urban areas to create a sustainable environment	Studies concerning other sustainable solutions for creating a sustainable environment
Environmental aspects	Include the importance of greenery incorporation and their environmental benefits *For example: Mitigating urban heat island effect*	Exclude the specific technical aspects of greenery incorporation *For example: Exact temperature measurements or exact materials*

Table 1. Scope and boundaries overview

This research focuses on the five largest municipalities in the Netherlands: Amsterdam, Rotterdam, Utrecht, Den Haag, and Eindhoven. These municipalities are responsible for the development and management of public open spaces within their cities, making them central to this research. These specific cities are selected because they are highly urbanized, with dense environments that have limited available space, creating challenges for the implementation of urban greenery (Buffam et al., 2022; Deely et al., 2020). Given the challenges caused by urbanization, implementing more greenery in these areas is especially important to help address these problems. Furthermore, because of the limited space for urban greenery within the dense urban areas, the scale of greenery projects is focused on small and medium sizes. Therefore, the greenery types for these projects will be limited to micro and meso greenery solutions.

As concluded from the bibliometric analysis, the decision-making process will be the main focus of the research within this specific scope. Decision-making is a critical step for integrating urban greenery into urban development projects, because it sets the foundation for the development of greenery within these projects. However, this step is often where significant challenges arise. By concentrating on the decision-making process, this research explores how to effectively integrate greenery early in the urban planning process.

2.   Theoretical background

Literature reviews were conducted to provide the theoretical background of the existing research context on urban greenery and urban planning, to answer research questions 1 and 2.

2.1. Urban greenery

This section introduces the concept of urban greenery, by outlining its key elements. This is followed by the elaboration on the benefits of urban greenery to answer research question 1: *"What are the benefits of urban greenery, and why is its implementation considered challenging for achieving these benefits?"*

2.1.1.   Introduction to urban greenery

Urban greenery, also referred to as urban green infrastructure, is defined by the European Commission as *"a strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, while also enhancing biodiversity"* (European Commission, 2024a). In other words, urban greenery includes all green spaces within urban areas and integrates nature into the built environment to enhance the sustainability and livability of cities, by providing multiple ecosystem services and other benefits.

The implementation of urban greenery includes a wide range of different greenery types, such as urban forests, pocket parks, street trees, and private gardens (Kumar et al., 2024). It also includes more engineered types, such as green roofs, green walls, and permeable pavements (C. Choi et al., 2021). These types of greenery differ not only in size, but also in their contributions to the urban sustainability, providing diverse ecosystem services (ES) and highlighting the multifunctional aspect of urban greenery (D. A. Choi et al., 2020; Pereira & Baró, 2022). Urban ES can provide provisional services (e.g. food, fresh water), regulation services (e.g. climate regulation), cultural services (e.g. recreational facilities), and other supporting services (e.g. biodiversity) (Belmeziti et al., 2018; Xu & Zhao, 2021). Implementing urban greenery is important for enhancing ES, as it helps to mitigate the environmental impacts of urbanization and climate change. The broad range of ES provided by urban greenery bring environmental, societal, economic, and cultural benefits (Lippert et al., 2022; Palme et al., 2020). These benefits include, for example, heat stress reduction, improved water and air quality, enhanced social cohesion and improved mental health (C. Choi et al., 2021; PBL, 2022). Section 2.1.2. will explore these benefits more extensively.

Besides the diversity in types of urban greenery and their related benefits, there is also a wide range of stakeholders involved in implementing urban greenery. Among these stakeholders, a key distinction exists between the responsibility for urban greenery on public and private land within cities. Residents and private companies can enhance urban greenery on private land by choosing domestic gardens over pavement and initiating greening projects on their properties (Bahr, 2024; Coolen & Meesters, 2012). Although these private spaces contribute to increasing urban greenery within cities, they are often not accessible to the public. In contrast, municipalities are responsible for creating and maintaining publicly accessible green spaces within cities, designed to offer benefits to all residents (Narváez Vallejo et al., 2024).

As the primary user, urban residents benefit directly from green public spaces through improved livability and health, making their involvement important for the effective implementation of urban greenery initiatives (Liu et al., 2024). Besides that, residents can also support greening initiatives through citizens engagement and participation activities in planning and maintenance (Salm et al., 2023). Beside residents, other stakeholders can also play a role in urban greenery efforts. For example, international organizations and local councils can provide strategic

guidance, develop plans, and influence policies to support effective greenery implementation (Bush, 2020; European Commission, 2024c). Despite the influences from diverse stakeholders, municipalities remain the most important stakeholder and have the main authority to initiate, regulate, and coordinate urban greenery projects in public areas, ensuring these projects align with broader urban planning goals (Emeis & Fallmann, 2022; Rincón et al., 2021). While they have primary responsibility for decisions around urban greenery, municipalities often face significant challenges, particularly in implementing urban greenery in densely urbanized areas.

This research specifically focuses on the implementation of urban greenery in highly urbanized public areas. Due to space constraints in these areas, mostly smaller types of greenery, such as pocket parks, street trees, or street planter, can be effectively integrated (D. A. Choi et al., 2020). Figure 4 illustrates two examples of transformations and improvements that greening projects can bring to limited public spaces. Understanding how municipalities approach the decision-making around the implementation of these urban greening initiatives is essential for optimizing urban planning and ensuring the success of greening initiatives.

Figure 4. Examples of urban greening transformations in high-density areas (Paris and Leiden)

2.1.2.   Benefits of urban greenery

Cities face a broad range of significant challenges due to the lack of urban greenery, including increased urban heat, loss of biodiversity and reduced mental well-being (Antoszewski et al., 2020; Pereira & Baró, 2022). Implementing more urban greenery can mitigate these challenges by providing a wide range of benefits. This highlights the importance of effectively integrating greenery into urban planning to achieve these benefits and mitigate the associated challenges.

The wide range of benefits can be structured into four main categories that focus on mitigating climate change impacts, improving the quality of life for urban residents, enhancing and protecting biodiversity, and promoting economic value (C. Choi et al., 2021; Kuitert & van Buuren,

2022a; Kumar et al., 2024). In Figure 5 these categories are referred to as: *Climate adaption*, *Health and well-being*, *Biodiversity*, and *Economic*. Within these overarching categories, there are many specific benefits that highlight the positive impacts of implementing urban greenery. Figure 5 presents an overview of the different benefits identified in the literature, associated with each category.
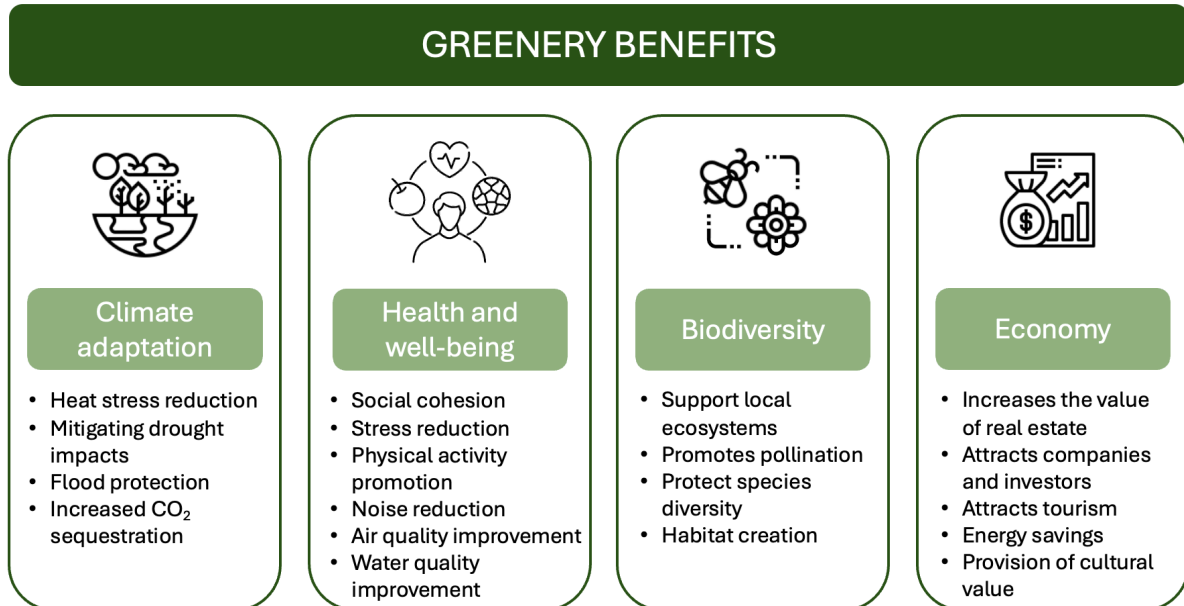

GREENERY BENEFITS

Climate adaptation
- Heat stress reduction
- Mitigating drought impacts
- Flood protection
- Increased CO_2 sequestration

Health and well-being
- Social cohesion
- Stress reduction
- Physical activity promotion
- Noise reduction
- Air quality improvement
- Water quality improvement

Biodiversity
- Support local ecosystems
- Promotes pollination
- Protect species diversity
- Habitat creation

Economy
- Increases the value of real estate
- Attracts companies and investors
- Attracts tourism
- Energy savings
- Provision of cultural value

Figure 5. Urban greenery benefits overview

For the Climate adaption category, the benefits are focused on reducing the risks related to climate change such as heat stress, droughts and floods (C. Choi et al., 2021). Health and well-being benefits include reducing noise, air and water pollution (Sharifi et al., 2021), stimulating more physical activity (Liu et al., 2024) and improving mental health by reducing stress and facilitating social cohesion (De Vries et al., 2013). For the Biodiversity category, urban greenery helps to protect biodiversity by providing habitat for native species (Connop et al., 2016) and protecting the diversity in species for plants and animals (Kowarik, 2023). Finally, economic benefits of urban greenery include attracting tourism (Terkenli et al., 2020) and increasing real estate values (Teo et al., 2023). These benefits are found based on the specific keywork search and their relevance for this research, additional benefits may be found if another detailed research within this topic is performed.

However, integrating urban greenery into cities to achieve the desired benefits is not experienced as a straightforward process. Urban greenery comes in different types and scales, such as grass, street trees, street planters, green walls, permeable pavements, and parks (Aparicio Uribe et al., 2022). Each type has different effects; for example, Kumar et al. (2024) demonstrate that street trees provide a greater cooling effect than permeable pavements. On the other hand, to enhance biodiversity, a greater variety of flowers and plants is necessary, instead of trees and permeable pavement. This indicates that a single type of greenery is not sufficient to realize all the benefits. Secondly, the physical characteristics of cities are critical factors for determining the locations and performance of urban greenery. These factors also influence how effectively urban greenery can achieve the intended benefits (Aparicio Uribe et al., 2022). Furthermore, Lippert et al. (2022) research argues that people's preferences for types of greenery can vary significantly based on socio-demographic factors. This also points to the challenge of integrating urban greenery in such a way that preferences and benefits are taken into account. Finally, research by Kumar et al. (2024) indicates that in order to successfully achieve the desired benefits, green implementation

approaches must vary significantly across regions worldwide, due to different regional contexts, climate conditions, and urban planning priorities.

These determining factors highlight the challenges of implementing urban greenery and achieving the necessary and desired benefits. For decision-makers it is essential to incorporate and understand local circumstances when planning the development of urban areas, and they should avoid one-size-fits-all approaches for the implementation of urban greenery (Zhao et al., 2024). This emphasizes the importance of working with tailored strategies, to ensure that the right decisions are made for successful implementation of urban greenery that provides the necessary and intended benefits.

In conclusion, the overview of benefits is helpful for decision-makers, as it provides a foundation for understanding the multifaceted nature of urban greenery implementation. By using this overview, decision-makers can understand how different aspects of urban greenery are interrelated. As a result, they can make more informed urban planning decisions to ensure that urban greenery is effectively integrated, achieving its benefits and addressing the associated challenges.

2.2. Urban planning

This section explores the urban planning and decision-making processes related to urban greenery, and discusses the characteristics of the Dutch approach to urban greenery implementation, answering research question 2: *"What is the role of urban planning and decision-making processes in the effective implementation of urban greenery?"*

2.2.1. From urban planning to decision-making

Integrating urban greenery improves the sustainability and livability of cities by providing multiple environmental, social, ecological, and economic benefits, as discussed in section 2.1. Despite these benefits, the importance of urban greenery is often underappreciated, which leads to limited considerations of urban greenery in *urban planning* decisions (Salm et al., 2023), which again leads to challenges for municipalities in the *decision-making process* (Rincón et al., 2021).

Bibri & Krogstie (2017) define urban planning as *"the process of guiding and directing the use and development of land, urban environment, urban infrastructure, and related ecosystem and human services".* In other words, urban planning is the process of designing and organizing all different aspects for city development. It involves the development of land use plans, infrastructure, housing, mobility, and public spaces, to create efficient, sustainable, and livable cities. Therefore, urban planning plays an essential role in determining how and where urban greenery should be integrated into cities.

When urban planning is in place for greenery, it provides the foundation through overarching long-term visions and strategic planning documents that guide cities in how to integrate urban greenery effectively (Al-Ghiyadh & Al-Khafaji, 2021). Municipalities play an important role in executing and managing urban planning at the local level. They are responsible for developing and implementing urban plans (Rincón et al., 2021). Through effective decision-making the urban plans are translated into practical local actions. Therefore, municipalities have the responsibility to incorporate urban greenery considerations into municipal decision-making (Measham et al., 2011). While urban planning sets the guidelines, the decision-making process adjusts those guidelines into actual development plans. However, Measham et al. (2011) mentions that there is currently a general lack of legislative directive and community best practice for how to incorporate climate adaption measures, such as urban greenery, into local decision-making. Therefore, municipalities face many complex challenges during the decision-making process, which can

lead to ineffective decision-making and unsuccessful implementation of urban greenery (Rincón et al., 2021).

The transition from urban planning to decision-making is an important step for municipalities because it requires moving from broad policy frameworks to specific actions, ensuring that the tailored strategies developed during urban planning are implemented correctly and effectively. The following section provides a detailed explanation of how the urban planning and decision-making process is structured and implemented within the Netherlands.

2.2.2.   Dutch urban planning

As a member of the European Union (EU), the Netherlands integrates the EU regulations into the national legal framework to ensure that the Dutch laws align with the EU directives. Since 2024, the New Environmental Planning Act (Omgevingswet) has come into effect in the Netherlands, encompassing all the laws and regulations related to spatial planning in the Netherlands into a single framework (European Commission, 2024b; Rijksoverheid, 2024).

In the Netherlands, urban planning is coordinated across three levels of government: the national government (Rijksoverheid), provinces, and municipalities. These levels have specific roles and responsibilities to ensure the sustainable and effective use of space, to coordinate all the diverse needs, including housing, transportation, industrial sites, and nature conservation (Bruinsma & Koomen, 2023; Rijksoverheid, 2024). The Dutch national government is primarily responsible for integrating EU directives into the national law. This involves interpreting and adapting the EU directives into a national legislative framework. Subsequently, the role of provinces is translating the national policies into regional strategies, by developing regional plans. At the local level, municipalities are responsible for translating the regional strategies into practical local actions. Municipalities develop local zoning plans, which regulate land use and development within the municipality. They also manage the practical aspects of urban planning, including building permits and land use (Bruinsma & Koomen, 2023). This structure ensures consistency in the urban planning across the different levels of government and effectively aligns the plans from EU directives to local municipal plans by overseeing the plans of the different levels (Rijksoverheid, 2024). This is depicted in Figure 6.
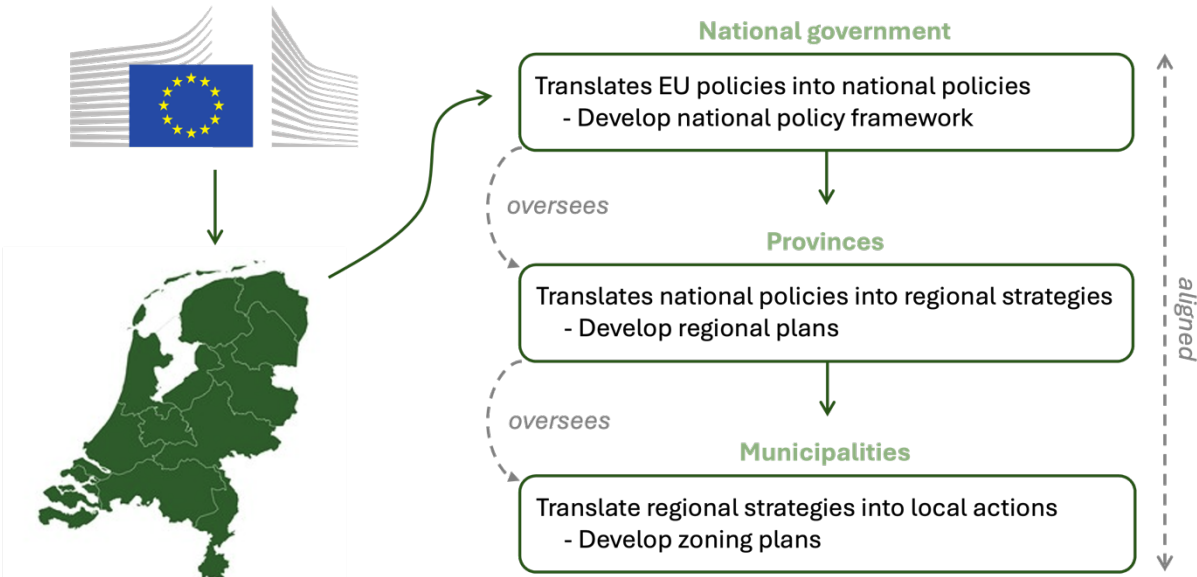

Figure 6. Dutch urban planning levels

Dutch municipalities have the main responsibility for the execution of the urban planning, including the realization of the urban plans in their cities. This highlights the crucial role of the municipalities in implementing greenery initiatives that align with regional and national directives. Because of the challenges caused by climate change and urbanization in the Netherlands, urban greenery is becoming increasingly important in the urban planning. Consequently, Dutch municipalities are formulating and adopting more comprehensive greening strategies. For example, the two largest cities in the Netherlands, Amsterdam and Rotterdam, are already actively engaged in their sustainability and greenery strategies. Amsterdam has established internal guidelines for this purpose, known as the 'Puccini Handboek Groen' to steer the greening initiatives (Gemeente Amsterdam, 2019). Also, Rotterdam set goals to increase the greenery in the city by 20 hectares in the coming years (Gemeente Rotterdam, 2019).

Besides the fact that the municipalities are becoming more aware of the potential of green initiatives to address climate change problems, they still encounter significant challenges in the urban planning and decision-making processes related to these green initiatives. These challenges often include managing competing land use goals, obtaining sufficient funding, and ensuring effective stakeholder engagement. As Mees & Driessen (2011) explain, "greenery initiatives require space, and since urban areas are under continuous development pressure and generally have scarce land resources, this is a major challenge. This is typically where urban planning could play an important role in mediating competing demands for land use". Additionally, Kuitert & van Buuren (2022b) highlight the challenge that "governments have to work with numerous parties with different interests, viewpoints, knowledge gaps, and uncertainties in relation to both the climate and society to make climate-resilient and sustainable urban planning successful".

As a result of these and many more urban planning and decision-making challenges many cities, including Dutch cities, are still not sufficiently green. This highlights the relevance of analyzing urban greening strategies of Dutch municipalities. This analysis can provide insights in the challenges municipalities experience and how they try to enhance the process for the effective implementation of urban greenery initiatives in the Netherlands.

3. Research methodology

This chapter describes the methodology used in this research. The first section outlines the methods used to address the research problem. Section 3.2. discusses the data collection methods, and section 3.3. focusses on the data analysis. Finally, section 3.4. explains the validation methods used to validate the research findings.

3.1. Research design

To justify the methodology for this research, the methodology is aligned with the research objective. The aim of this study is to address the limited implementation of urban greenery, by understanding the barriers and enablers that municipal decision-makers face when implementing greenery into urban areas. Therefore, the objective is to develop a comprehensive overview of barriers and enablers and explore opportunities for practical applications to address the barriers.

Based on the research objective a qualitative research methodology is chosen. This method is the right approach for studying the factors that influence decision-making processes of urban greenery implementation. Qualitative methods allow for a deeper exploration of the perspectives and experiences of decision-makers, which is important for understanding the complexity of urban greenery implementation. For this research, the qualitative methodology combines primary and secondary data. This approach provides an understanding of the research problem by combining practical experiences with existing knowledge from the literature (Ajayi, 2023).

- Primary data was collected through *semi-structured interviews* with municipal stakeholders involved in urban greenery projects. These interviews provide in-depth insights into the real-world barriers and enablers experienced by these stakeholders.
- Secondary data was obtained through a *systematic literature review*. This approach reviewed existing knowledge on the barriers and enablers related to urban greening, providing a foundation for understanding the current state of the available literature.

Semi-structured interviews is selected to collect detailed primary data on the perspectives and experiences of decision-makers directly involved in urban greenery initiatives across multiple Dutch municipalities, such as urban planners and environmental experts. This is important, as the research not only aims to understand the technical challenges of urban greenery implementation but also the social, political, and institutional factors that influence the implementation. Because the objective of the research is to develop a broad and comprehensive overview of the barriers and enablers, conducting interviews was preferred over analyzing case studies. Semi-structured interviews will explore a broader scope that is valuable for identifying barriers and enablers that apply beyond specific cases, while case studies provide insights into cases within specific contexts (Thelwall & Nevill, 2021). By gathering information from several interview respondents about the multiple urban greenery projects they have been involved in, the interviews will offer a comprehensive overview of the barriers and enablers experienced across different cases and contexts.

By integrating practical experiences from interviews with theoretical insights from the literature, this methodology ensures that the results from this research are based on both practice and theory. This combination helps to develop a comprehensive understanding and overview of the barriers and enablers for urban greenery implementation. This is done by analyzing the data using thematic analysis, which helps identify key patterns and themes in the results.

In addition to identifying barriers and enablers, this research combines the results to explore potential mitigation strategies by matching specific enablers with barriers. This matching process represents the final step of the research design, aiming to provide municipalities with practical strategies to overcome implementation challenges. By using this approach, the study not only fulfills its objective of creating a comprehensive overview of barriers and enablers but also highlights opportunities for practical applications that can support the effective implementation of urban greenery.

This research design is represented in Figure 1 in section 1.2. The following sections will provide a more detailed explanation of the data collection and analysis approaches.

3.2. Data collection

This section provides an overview of the data collection process for the two research methods used in this thesis. First, the process of conducting the systematic literature review is explained, followed by a description of the interview process.

3.2.1. Systematic literature review

The systematic literature review aims to answer research question 3: *"Which barriers and enablers influence the decision-making process of municipalities for implementing urban greenery, according to scientific literature and decision-makers?"*

Therefore, the focus was first on gathering information on the barriers and enablers related to urban greening by exploring the existing literature on the topic. The academic database Scopus was used to retrieve the relevant scientific articles. The first step in the systematic literature review was a structured search on Scopus, using the following relevant keywords: *"urban" AND "planning" AND "green" AND "barrier".* Although "enabler" was initially included as an additional keyword in the Scopus search, it resulted in just nine articles, of which only four articles remained after applying the PRISMA guidelines. These four articles were also found in the search without including the keyword "enabler". Therefore, incorporating "enabler" as a keyword did not expand the scope of relevant findings for this review and was not included as a final keyword in the Scopus search.

The search on Scopus identified 360 articles that formed the foundation for the literature review. These articles were systematically reduced and analyzed to end up with the relevant articles for this research. For this systematic approach, the PRISMA guidelines were followed. PRISMA is a framework that improves the transparency of systematic reviews by providing clear steps for identifying, screening, and selecting the relevant articles (Page et al., 2021). Figure 7 shows the process for this research in the PRISMA flow diagram.
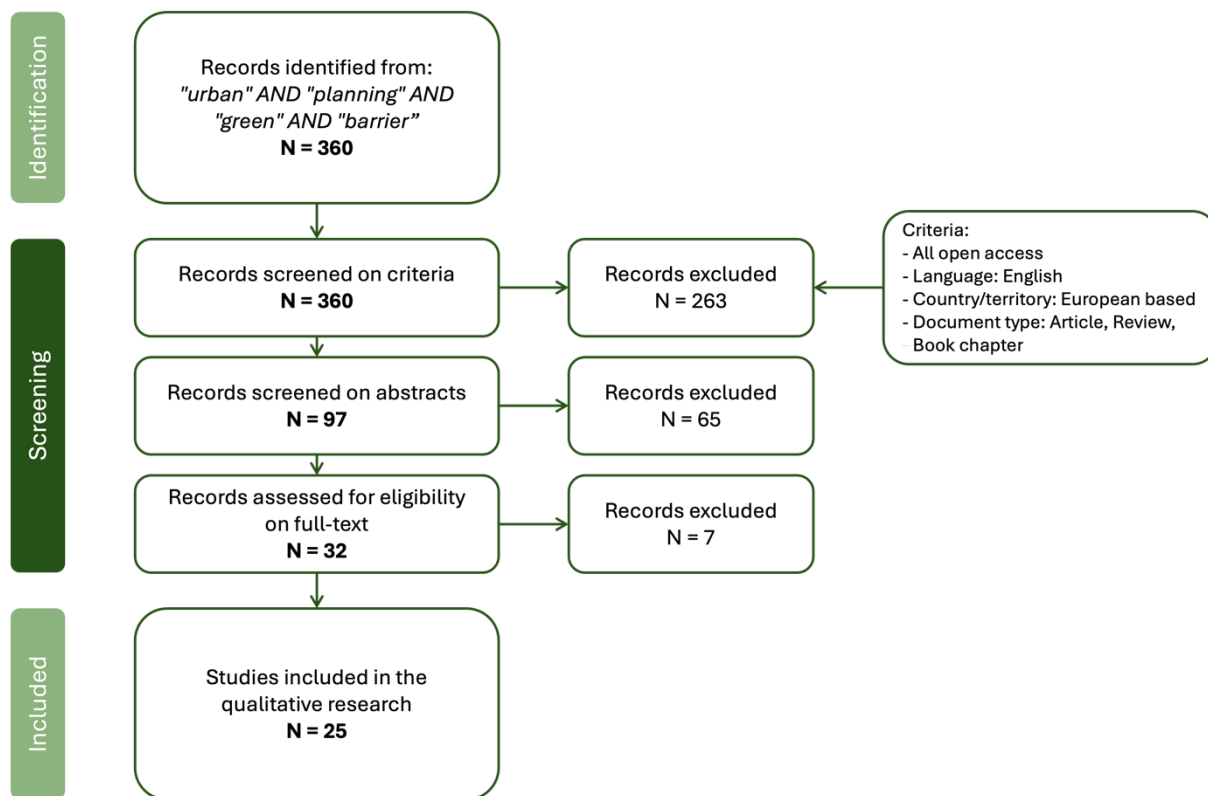
Figure 7. Systematic literature review process, in PRISMA flow diagram

The first step of the PRISMA framework was screening the initial 360 articles based on important criteria. The first criteria are that only open-access and English written articles were included. Next to that, only European-based articles were selected to ensure that the research findings are relevant to the climate, political, and socio-economic conditions of the Netherlands. Finally, for the relevant document types for this research articles, reviews, and book chapters were selected. After this criteria screening, 97 articles remained. The second step of the screening process involved screening the articles by reading the abstracts. The articles with abstracts that were not relevant to the research topic were excluded. This screening resulted in 32 relevant articles. The final step in the systematic literature review was screening the remaining 32 articles, this was done by reading the full texts of the articles. After this full-text review, 25 articles remained and were included in the final analysis for the research.

3.2.2.   Interviews

For this research two types of interviews were conducted to collect valuable insights into urban greenery: exploratory interviews and semi-structured interviews. The exploratory interviews were conducted to help define the scope of the research and the focus of the semi-structured interviews. The semi-structured interviews were performed to gather information on the barriers and enablers of urban greenery implementation in Dutch municipalities, this information forms a part of the results of this research.

Exploratory interviews
To refine the focus of the research, exploratory interviews were conducted in the early stage of the research process. Exploratory interviews are most effective in the early stages of a research as they help to get a better understanding of the topic, clarify terminology, and connect initial ideas to potential research directions (IMA, 2021). According to George (2023), *"Exploratory research helps to understand more about a particular topic of interest. They help connect ideas and lay the foundation for the research, without introducing any preconceived notions or assumptions."*

For this research, exploratory interviews were performed with 5 experts from different relevant fields. Table 2 outlines the topics, and the roles of the respondents involved in these exploratory interviews.

No.	Professional title or role interviewee	Topic of the exploratory interview
1	Consultant/Advisor Brink	Defining scope for urban greenery projects
2	Consultant/Advisor Brink	Differences in Dutch municipalities
3	Consultant/Advisor Brink	Social and financial value of urban greenery
4	Architect and PhD	Experience in working with municipalities on greening
5	Sustainability Advisor (municipality)	Determine focus for semi-structured interviews

Table 2. Exploratory interview candidates and topics

These interviews aimed to gather general perspectives on key topics within the urban greenery field, providing context on how urban greening is approached in practice. They helped to clarify the scope and focus of the research and provided a foundation for the semi-structured interviews, the interviews particularly elaborated on urban greenery in Dutch municipalities.

For example, the first exploratory interview highlighted multiple distinctions in types of urban greenery projects, such as projects initiated by municipalities versus those driven by citizens, as well as projects focused on municipal land versus those involving private land. These variations in urban greenery implementation emphasized the complexity and broad aspect of the topic, highlighting the need to define a specific scope for this research. Alongside the findings from scientific literature, which further outlined important themes and gaps in existing studies, this interview helped to refine the research's focus on specific types of urban greenery projects. Together, these insights from both practical and theoretical perspectives shaped a clear and targeted scope for the research.

The final exploratory interview was conducted with a municipal employee, the aim of this interview was to refine the approach for the main interviews of this research. It served as a pilot interview, to help determine the most effective structure for gathering information on barriers and enablers. This exploratory interview indicated that framing the questions very broadly allowed the respondent to discuss a wider range of categories of barriers and enablers, and allowing for follow-up questions based on the responses. This highlighted the benefit of using an adaptable interview format with general, open-ended questions, where the specific focus can be adjusted during the interview based on the different responses. Therefore, a semi-structured format would enable a comprehensive exploration of categories of barriers and enablers during interviews.

Semi-structured interviews
After the exploratory interviews and the systematical literature review, the semi-structured interviews were performed. Similar to the systematic literature review, these interviews also aim to answers research question 3: *"Which barriers and enablers influence the decision-making process of municipalities for implementing urban greenery, according to scientific literature and decision-makers?"* The purpose of the interviews is to gain insights from the practical side. The interviews were designed to delve deeper into the real-world experiences of Dutch municipalities, related to the urban planning and decision-making for urban green projects.

The interviews were conducted in a semi-structured format, this offered flexibility to explore new insights during the interviews, while ensuring that all the relevant topics were covered. Therefore, for these interviews, a set of pre-determined questions was prepared, while still allowing enough flexibility to adapt the conversation based on respondents' answers. This type of interview creates

a comfortable environment for respondents to reflect on their experiences, which offers deeper insights into the research topic (Sadler et al., 2020). This approach was effective in collecting detailed data on the barriers and enablers of urban greenery implementation. The pre-determined questions are presented in Appendix A.

To gather the necessary information for this research, the semi-structured interviews were conducted with employees of Dutch municipalities to understand the barriers and enablers they experience. The municipalities were pre-determined in the scope of the research, focusing on the five largest cities: Amsterdam, Rotterdam, Den Haag, Utrecht, and Eindhoven. The selection of the municipal respondents was based on their expertise and roles within the municipalities, ensuring a diverse range of departments and perspectives. However, the roles had to be connected to the correct urban greenery field to ensure that the respondents had relevant expertise.

To ensure that the selected respondents aligned with the scope of the research, detailed information on the research topic and objectives was shared in advance with municipal contacts via email. This enabled the municipalities to recommend the right employees whose roles were directly relevant to the focus of the research. This selection approach confirmed that only municipal employees with the right expertise and background in urban greenery implementation were selected. Besides the right selection process, this approach also allowed respondents to understand the research focus clearly, leading to more targeted data collection during the interviews.

In total 14 respondents were interviewed, with three respondents from the municipalities Amsterdam, Rotterdam, Den Haag and Eindhoven to ensure a diverse range of perspectives, except for Utrecht, which had two respondents. The details of the respondents and the interviews are provided in Table 3.

Interviewee	Professional title or role	Method	Date	Duration (min)
Respondent 1	Strategic Advisor Climate Adaptation	Microsoft Teams	30-07-2024	54
Respondent 2	Project Leader Public Space / Urban Planner	Microsoft Teams	30-07-2024	46
Respondent 3	Ecology Advisor	Microsoft Teams	01-08-2024	55
Respondent 4	Green Policy Advisor	Microsoft Teams	07-08-2024	59
Respondent 5	Green and Tree Manager - Urban Management	Microsoft Teams	12-08-2024	35
Respondent 6	Green Manager	Microsoft Teams	13-08-2024	35
Respondent 7	Policy Advisor for Green and Ecology	Microsoft Teams	14-08-2024	45
Respondent 8	Senior Policy Officer Green	Face-to-face	19-08-2024	60
Respondent 9	Public Space & Green Advisor	Microsoft Teams	21-08-2024	34
Respondent 10	Urban Designer	Face-to-face	22-08-2024	49
Respondent 11	Senior Policy Officer Green	Microsoft Teams	22-08-2024	55
Respondent 12	Landscape Designer	Microsoft Teams	26-08-2024	37
Respondent 13	Senior Project Manager Green	Microsoft Teams	30-08-2024	60
Respondent 14	Green and Ecology Advisor	Microsoft Teams	03-09-2024	46

Table 3. Semi-structured interviews overview

The semi-structured interviews were recorded to ensure correct and complete capture of all the respondents' answers. After the interviews, the recordings were transcribed into text, preparing the data for the detailed analysis. The analysis of this data will be discussed in the following

section. Additionally, before conducting the interviews, respondents were provided with an informed consent form, outlining the study's purpose and ensuring ethical research practices.

The interview format, including the interview questions, and the informed consent forms can be found in Appendix A.

3.3. Data analysis

This section explains how the data collected through the systematic literature review and interviews is analyzed. The analysis focuses on identifying key themes and insights on the barriers and enablers to address the research objective.

3.3.1. Thematic analysis

The data from both the systematic literature review and the semi-structured interviews is analyzed trough thematic analysis. This approach is effective for identifying patterns, or themes, within the data, which aligns with the goal of this research to analyze key barriers and enablers in urban greenery implementation. Thematic analysis provides comprehensive insights into respondents' experiences, helping to gain a deeper understanding of the barriers and enablers within this context (Braun & Clarke, 2006).

The thematic analysis in this research followed the six steps from the thematical analysis framework. These steps are: (Vaismoradi et al., 2013)
1. Familiarizing with data
2. Generating initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the report

To effectively structure and analyze the data from the literature review and interviews, an Excel file was used as a tool. (1) The process started by thoroughly reading through the data from the articles and transcribing the information collected from the interviews. (2) During this first step, the barriers and enablers mentioned in both the interviews and articles were identified and written down in the Excel file. These barriers and enablers were rewritten and coded, trying to group similar data under the same codes to highlight relevant themes. (3) After that, these results were grouped based on their characteristics, overarching categories were created to categorize the barriers and enablers in a clear and structured way.
During this step, the focus was on analyzing patterns in the data by clustering similar information from the literature review and interviews. This analysis identified consistent themes, which formed the basis for creating the categories and sub-categories. By analyzing these patterns, the data was structured in a way that highlights the underlying relationships and distinctions among the barriers and enablers.

(4) Following this, the categories were reviewed to ensure that all barriers and enablers were correctly placed under the right categories. (5) After that, the names and definitions of each category were refined, ensuring that the names clearly reflected the key themes arising from the data. (6) Finally, the thematic analysis was completed by writing the results in the report. For this step, strong examples from the data were selected to explain and support the results. This structured approach ensured that the thematic analysis provided a clear and comprehensive understanding of the data that supported the important findings.

The results from the thematic analysis on the barriers and enablers can be found in section 4.1.

3.3.2. Result matching

After identifying the barriers and enablers, research question 4 is addressed: *"How can the enablers be strategically matched with barriers to support municipalities in overcoming challenges related to urban greenery implementation?"* By integrating insights from the thematic analysis, connections and patterns were analysed to explore possible matches between barriers and enablers.

The approach focuses on identifying logical overlaps and connections, offering examples of how specific enablers might help overcome key barriers. This pattern recognition process highlights potential mitigation strategies, supported by the results from both the interviews and scientific articles. By combining practical and theoretical knowledge, the guidance developed to address the research question is based on real-world experiences and supported by academic research.

The results provide illustrative examples of how enablers can be strategically applied to address specific challenges, offering municipalities practical guidance and adaptable strategies for improving urban greenery implementation. While barriers and enablers are analysed as separate elements, this section does not aim to formulate fixed solutions by matching all of them into a single solution. Instead, it emphasizes exploring potential interconnections and presenting examples of how certain enablers may effectively mitigate barriers, thereby supporting more informed and flexible decision-making processes.

The matching results can be found in section 4.2.

3.4. Validation

The final step of the research was conducting a validation session with experts in the urban greenery field. This session was designed to validate the accuracy of results for barriers, enablers and mitigation strategies identified during the research. The validation session took place on 23 September 2024 and involved three expert advisors from the company collaborating on this research, Brink Management en Advies. Brink is a company specialized in projects within the construction, infrastructure, and real estate sectors. They have expertise across multiple different stages of projects, including policy, strategy, planning, implementation, management, and operations (Brink, 2024). Among these varied projects, Brink also collaborates with municipalities, often addressing diverse challenges, including challenges related to urban greening. For this validation session, three employees with experience in collaborating with municipalities on urban greenery initiatives participated as expert advisors.

The validation session was important to ensure the reliability of the research findings. The three experts were involved to evaluate and verify if the results align with real-world practices and if they address the needs of the key stakeholders, in this research particularly municipalities. The goal of the session was to gather feedback on the findings from a different perspective then from municipal employees. Since these experts work with municipalities on urban greening initiatives, their input was valuable for validating the results.

The session started with a presentation on the findings on the barriers, enablers, and mitigation strategies. After the presentation, a discussion followed, where the experts provided their insights on the results. The session was recorded and analyzed.

The results from the validation session can be found in section 4.3.

4. Results

The results chapter consists of three sections: first, the results on the barriers and enablers from both the scientific articles and interviews are presented and analyzed. Then, section 4.2. explores how the barriers and enablers are connected and can be matched to address the barriers. Finally, section 4.3. presents the results from the validation meeting, to confirm the reliability of the results.

4.1. Barriers and enablers

The results in this section will answer research question 3: *"Which barriers and enablers influence the decision-making process of municipalities for implementing urban greenery, according to scientific literature and decision-makers?"* To answer this question a combination of systematic literature review and interviews is conducted. This approach helps to draw comprehensive conclusions by combining the literature insights with practical experiences from the interviews. In this research, barriers refer to the obstacles or challenges that hinder the effective decision-making process for the implementation of urban greenery, and enablers refer to the factors or conditions that facilitate and support this process.

In total, 182 barriers and 110 enablers were identified in 25 scientific articles and 14 interviews, these results were analyzed using thematic analysis, as explained in section 3.3.1. This analysis identified seven categories for the barriers and enablers: Organizational, Governance and Regulatory, Social and Psychological, Financial, Research and Knowledge, Spatial, and Participation. The findings on barriers and enablers are organized in these categories. The thematic comparison of the results from the articles are shown in Figure 8 and from the interviews in Figure 9.
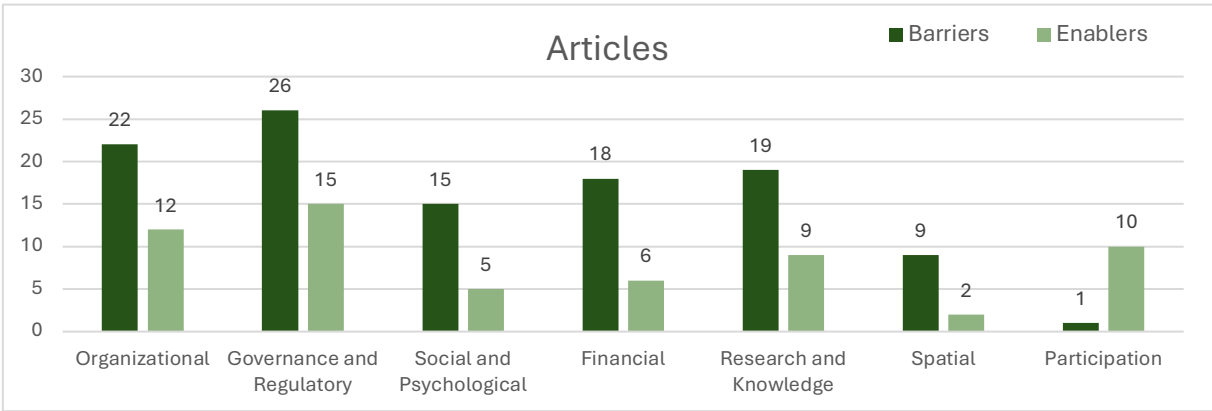

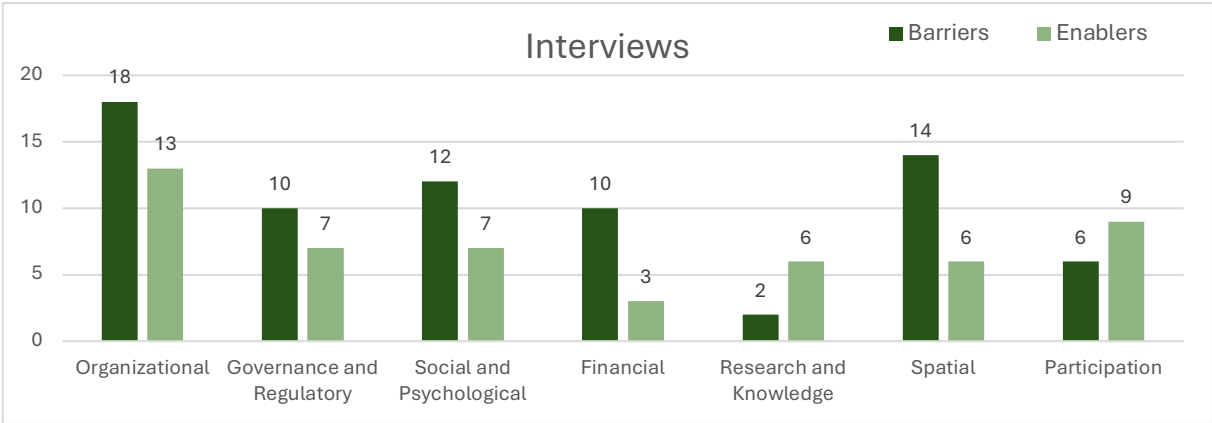*Figure 8. Overview barriers and enablers in categories, from scientific articles.*

Figure 9. Overview barriers and enablers in categories, from interviews.

The scientific articles identified 110 barriers and 59 enablers, while the interviews revealed 72 barriers and 51 enablers. Some differences can be observed from the figures between the distribution of the categories from the articles and those from the interviews. The figures show that the most prominent categories are *Organizational* for interviews and *Governance and Regulatory* for the articles. One remarkable observation is that nearly all categories have more barriers than enablers, except for the *Participation* category, where enablers are among the most frequently mentioned and barriers are relatively fewer. Additionally, the *Research and Knowledge* category shows more enablers than barriers in the interview results. However, in the articles, *Research and Knowledge* is one of the most significant barrier categories, while it was only mentioned twice as a barrier in the interviews. On the other hand, *Spatial* is the least mentioned category in the articles.

Before diving into the specific analysis of the barriers and enablers, the categories are explained as follows:

Organizational - Relates to internal structures, coordination, capacity, and roles within organizations, influencing how projects and tasks are managed.

Governance and Regulatory - Refers to policies, legal standards and regulations, political decisions and leadership that can support or restrict urban green implementation.

Research and Knowledge - Involves the availability of (scientific) research and knowledge, as well as how they are shared and utilized to inform decisions.

Social and Psychological - Addresses societal perceptions and awareness, that can impact decision-making and public support.

Financial - Addresses funding availability, budget constraints, and financial management, which affect the feasibility of urban green projects.

Participation - Involves the level and quality of community involvement and participation in decision-making processes, which can drive or hinder urban green implementation.

Spatial - Involves the availability and use of urban land, which can either limit or facilitate projects depending on factors like land use, space allocation, and geographical layout.

The categories are further divided into sub-categories, representing specific types of barriers and enablers identified through thematic analysis. In total, the 182 barriers are sub-categorized into 36 different types of barriers and the 110 enablers into 44 different types of enablers. The following sections will separately discuss these barrier and enabler types identified in both the articles and interviews. Statements from the articles and interviews are linked to these barriers and enablers to provide additional context and support the analysis of the results.

The complete overview of the identified barriers and enablers from the articles and interviews is presented in Appendix B, wit separate tables for barriers and enablers. Additionally, an overview of the ten most frequently mentioned barriers and enablers is also included.

4.1.1. Barriers identified in articles

From the 25 scientific articles analyzed in the literature review, 110 barriers were identified. These barriers highlight the key factors that hinder the successful implementation of greening initiatives. These barriers are categorized into sub-categories, as shown in Table 4. Each category is examined, with emphasis on the most prominent sub-categories. This provides deeper insights into the main barriers observed in the literature.

Category	Sub-category	Citation count	Reference
Organizational	Fragmentation in coordination and responsibilities	16	(Buffam et al., 2022; Deely et al., 2020; Hoang & Fenner, 2016; Kabisch et al., 2016; Lara & Del Moral, 2022; Li et al., 2020a; Mattijssen et al., 2023; Mees & Driessen, 2011; Runhaar et al., 2012; Sanz et al., 2022; Stork et al., 2023; Suárez et al., 2024; Vaňo et al., 2021; Voskamp et al., 2021; Wihlborg et al., 2019; Zhao et al., 2024)
	Resistance to change	3	(Deely et al., 2020; O'Donnell et al., 2017; Sanz et al., 2022)
	Unclear responsibilities for maintenance	2	(Li et al., 2020a; Williams et al., 2019)
	Capacity constraints	1	(Sanz et al., 2022)
Governance and Regulatory	Political influence	8	(Buffam et al., 2022; Liu et al., 2024; Runhaar et al., 2012; Sanz et al., 2022; Suárez et al., 2024; Vaňo et al., 2021; Voskamp et al., 2021; Wihlborg et al., 2019)
	Lack of supporting policies	7	(Adams et al., 2023; Connop et al., 2016; Deely et al., 2020; Li et al., 2020a; Mees & Driessen, 2011; Megyesi et al., 2024; Sanz et al., 2022)
	Lack of regulatory standards	7	(Deely et al., 2020; Mattijssen et al., 2023; Runhaar et al., 2012; Vaňo et al., 2021; Voskamp et al., 2021; Wihlborg et al., 2019; Williams et al., 2019)
	Lack of awareness or urgency by politicians	3	(Kabisch et al., 2016; Lara & Del Moral, 2022; Voskamp et al., 2021)
	Lack of political leadership	1	(Li et al., 2020a)
Social and Psychological	Conflicting perceptions	6	(Connop et al., 2016; Hoang & Fenner, 2016; Kuitert & van Buuren, 2022a; Runhaar et al., 2012; Sanz et al., 2022; Williams et al., 2019)
	Lack of awareness	5	(Buffam et al., 2022; Deely et al., 2020; Kabisch et al., 2016; Runhaar et al., 2012; Salm et al., 2023)
	Uncertainty	3	(Deely et al., 2020; Lara & Del Moral, 2022; Mees & Driessen, 2011)
	Lack of social urgency	1	(Kuitert & van Buuren, 2022a)
Financial	Lack of funding	13	(Buffam et al., 2022; Deely et al., 2020; Kabisch et al., 2016; Lara & Del Moral, 2022; Li et al., 2020a; Liu et al., 2024; Mattijssen et al., 2023; Megyesi et al., 2024; O'Donnell et al., 2017; Sanz et al., 2022; Stork et al., 2023; Voskamp et al., 2021; Zhao et al., 2024)
	Financial constraints for maintenance	6	(Deely et al., 2020; Kabisch et al., 2016; Li et al., 2020a; O'Donnell et al., 2017; Salm et al., 2023; Williams et al., 2019)
	Estimation and valuation difficulties	2	(Deely et al., 2020; Zhao et al., 2024)
	Complexity of funding instruments	1	(Kabisch et al., 2016)
Research and Knowledge	Lack of knowledge	11	(Connop et al., 2016; Deely et al., 2020; Kabisch et al., 2016; Lara & Del Moral, 2022; Li et al., 2020a; Mattijssen et al., 2023; Mees & Driessen, 2011; Megyesi et al., 2024; O'Donnell et al., 2017; Voskamp et al., 2021; Wihlborg et al., 2019)

Research and Knowledge	Difficulty in quantifying benefits	3	(Kabisch et al., 2016; O'Donnell et al., 2017; Runhaar et al., 2012)
	Knowledge-practice gap	2	(Deely et al., 2020; Zhao et al., 2024)
	Abstract knowledge	1	(Runhaar et al., 2012)
	Lack of knowledge distribution	1	(Mees & Driessen, 2011)
	Lack of localized knowledge	1	(Zhao et al., 2024)
Spatial	Limited space allocation	9	(Buffam et al., 2022; Deely et al., 2020; Hoang & Fenner, 2016; Li et al., 2020a; Liu et al., 2024; Mees & Driessen, 2011; Megyesi et al., 2024; O'Donnell et al., 2017; Voskamp et al., 2021)
Participation	Lack of community involvement	1	(Lara & Del Moral, 2022)

Table 4. Barriers from scientific articles

Organizational

Within the Organizational category, *Fragmentation in coordination and responsibilities* is the most mentioned barrier, 16 from the 25 articles mention this barrier. This sub-category refers to fragmentation across different municipal departments, teams or governance levels, which leads to delays, and inefficiencies. It is marked by departments frequently working in isolation, and each focusing primarily on its own regulations, visions (Zhao et al., 2024), interest and priorities (Hoang & Fenner, 2016). The fragmented structure of organizations creates multiple challenges that hinder the efficient implementation of greening projects.

Firstly, the fragmentation across different municipal departments results in inefficient and unintegrated planning processes (Vaňo et al., 2021). Each department operates with its own budget and specific responsibilities, which encourages 'silo' thinking. This means departments focus only on their designated tasks without a holistic view of the broader planning process (Wihlborg et al., 2019).

Additionally, the fragmentation results in a lack of collaboration between departments with different areas of responsibility, making it difficult to understand and implement plans and strategies, while it also hinders innovation (Buffam et al., 2022; Lara & Del Moral, 2022; Suárez et al., 2024). Kabisch et al. (2016) describe this as each department operating within their own 'sectoral language', leading to knowledge trapped in 'sectoral silos', and causing fragmented information across departments (Hoang & Fenner, 2016).

Next to that, fragmentation between teams and departments raises the question of who the problem owner is (Runhaar et al., 2012), which leads to confusion about responsibility for implementing and maintaining urban greenery. Because many departments operate within their own defined fields of duty and restricted responsibilities, it becomes difficult to determine who should take the lead on aspects such as green initiatives (Kabisch et al., 2016; Mattijssen et al., 2023). This lack of clear leadership and ownership complicates the process of implementing greenery further (Deely et al., 2020).

As a result of these fragmentation challenges, Stork et al. (2023) highlights that the fragmented governance landscape significantly slows down the implementation of urban greenery. Similarly, Voskamp et al. (2021) point out that because responsibility for green initiatives is often shared between multiple departments, the development, decision-making and implementation processes will be more time-consuming and uncertain. Unfortunately, management skills to overcome fragmentation and its challenges are still lacking (Mees & Driessen, 2011).

Besides this barrier, *Resistance to change* is also highlighted as a barrier in a few articles. These articles underline the resistance from government bodies to shift from traditional grey infrastructure to green infrastructure (O'Donnell et al., 2017). The preference for business as usual and existing institutional frameworks, make it difficult to adopt new, innovative approaches

that are required for the successful development of green initiatives (Deely et al., 2020; Sanz et al., 2022).

Governance and regulatory

For this category the most discussed barrier is *Political influence*. The priorities of politicians and governments are crucial factors for putting urban greenery on the political agenda (Wihlborg et al., 2019). Because of different interests and political biases, there is not always support for urban greenery (Vaňo et al., 2021). The lack of political priority for urban greenery is mostly because politician consider other problems more urgent (Runhaar et al., 2012). Besides that, according to Voskamp et al. (2021), political continuity can be lacking because of structural changes in local governments and periodic local elections. The political cycles create a lack of consistency and continuity and also influences the amount of money assigned to greenery initiatives (Sanz et al., 2022; Suárez et al., 2024).

Next to political influence, *Lack of supporting policies* and *Lack of regulatory standards* are both important barriers in this category. The difference between them is that a lack of supporting policies refers to the absence of strategic decisions and plans that guide the municipal urban greening efforts, while a lack of regulatory standards refers to the absence of specific rules and regulations to ensure successful implementation and maintenance of these projects.

First, *Lack of supporting policies* is mentioned as a significant barrier. Because of the high interest in grey infrastructure, there is no motivation for policy development to improve current legislation, which hinders the integration of greenery in urban planning (Deely et al., 2020). Existing policies lack clear guidance for implementing urban greenery (Sanz et al., 2022). However, for the policies that do support urban greenery, their practical implementation is experienced as a barrier. Mees & Driessen (2011) and Adams et al. (2023) state that it is difficult to translate and implement generalized top-down policies for greenery into concrete and feasible policies and measures at local level. This eventually can lead to conflicts, delays, and conflicting goals (Adams et al., 2023).

Urban greenery also faces barriers due to *Lack of regulatory standards*. There is a lack of national design standards and specific regulations regarding challenges such as heat stress, which limits the incentive to address these challenges (Runhaar et al., 2012; Williams et al., 2019). Most of the existing regulatory and legal conditions are designed for traditional grey infrastructure, these policies hinder urban greenery uptake (Voskamp et al., 2021). For example, existing rules and regulations, such as standards about the number of parking spaces and the size of a turning zone, do not support greenery initiatives and favor traditional approaches (Mattijssen et al., 2023; Wihlborg et al., 2019). However, there are no clear rules and regulations for greenery related aspects. Similar to the lack of supporting policies, Vaňo et al. (2021) mentions that the top-down planning documents fail to provide binding standards and regulations for decision makers at lower planning levels, this hinders the integration of urban greenery.

Social and psychological

Conflicting perceptions is mentioned as the main barrier in the social and psychological category. Conflicting perceptions are differences in opinions on what green areas should look like (Connop et al., 2016; Williams et al., 2019), this creates challenges in achieving agreement on designs of greening plans. Negative perceptions about urban greenery hinder implementation and maintenance (Hoang & Fenner, 2016). Besides the design of greenery, conflicting perceptions also encompass differences in how climate change is perceived. Runhaar et al. (2012) highlight that there is a gap between the scientists' perceived urgency in addressing climate change and planners' perceptions of whether integrating greenery into urban planning is necessary.

The barrier *Lack of awareness* refers to the limited understanding and recognition of the greenery benefits, climate change problems, and potential impacts of planning and implementing green infrastructure (Kabisch et al., 2016; Salm et al., 2023). Most of the urban greenery related problems are not recognized, because of unawareness, and the complexity and uncertainties around green initiatives (Runhaar et al., 2012). When key stakeholders within an organization lack an overarching awareness of the importance of green areas, it can hinder the effective implementation of urban greenery (Buffam et al., 2022).

Financial

The barrier *Lack of funding* was mentioned in 13 articles, which makes it a significant barrier for successful urban greening initiatives. All these articles emphasize that limited budgets are available for implementing greenery. Many municipalities face financial constraints for their urban planning projects, especially in the initial phases of projects they experience challenges to achieve financial self-sufficiency (O'Donnell et al., 2017; Stork et al., 2023). Additionally, Stork et al. (2023) also mention that the lack of suitable financing models and the complexity of obtaining funding makes it more difficult to develop greening projects.

Not only the financing of green implementation is experienced as a barrier, but *Financial constraints for maintenance* is also a challenge for greenery projects. Several articles mention that municipalities struggle not only with obtaining initial funding but also with obtaining financial support for ongoing maintenance (Deely et al., 2020; Kabisch et al., 2016; O'Donnell et al., 2017). The costs for maintaining green areas are often high, however many urban planning budgets do not include these expenses (Salm et al., 2023; Williams et al., 2019).

Research and knowledge

The most significant barrier in this category is *Lack of knowledge*. Lack of knowledge leads to unwillingness to understand and recognize the importance of implementing and maintaining green infrastructure (Wihlborg et al., 2019) and has negative effects on the awareness among local authorities and the public (O'Donnell et al., 2017).

According to several studies, the missing knowledge mainly concerns the benefits that urban greenery provides, including the effectiveness and the long-term impact on climate challenges (Connop et al., 2016; Kabisch et al., 2016; Megyesi et al., 2024; Voskamp et al., 2021). Besides that, the insufficient knowledge is also present for the technical aspects of green infrastructure. This affects the know-how, skills and expertise among staff responsible for implementing greening projects (Deely et al., 2020; Mattijssen et al., 2023; Mees & Driessen, 2011).

Secondly, *Difficulty in quantifying benefits* of urban greenery remains a challenge, which also affects decision-making and implementation processes. For instance, benefits like reduction in adverse health effects are often difficult to quantify and do not have the highest priority for local politicians (Runhaar et al., 2012). Assigning exact values to benefits such as biodiversity enhancement, and climate adaptation is also mentioned as a barrier for this category (O'Donnell et al., 2017).

Spatial

Limited space allocation is identified as a significant spatial barrier for implementing urban greenery. Many urban areas face pressures from densification and competing needs for infrastructure development, resulting in limited available land for greenery projects (Buffam et al., 2022; Deely et al., 2020; Mees & Driessen, 2011). The articles highlight that the lack of space presents major challenges for implementing greening initiatives (Hoang & Fenner, 2016; Megyesi et al., 2024; Voskamp et al., 2021). Additionally, the dense and complex underground networks

further complicate the implementation of greenery (Li et al., 2020a). These spatial constraints limit the opportunities for urban greenery projects.

Participation

Lack of community involvement is the only barrier identified in this category and is mentioned by just one article, this suggests that the other articles do not consider participation as an important barrier. Lara & Del Moral (2022) state that limited involvement and empowerment of community members in decision-making leads to poor participation. This can create a disconnect between the greenery initiatives and the local population, which can reduce the success of greenery projects.

4.1.2. Barriers identified in interviews

From the 14 interviews, 73 barriers were identified. These barriers highlight the key factors that hinder the successful implementation of greening initiatives. The barriers are categorized into sub-categories, as shown in Table 5. Each category is examined, with emphasis on the most prominent sub-categories. This provides deeper insights into the main barriers mentioned in the interviews.

Category	Sub-category	Times mentioned	Respondent
Organizational	Fragmentation in coordination and responsibilities	8	1, 2, 4, 5, 6, 12, 14
	Capacity constraints	5	3, 6, 8, 9, 11
	Planning challenges	3	1, 5, 12
	Lack of organizational alignment	2	8, 10
Governance and Regulatory	Regulatory complexity	4	4, 6, 14
	Political influence	4	8, 11, 12, 14
	Lack of supporting policies	2	3
Social and Psychological	Conflicting perceptions	9	2, 4, 5, 6, 7, 8, 9, 13, 14
	Lack of awareness	2	3, 8
	Safety concerns	1	3
Financial	Lack of funding	5	1, 2, 10, 13, 14
	Financial constraints for maintenance	4	1, 2, 3, 14
	Lack of a clear return on investment	1	8
Research and Knowledge	Lack of research	2	7, 8
Spatial	Limited space allocation	9	1, 2, 3, 6, 7, 10, 13, 14
	Resistance to parking space removal	5	1, 9, 11, 13, 14
Participation	Long participation process	3	4, 11, 13
	Technical knowledge complexity in participation	1	13
	Lack of trust in citizens	1	4
	Maintenance neglect by citizens	1	1

Table 5. Barriers from interviews

Organizational

Similar to the findings in the articles, the most frequently mentioned barrier from the interviews in this category is also *Fragmentation in coordination and responsibilities*. Due to the size and the complexity of municipal organizations, it is often challenging to know who to involve in plans, to execute them quickly and successfully (Respondent 12). Respondent 14 describes this barrier as follows: "*Municipalities are large organizations with multiple different departments, such as management, city engineers, and spatial planning, and they often do not communicate enough with each other. As a result, not everyone is involved from the start of greening plans, which can sometimes cause plans to fail or not be carried out successfully*".

The available knowledge and expertise within the municipalities are not always effectively integrated into the decision-making processes because of this fragmentation. For instance, designers and implementers do not always communicate or involve each other in decision-

making (Respondent 2). Respondent 5 points out that instead of consulting ecologists, urban green space managers are often asked to provide advice on the specific type of planting. This means that the right experts are not always consulted initially.

Additionally, there are differences in the greening approaches across city districts. Respondents 1 and 4 mention that city districts can differ in terms of the project leaders' responsibilities and focus when initiating greening projects. This fragmented approach can hinder uniform greening progress within cities, leading to differences in the implementation and success of greening initiatives between districts.

Capacity constraints are identified as an Organizational barrier in five interviews. Respondents 6, 9 and 11 mention that understaffing is experienced as a key barrier, which limits the ability to effectively carry out greening projects. These capacity constraints are experienced by different important stakeholders in greening projects. For example, Respondent 3 mentions that municipal ecologists often lack the time to be fully involved in projects from start to finish. Additionally, the management teams of green spaces face similar challenges, as their teams lack the capacity to maintain all the green areas (Respondent 8). Moreover, the complex and fragmented structure of municipalities does not allow the right people to quickly and efficiently take on new projects, which further complicates the capacity challenges (Respondent 9).

Governance and regulatory
The *Regulatory complexity* barrier refers to the challenges of applying the existing fragmented set of rules and regulations for urban greenery. These complexities can slow down decision-making processes and hinder collaboration across departments. Respondent 6 says that *"due to the many regulations and lengthy processes in municipalities, the biggest obstacle is essentially always the municipality itself when it comes to greening the cities"*.

Nowadays, most Dutch municipalities have developed vision and policy documents outlining the plans and rules and regulations for greening. However, these documents are most of the time extensive and not concrete, which makes them difficult to apply (Respondent 4). Respondent 14 argues that due to the generic nature of the documents on greenery, discussions with advisors and other stakeholders start over with each new project, focusing again on where the greening efforts should be directed. This can lead to delays, insufficient collaboration, and makes it difficult for municipalities to implement green initiatives efficiently.

Four respondents mention in the interviews that *Political influence* is experienced as a significant barrier. The decisions regarding green initiatives are highly influenced by the political situation at both the national and municipal levels (Respondent 8). The political situation plays a crucial role in determining how much effort and funding is dedicated to greening projects within municipalities (Respondent 12). As a result, municipalities are often restricted by the fluctuating political support, which can either stimulate or hinder the progress of greening efforts.

Social and psychological
Similar to the findings in the articles, *Conflicting perceptions* is also the most frequently mentioned barrier in this category during the interviews. Different stakeholders, such as residents, municipal employees, and other decision-makers, often have different views on how urban greenery should be designed and maintained. Residents can have conflicting opinions about the addition of greenery in their neighborhoods. They not only express concerns about how the green areas should look, but they also have differing views on the land use of public spaces (Respondent 2, 5, 13). Especially, when municipalities use participatory approaches, these conflicting opinions can make decision-making more difficult. By trying to take into account all

the different preferences of residents, municipalities may face delays, and sometimes this may result in reduced implementation of greenery (Respondent 14).

Within municipalities, conflicting perceptions also exist. Respondent 4 mentions the following: *"Within municipalities there are often different perceptions and interests when it comes to greening. Sometimes a greening project receives negative feedback and will not be executed because not everyone is on the same page".* This shows that different departments and individuals may prioritize their specific agendas and goals, which may not always align with the goals of urban greening. As a result, greening projects might lack the necessary support to move forward (Respondent 6). The combination of conflicting perceptions, both within and outside municipal organizations, hinder the efficient realization of urban greening initiatives.

Especially greenery that supports biodiversity often faces implementation challenges due to conflicting perceptions about the appearance of the plants. Respondents 7 and 9 mention that greenery that supports biodiversity is sometimes seen as messy or too large, which makes it difficult for designers to choose plants that both support biodiversity and meet aesthetic expectations.

Financial
Lack of funding is experienced as a significant financial barrier in the interviews. Despite having plans and policies for urban greening, there is often insufficient financial support to execute and implement the greening initiatives (Respondent 1, 14). Municipalities usually operate with limited budgets, and greening initiatives are often the first to face budget reductions. This leads to high uncertainty regarding the availability of funding for greening projects (Respondent 10, 13). Besides that, costs for larger greenery, to support biodiversity and climate adaptation, are significantly higher due to required underground infrastructure assessments and the higher cost of the plants themselves. However, these types of greenery are crucial for effective climate adaptation and biodiversity, which further increases this financial barrier (Respondent 2).

Financial constraints for maintenance is also identified as a barrier in the interviews. Even when sufficient funds are available to implement greening projects, there is often insufficient budget for the maintenance of the implemented greenery. Certain types of greenery, particularly those that support biodiversity, are more expansive and more complex to maintain, compared to simpler and smaller greenery types. As a result, municipalities often prioritize easier-to-manage greenery to reduce maintenance costs, and thereby sacrificing the quality and biodiversity of greenery (Respondent 1, 2, 3). Therefore, this financial limitation creates a significant barrier and reduces the success and ecological impact of greening projects.

Research and knowledge
The barrier *Lack of research* is the only barrier identified in this category and is mentioned in just two interviews. This suggests that the other respondents do not consider this barrier category as important as the other categories. However, Respondent 7 mentions that there is still insufficient scientific research focused on the opportunities for greening, universities conduct more research in the field of sustainability on topics such as circularity and green energy. Additionally, Respondent 8 argues the need for more research into the technical aspects of implementing greenery to increase efficiency in greening initiatives.

Spatial
Limited space allocation is a prominent barrier in the interviews. Both above ground and underground limitations significantly hinder opportunities for urban greening in densely built areas (Respondent 7, 13). The underground infrastructure exists of large networks of cables, pipes, and other infrastructure, leaving little space for the roots of trees and shrubs, which need

sufficient room to grow. This lack of underground space often prevents the implementation of larger greenery that supports biodiversity and climate adaptation efforts (Respondent 1, 2, 6). Above ground, cities face similar limitations. In densely populated urban areas, space is often first allocated to functions such as pedestrian walkways, cycling paths, roadways, and parking spaces, leaving small leftover space for greenery (Respondent 2, 3). This prioritization reduces the opportunities for successful greening initiatives, especially for larger plants and trees. Respondent 10 notes that other projects, such as energy transition measures and underground waste containers, further compete for the already limited available space, complicating efforts to implement greenery.

Alongside the barrier of limited space allocation for greenery, *Resistance to parking space removal* is another important barrier that is linked to the physical space allocation. Residents often view parking spots as essential in their neighborhoods, leading to resistance when municipalities attempt to redesign these areas for greenery (Respondent 1, 9, 13). This strong attachment to parking makes it difficult for municipalities to gain public support for removing parking spaces to implement more greenery alternatives (Respondent 11). Besides, even when parking spaces are successfully removed, they are not always replaced with greenery. Instead, competing demands, such as bicycle racks or trash bins, often have priority (Respondent 14). This limits the space available for greenery and increases the difficulty of integrating green infrastructure in densely built urban areas.

Participation
The barrier *Long participation process* highlights the challenge of successfully integrating participation into the planning of greening initiatives. For example, when streets are already scheduled to be opened for maintenance activities, the lengthy participation process can hinder the timely alignment and integration of greening initiatives (Respondent 4). Additionally, when residents propose ideas for greening projects, these ideas must pass through municipal advisory committees, this often results in lengthy back-and-forth approvals that can delay the progress of the projects. This discourages residents and reduces their engagement (Respondent 11). Respondent 13 explains this effect on residents as follows: *"Due to the lengthy participation process of municipal greening projects, it causes frustration among residents, especially for those who were initially enthusiastic".*

4.1.3. Enablers identified in articles

In addition to the 110 barriers mentioned in the articles, 59 enablers have been identified. These enablers highlight the key factors that can support the successful implementation of greening initiatives. The enablers are categorized into sub-categories, as shown in Table 6. Each category is examined with a focus on the most prominent sub-categories, to provide a detailed understanding of the main enablers identified in the articles.

Category	Sub-category	Citation count	Reference
Organizational	Collaborative governance models	6	(Adams et al., 2023; Kabisch et al., 2016; Kuitert & van Buuren, 2022a; Lara & Del Moral, 2022; Stork et al., 2023; Zhao et al., 2024)
	Early stakeholder involvement	3	(Connop et al., 2016; Kuitert & van Buuren, 2022a; O'Donnell et al., 2017)
	Management tools for horizontal coordination	1	(Mees & Driessen, 2011)
	Coordinated strategic planning	1	(Kuitert & van Buuren, 2022a)
	Mediatory agency	1	(Vaňo et al., 2021)
Governance and Regulatory	Regulatory changes	5	(Li et al., 2020a; Megyesi et al., 2024; O'Donnell et al., 2017; Suárez et al., 2024; Wihlborg et al., 2019)
	Political support	3	(Li et al., 2020a; Mees & Driessen, 2011; Runhaar et al., 2012)
	Clear communication strategy	3	(Liu et al., 2024; Megyesi et al., 2024; Zhao et al., 2024)
	Enhanced regulatory control	1	(Momm-Schult et al., 2013)
	Long-term policies	1	(Momm-Schult et al., 2013)
	Multi-level policy alignment	1	(Momm-Schult et al., 2013)
	Policy implementation alignment	1	(Mattijssen et al., 2023)
Social and Psychological	Raising awareness	4	(Li et al., 2020a; Mattijssen et al., 2023; Megyesi et al., 2024; Williams et al., 2019)
	Develop common understanding	1	(Zhao et al., 2024)
Financial	Innovative financial models	4	(Li et al., 2020a; Megyesi et al., 2024; Stork et al., 2023; Wihlborg et al., 2019)
	Funding support	1	(Runhaar et al., 2012)
	Citizen engagement in funding	1	(Salm et al., 2023)
Research and Knowledge	Knowledge exchange platforms	3	(Adams et al., 2023; Kabisch et al., 2016; Wihlborg et al., 2019)
	Education programs	3	(Li et al., 2020a; Mees & Driessen, 2011; O'Donnell et al., 2017)
	Knowledge development	2	(Mattijssen et al., 2023; Runhaar et al., 2012)
	Knowledge institutions involvement	1	(Sanz et al., 2022)
Spatial	Multi-functional land use	1	(Mees & Driessen, 2011)
	Car restraint policies	1	(Liu et al., 2024)
Participation	Community engagement	7	(Connop et al., 2016; Liu et al., 2024; Mattijssen et al., 2023; Mees & Driessen, 2011; Momm-Schult et al., 2013; O'Donnell et al., 2017; Suárez et al., 2024)
	Collaborative innovative approaches	1	(Sanz et al., 2022)
	Citizen engagement activities	1	(Salm et al., 2023)
	Qualitative participatory methods	1	(Salm et al., 2023)

Table 6. Enablers from scientific articles

Organizational

Collaborative governance models is highlighted as an important enabler for the successful implementation of greening initiatives. The articles mention that traditional top-down governance approaches are led by government authorities only, while collaborative models stimulate bottom-up initiatives by integrating active involvement from a range of stakeholders, including local citizens, businesses, and civil society organizations (Adams et al., 2023; Kabisch et al., 2016;

Kuitert & van Buuren, 2022a; Stork et al., 2023). By involving a broad range of actors, these governance models help to align different interests and ensure that greenery projects are effective and responsive to community needs. Collaborative governance is not only about sharing responsibilities, but it also ensures transparency, legitimacy, and openness in decision-making processes, which creates an inclusive environment for urban greening (Kabisch et al., 2016; Lara & Del Moral, 2022). Additionally, these collaborative approaches allow municipalities to use the resources and knowledge of private actors. This increases funding opportunities, shares the risks associated with greening projects, and combines the inflexibility of top-down governance with the flexibility of the private sector (Zhao et al., 2024).

Another effective organizational enabler mentioned in three articles is *Early stakeholder involvement*. Engaging a broad range of internal and external key stakeholders early in the planning process facilitates successful collaboration and helps to find creative solutions (Connop et al., 2016; Kuitert & van Buuren, 2022a; O'Donnell et al., 2017). This approach ensures that the perspectives of all the relevant parties are considered from the start of the project, which will increase the likelihood of smooth project execution and stakeholder alignment throughout the entire process.

Governance and regulatory

A key enabler in overcoming institutional barriers to greening initiatives is *Regulatory changes*. By changing and improving legislation, regulations, and planning guidelines, municipalities will be able to better integrate their greening plans into early-stage planning processes (Li et al., 2020a). These changes will help remove obstacles by for example including technical requirements for urban greenery and will promote collaboration among stakeholders (O'Donnell et al., 2017; Wihlborg et al., 2019). Policies should also recognize the multifunctionality of greenery, to ensure a broad range of benefits and ecosystem services is provided when implementing greenery (Suárez et al., 2024).

Besides the regulatory aspect, *Political support* is also important for the successful implementation of urban greening projects. Therefore, raising support from high-level governments and ensuring alignment with governance policies can help prioritize greenery in urban planning (Li et al., 2020a; Runhaar et al., 2012). Raising support from politicians is linked to awareness among politicians and can be achieved through many different approaches. For example, Mees & Driessen (2011) mentions that in Rotterdam, political support for climate adaptation and urban greenery significantly grew after the International Architecture Biennale of 2005. This event focused on flood resilience and led to a new vision for the city's urban planning.

Additionally, *Clear communication strategies* is also mentioned by three articles as an enabler for successful greening initiatives. It is essential to effectively communicate the importance and benefits of greenery to government officials and the public (Megyesi et al., 2024). Developing clear and understandable visions and guidelines, that align with public expectations, ensures that greening initiatives will be more supported and successfully implemented (Liu et al., 2024; Zhao et al., 2024). Without clear communication strategies, the awareness and urgency surrounding greenery implementation will be lower.

Social and psychological

Raising awareness is a key social and psychological enabler. Raising awareness about the value and benefits of green areas help to stimulate the implementation of green initiatives (Mattijssen et al., 2023; Megyesi et al., 2024). It also affects multiple other aspects, such as gaining public and political support for urban greenery. Public education, media campaigns, and social media engagement can significantly increase awareness of the importance and benefits of green implementation (Li et al., 2020a). Additionally, raising awareness is crucial for ensuring that

developers and practitioners make informed decisions about selecting the right types of greenery (Williams et al., 2019).

Financial

Implementing *Innovative financial models* is highlighted in four articles as a key enabler for addressing the financial challenges of urban greening. Introducing new financing systems can help to address the current investment shortages in greening initiatives (Megyesi et al., 2024). Different options for innovative financial models, such as public-private partnerships, social enterprises, and increased private investment, can provide more reliable funding sources for greening initiatives (Li et al., 2020a; Stork et al., 2023). Additionally, government grants can also be applied to support these initiatives (Wihlborg et al., 2019). Innovative financing models can diversify funding streams, making the financial situation less uncertain and reducing costs for the municipalities (Stork et al., 2023).

Research and knowledge

Knowledge exchange platforms play an important role in the distribution of knowledge, expertise and information on urban greening. Establishing a dedicated knowledge platform that collects the expertise of policymakers, citizens, and researchers can help centralize and distribute valuable information about urban greenery (Kabisch et al., 2016). These platforms can improve knowledge sharing within municipalities (Wihlborg et al., 2019) and also enable cities to exchange valuable insights and best practices, which promotes collaboration across different cities (Adams et al., 2023).

Another enabler mentioned in the articles for this category is *Education programs*, which present a key opportunity to address the knowledge gaps on urban greenery (Mees & Driessen, 2011). Investing in improving education will benefit the awareness on the importance of urban greening projects (O'Donnell et al., 2017). While education programs improve the lack of knowledge, understanding and awareness, it also helps to shift perceptions and encourage public and political support for urban greening initiatives (Li et al., 2020a).

Spatial

The spatial enablers mentioned in the articles are limited, only two examples are provided. First, *Multi-functional land use* is mentioned as an enabler, which refers to the integration of social, economic, and environmental aspects into urban planning through multi-functional land use designs. By addressing these aspects together, greenery is also incorporated early in the planning process. One example of this approach is 'Dakpark' in Rotterdam, which combines a district park, commercial center, and parking (Mees & Driessen, 2011). The other enabler identified is *Car restraint policies*, as mentioned by Liu et al. (2024). Policies for removing parking spaces and increasing parking prices are highlighted as effective strategies to reduce car ownership. This can potentially free up space in urban areas and creates possibilities for the implementation of greenery initiatives.

Participation

Community engagement is mentioned as a key enabler in seven articles, emphasizing the importance of involving citizens in the decision-making process for urban greening (Momm-Schult et al., 2013). Encouraging public participation during the design, implementation, and monitoring stages of urban greening can significantly increase the resilience of these projects (Suárez et al., 2024). By promoting more active community engagement and communication, rather than passive engagement, citizens are encouraged to initiate more local initiatives, to help overcome the implementation barriers (Mattijssen et al., 2023; O'Donnell et al., 2017). Active participation can generate wider public support but also helps to attract political attention, which is important for the success of urban greening efforts (Liu et al., 2024).

4.1.4.   Enablers identified in interviews

In addition to the 72 barriers mentioned in the interviews, 52 enablers have been identified by the respondents. These enablers highlight the key factors that can support the successful implementation of greening initiatives. The enablers are categorized into sub-categories, as shown in Table 7. Each category is examined with a focus on the most prominent sub-categories, to provide a detailed understanding of the main enablers mentioned in the interviews.

Category	Sub-category	Times mentioned	Respondent
Organizational	Proactive planning	4	2, 11, 12
	Early stakeholder involvement	2	1, 2
	Early-stage green integration	2	3,8
	Integrated organizational approach	2	3, 9
	Efficient project prioritization	1	12
	Organizational capacity building	1	5
	Leadership	1	6
Governance and Regulatory	Standardized regulations	3	2, 4, 14
	Political support	2	4, 6
	Multi-level policy alignment	1	3
	Green-first approach	1	1
Social and Psychological	Raising awareness	5	2, 8, 13, 14
	Building support through trust	1	4
	Social greening initiatives	1	1
Financial	Financial contribution private sector	1	14
	Cost efficiency through standardization	1	4
	Dedicated funding	1	5
Research and Knowledge	Tools and frameworks for implementation	6	1, 3, 6, 7
Spatial	Car restraint policies	6	1, 9, 10, 11, 13, 14
Participation	Community engagement	4	4, 9, 13, 14
	Community-driven maintenance	3	1, 4, 13
	Different participation models	1	13
	Citizen engagement activities	1	9

Table 7. Enablers from interviews

Organizational

Proactive planning is identified as an enabler for successful implementation of greening initiatives in three interviews. By having detailed design plans and analyses ready in advance, municipalities can act quickly when funding becomes available, ensuring fast realization of projects (Respondent 11, 12). By preparing these design proposals and guidelines for specific neighborhoods, municipalities can reduce barriers in the later stages of a project. This proactive approach makes it easier to integrate greenery with other urban developments, and it will help to streamline the entire process (Respondent 11, 12). This proactive approach can involve quarterly or semi-annual meetings with project leaders to discuss available capacity and upcoming projects, allowing for effective planning and execution (Respondent 2).

Besides this enabler, three other enablers are mentioned twice in the interviews within the organizational category. First, *Early stakeholder involvement* ensures that key stakeholders, such as project leaders and maintenance teams, are engaged from the beginning. This allows potential issues related to maintenance and project requirements to be identified and addressed at an early stage, preventing costly changes later in the process (Respondent 1, 2). Secondly, *Early-stage green integration* is also experienced as an enabler. It refers to the integration of greenery into urban planning from the beginning, by already including specific plans and regulations on greenery in city planning decisions. By considering aspects like biodiversity goals and climate adaptive measures early on, it can save both time and money by avoiding the need for costly adjustments later in the project (Respondent 3, 8). Lastly, adopting a more *Integrated organizational approach* can facilitate smoother project execution by actively involving experts from relevant departments (Respondent 3). Respondent 9 highlights that working in smaller

teams, with close coordination between experts on design, management, and execution, are experienced to be effective. This approach leads to more efficient "quick wins" in greenery implementation.

Governance and regulatory

Standardized regulations is identified as a regulatory enabler for successful urban greening projects. By establishing standard rules, such as requirements to reduce hard surfaces by a specific percentage and biodiversity guidelines, municipalities can ensure that greenery becomes a consistent priority for all urban development projects (Respondent 2, 14). For example, Amsterdam has the Puccini handbook, which provides guidelines for public space design, ensuring that the implementation and maintenance of greenery are coordinated and aligned with the city's broader sustainability goals (Respondent 4).

Next to that, *Political support* is mentioned by two respondents as an enabler. The political situation within a city, both at the municipal level and among its residents, significantly influences the extent to which greenery projects are executed (Respondent 4). In cities with green-oriented leadership, such as those with a "green coalition" in power, are the chances of implementing and prioritizing urban greenery much higher (Respondent 6). Therefore, raising political support is crucial for the successful implementation of greening projects.

Social and psychological

Similar to findings in the articles, *Raising awareness* is identified as a crucial enabler in the interviews. Ensuring that residents understand the benefits of greenery and its role in climate adaptation helps to build support for projects (Respondent 2). Initiatives such as providing information on greening opportunities around homes and explaining the technical aspects of urban development to residents are effective strategies for increasing awareness (Respondent 8, 13). Respondent 2 approaches this by creating green areas in locations where many people pass by and can really enjoy the greenery, with the aim of increasing awareness of greening among residents.

Financial

For the financial category, three different enablers are identified, each mentioned by only one respondent. First, *Financial contribution from the private sector* highlights the potential of engaging private owners to financially contribute to greening initiatives near their buildings, as it also enhances the value of their property (Respondent 14). Additionally, *Cost efficiency through standardization* focuses on establishing standardized guidelines, such as the Puccini handbook in Amsterdam. By ensuring that greenery and maintenance procedures are uniform across different areas, costs can be reduced (Respondent 4). Lastly, *Dedicated funding* refers to the increased availability of funding specifically allocated for greening projects, allowing to execute them independently from other infrastructure projects (Respondent 5).

Research and knowledge

The use of *Tools and frameworks for implementation* is identified as an important enabler for urban greening projects. These tools and frameworks can serve as practical guides for the design and implementation of greening initiatives. Besides that, they also function as tools to raise awareness for the importance of greenery. By developing studies and maps that highlight specific greening opportunities, they will provide clear direction on where greenery should be implemented in the city (Respondent 3, 6, 7). For example, Respondent 7 mentions a tool that was developed to calculate the required square meters of green space for new projects, while also offering recommendations for green solutions and advise on the quality of the greenery.

Spatial

Car restraint policies is the enabler that is most mentioned by the respondents. Six respondents highlight that reducing car usage and removing parking spaces in cities effectively create opportunities for greening projects. For example, introducing policies to make the cities more pedestrian-friendly by removing parking spaces and reallocating this space for greenery (Respondent 1, 13, 14). New plans for parking will lead to the redesign of streets, which requires coordination with mobility experts to explore greening possibilities (Respondent 9). Another car restraint policy, that will lead to the redesign of streets and creates space for greenery, is the introduction of 30 km/h zones (Respondent 10). Respondent 11 mentions a pilot solution for removing parking spaces by using tree-bicycle platforms placed on parking spots. These platforms serve as a trial to gauge public support before permanently transforming these areas into green areas.

Participation

Four respondents highlight that *Community engagement* is a key enabler in driving urban greening projects through active resident involvement. Community engagement can be achieved through various engagement initiatives and approaches. For example, Respondent 9 mentions the introduction of a greening desk, a (digital) counter where citizens can share their greening ideas and suggestions. This initiative tries to lower the threshold for residents to approach the municipality, ensuring that their ideas are taken into account and allowing faster implementation of projects. Additionally, initiatives like "Groen in de Buurt" are specific projects focusing on engaging the community in greening efforts (Respondent 4). Voluntary groups can also play a role in participation and raising awareness, their initiatives often serving as examples for larger municipal projects (Respondent 14). Besides these initiatives, it is important that continuous feedback and evaluation with residents is caried out, to allow municipalities to refine participation efforts (Respondent 13).

Another enabler that was mentioned in the interviews is *Community-driven maintenance*. Giving residents responsibility for maintaining local green areas promotes a sense of ownership (Respondent 1). Respondent 4 highlights that involving residents in maintenance accelerates the implementation of projects. Additionally, it builds long-term support and enthusiasm for urban greenery among residents (Respondent 13).

4.2. Connecting barriers and enablers for mitigation

This section interprets the results on barriers and enablers for urban greenery implementation by exploring how they can be matched to address the barriers. Although barriers and enablers have been identified separately in previous section, understanding their interconnections allows for the possibility to develop mitigation strategies. This section does not aim to formulate fixed solutions or match every barrier with an enabler. Instead, it offers possibilities and examples of how certain enablers might address specific barriers, providing municipalities with adaptable guidance to support their decision-making processes. The results will answer research question 4: *"How can the enablers be strategically matched with barriers to support municipalities in overcoming challenges related to urban greenery implementation?"*

Section 4.2.1. explores the interconnectedness of barriers and enablers, explaining how these factors influence each other and contribute to the complexity of urban greenery implementation. Section 4.2.2. presents potential mitigation strategies, showing examples of which enablers can be applied to address multiple barriers. Finally, section 4.2.3. introduces a 'Barrier and enabler identification framework,' a framework to help municipalities address and prioritize their barriers and enablers for urban greenery initiatives.

4.2.1. Interconnectedness of barriers and enablers

The first important part for answering research question 4 is to gain a better understanding of how the identified barriers and enablers from the articles and interviews are connected. Recognizing these connections is important, as it shows how enablers and barriers can influence each other. The understanding of how these factors interact within the decision-making of urban greenery provides a more comprehensive overview of the complexities municipalities face in implementing urban greenery. This can play a crucial role in formulating strategies to mitigate the barriers and enhance the urban greenery implementation.

Figure 10 shows a systems diagram of the five most mentioned barriers and enablers to give an example of the possible connections. It's important to note that the connections shown in Figure 10 represent one possible interpretation, based on the data gathered. Different stakeholders can see alternative or additional interactions based on their experiences and priorities.
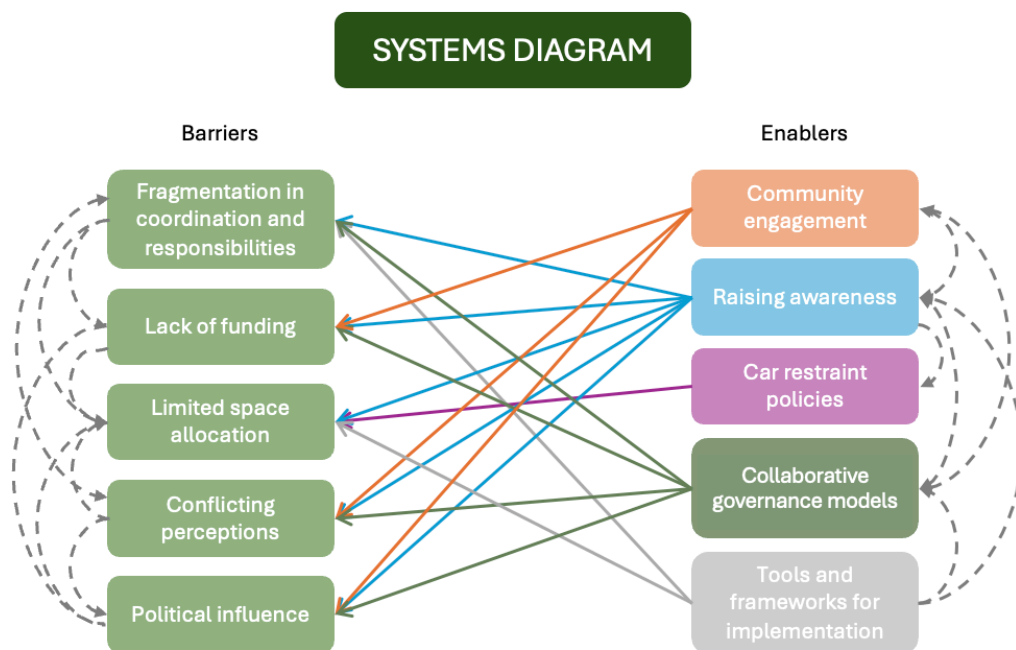

Figure 10. Systems diagram: possible effects barriers and enablers.

The systems diagram illustrates many potential interactions between enablers and barriers. For example, Fragmentation in coordination and responsibilities is influenced by the enablers Collaborative governance models and Tools and frameworks for implementation, which can both help to improve the coordination between key stakeholders (Kabisch et al., 2016; Respondent 3). Additionally, Collaborative governance models and political support can play a role in addressing the Lack of funding for urban greenery projects. Collaborative governance models may increase funding opportunities through partnerships and resource sharing (Zhao et al., 2024), while political support can stimulate policy changes that allocate necessary funding (Li et al., 2020a; Respondent 4). The enabler Raising awareness has a wide-spread effect on all the barriers in the systems diagram, indicating that initiatives for raising awareness can possibly address multiple barriers simultaneously (Li et al., 2020a; Megyesi et al., 2024). While the arrows between enablers and barriers show potential influences, they do not guarantee a real effect. The effectiveness of the connections depends on the specific strategies and how the enablers are implemented.

The barriers and enablers also have interconnections among themselves (dashed lines in the diagram), which can either weaken or strengthen their impact. For example, Fragmentation in

coordination and responsibilities impacts both Lack of funding and Limited space allocation. Fragmentation often leads to uncoordinated budget allocation because departments work in silos and prioritize their own projects, making it difficult to secure comprehensive funding for urban greenery initiatives (Wihlborg et al., 2019). It also influences Limited space allocation, as departments may compete over land use priorities without having a shared vision, which can limit available land for greenery (Hoang & Fenner, 2016; Respondent 12, 14). Among the enablers, Tools and frameworks for implementation can support Collaborative governance models by offering structured processes and standardized guidelines. These tools and frameworks can help municipal departments and stakeholders to work together more effectively, reducing misunderstandings and fostering trust within collaborative efforts (Zhao et al., 2024; Respondent 6). This structured collaboration can lead to more coordinated and efficient urban greenery initiatives.

This interconnectedness represent the complexity of how the barriers and enablers influence the implementation of urban greenery. The many connections in the diagram reveal that some enablers can influence multiple barriers simultaneously. Additionally, the connections between the barriers emphasizes that the barriers are often not isolated challenges but can be interdependent; by addressing one barrier it may positively impact others. Therefore, this complexity indicates that municipalities may benefit from comprehensive strategies that do not address barriers in isolation but rather use enablers that can address multiple challenges at the same time. This will be explained in more detail in the next section.

4.2.2.   Mitigation strategies

Building on the understanding of the interconnectedness, this section will explore the possibility of formulating mitigation strategies by matching identified barriers with enablers. The matching approach aims to identify connections and overlaps between barriers and enablers, focusing on logical combinations to develop potential mitigation strategies that can offer guidance for municipalities to improve decision-making for urban greenery implementation. Mitigation strategies are defined as approaches that apply enablers to overcome identified barriers. While the enablers are important elements in forming mitigation strategies, the effectiveness of the strategies depends on implementing these enablers in a structured and practical way to address specific barriers.

For this matching approach, the ten most mentioned barriers were matched with the ten most mentioned enablers. The mitigation strategies are presented in Table 8. The connections presented in the table are based on a detailed analysis and understanding of the enablers identified from the gathered data, demonstrating how these enablers can simultaneously address multiple barriers and support comprehensive mitigation strategies. They serve as examples based on the research data and represent a possible approach to addressing the identified barriers. Similar to the previous section on interconnectedness, these strategies reflect one particular interpretation based on the current findings. Different stakeholders may, however, identify alternative or additional strategies based on their experiences and priorities, allowing for tailored strategies that align with their specific needs.

Table 8. Mitigation strategies (overview of direct impacts)

Enablers \ Barriers	Fragmentation in coordination and responsibilities	Lack of funding	Limited space allocation	Conflicting perceptions	Political influence	Lack of knowledge	Financial constraints for maintenance	Lack of supporting policies	Lack of regulatory standards	Lack of awareness
Community engagement				X	X	X	X			X
Raising awareness				X	X					X
Car restraint policies			X					X		
Collaborative governance models	X	X		X		X	X			
Tools and frameworks for implementation	X					X				X
Early stakeholder involvement	**X**			**X**		**X**	**X**			**X**
Regulatory changes	**X**		**X**					**X**	**X**	
Political support		X			X			X	X	
Proactive planning	X		X							
Innovative financial models		X					X			

Table 8 provides an overview of the specific barriers that each of these enablers can directly address. Each "X" in the table indicates a direct relationship between an enabler and barrier. This highlights the opportunities to implement certain enablers to address multiple barriers at the same time, thereby maximizing the potential and impact of the enablers. However, it's important to note that the actual effectiveness of each enabler depends on how it is implemented in practice. The table focuses only on direct impacts; therefore, additional indirect influences may also be present. Two mitigation strategies, based on the enablers *Early stakeholder involvement* and *Regulatory changes*, are discussed in more detail to show how these enablers can be used to address a combination of barriers.

Early stakeholder involvement addresses five barriers, this makes it one of the most effective mitigation strategies in this table. This strategy promotes collaboration among municipal departments, private organizations, and communities from the start of greenery initiatives. Early involvement improves coordination and reduces fragmentation between different departments (Connop et al., 2016; O'Donnell et al., 2017). Additionally, discussions with all the relevant stakeholders early in the process helps to address conflicting perceptions, including those from residents, and will align everyone around a shared vision for urban greenery (Respondent 1, 2). Furthermore, early stakeholder involvement addresses the barrier Lack of knowledge by involving different stakeholders with their own expertise and knowledge on greenery (Kuitert & van Buuren, 2022a). This collaboration from the start of a greening project helps to reduce knowledge gaps and ensures that all stakeholders are informed, and that decision-makers will make informed decisions. Finally, involving all stakeholders will help raise awareness about the importance of greenery (Williams et al., 2019). This collective awareness can stimulate more public support, which is important for the success of urban greening projects.

The mitigation strategy for *Regulatory changes* refers to the improvement of the current regulations on urban greenery, to make it more successful. It addresses the barrier Fragmentation in coordination and responsibilities by developing clear regulations that stimulate collaboration between different departments and stakeholders. The improved regulations can help municipal departments involved in urban greening projects to align their approaches, this reduces the inefficiencies caused by the fragmented structure (O'Donnell et al., 2017; Wihlborg et al., 2019). By providing a shared set of standards, regulatory changes can streamline the greenery processes within municipalities. This strategy also addresses the barriers Limited space allocation, Lack of supporting policies, and Lack of regulatory standards. By developing specific regulations on how urban spaces should be allocated for greenery, greening can be more prioritized in densely built areas (Respondent 4). Regulatory changes also have to be integrated in municipal policies on greenery, which lead to the development of supporting policies. By implementing these regulatory changes, municipalities can standardize processes, ensuring that greenery is consistently incorporated into urban planning and development.

While the matches in the table are based on direct impacts on the barriers, it is also important to recognize that the enablers can have indirect impacts on other barriers. Early stakeholder involvement helps to reduce fragmentation by improving coordination with other departments, like the mobility department. This can create an indirect snowball effect on Limited space allocation, where this coordination can lead to more informed and strategic decisions on where to implement greenery. As a result, locations for greening initiatives will better align with the overall urban planning. For Regulatory changes, the indirect effect on Lack of awareness can result from the increased presence of urban greenery. As regulations promote more implementation of greening initiatives, the public becomes more exposed to green spaces, which can stimulate the awareness (Respondent 2). Additionally, new regulations often involve public communication, which can further stimulate the awareness among residents on the benefits and importance of urban greenery (Li et al., 2020a).

These potential indirect, snowball effects may result from the inherent connections among the barriers and enablers themselves. For example, the enabler Raising awareness: while it may initially address one barrier directly, the positive effect of more awareness can trigger a snowball effect across many other barriers due to their interconnected nature. When municipalities become more aware about the importance and benefits of urban greenery, each barrier can be influenced positively, creating a reinforcing effect that strengthens overall support for greenery initiatives.

These results show that enablers can have a widespread effect on multiple different barriers, direct or indirect. Besides that, the effectiveness of a mitigation strategy depends on how it is applied and which specific barriers it aims to address. Therefore, the specific focus and implementation of mitigation strategies significantly determine their impact. This highlights the difficulty of predicting and matching all the possible effects to formulate clear and comprehensive mitigation strategies for urban greening projects.

Finally, it is important for municipalities to use a flexible and adaptive approach when applying the mitigation strategies in decision-making. Within every municipality different barriers may occur because of the specific context and stakeholders involved (Aparicio Uribe et al., 2022; Lippert et al., 2022). Therefore, municipalities need to adapt the mitigation strategies to ensure that they will be effective within their own local context (Kumar et al., 2024; Zhao et al., 2024). This highlights that standardized, one-size-fits-all mitigation strategies may not be the most effective, however, the overview of possible strategies presented in this section provides valuable insights and possibilities for municipalities to address diverse challenges.

4.2.3. Barrier and enabler identification framework

To address the need for flexibility in municipal decision-making, this section will present another effective approach. The collected data from this research can be organized into an identification framework for barriers and enablers, that can help municipalities to become more aware of their urban greenery challenges and effectively address them. By using a flexible framework, municipalities can better manage the complexities of urban planning and decision-making, ultimately improving the implementation of urban greenery initiatives.

The idea of this framework is introduced in the article of Deely et al. (2020). They developed in their research a barrier identification framework to help urban planners with predicting and managing the barriers that may occur during the greenery projects, by categorizing and assigning threat levels to each barrier. Their barrier identification framework only focused on barriers. Therefore, they highlighted that a key limitation of their framework is that it does not provide guidance in overcoming the identified barriers. This research addresses their limitation by adding a framework for enablers, to create a more comprehensive framework that municipalities can use to overcome their barriers.

The research of Deely et al. (2020) conducted a literature review to identify barriers related to both green and blue infrastructure, analyzing 40 relevant articles. In comparison, this research focused only on the urban greenery aspect and combined results from a literature review of 25 articles and interviews with 14 experts. Deely et al. identified 25 types of barriers across 5 categories, this research expanded on that by identifying 36 types of barriers organized into 7 categories. Both studies found similar categories, with only two differences in categorization. The research of Deely et al. combines the categories Organizational with Governance and Regulatory, as well as Participation with Social, in this research these categories are separated. Additionally, while Deely et al. (2020) provided a valuable framework for identifying barriers, this research extends their work by introducing an enabler framework, containing 44 types of enablers. This additional enabler framework offers municipalities a first step in guidance for addressing and overcoming identified barriers.

Tables 9 and 10 present a small part of the identification frameworks from this research as an example, Appendix C provides the complete barrier and enabler identification frameworks. The barriers and enablers identified in the literature review and interviews are integrated in the identification frameworks. Municipalities can use these frameworks by assigning a 'Threat level' to the barriers and an 'Impact level' to the enablers, both rated on a scale from None, Low, Medium, to High. This framework can help municipalities to predict the potential influence of each barrier and enabler, which can guide decision-makers in prioritizing which barriers to address, and how impactful enablers might be to overcome the barriers for their greenery projects.

Category	Barrier types	Threat level
Organizational	Fragmentation in coordination and responsibilities Capacity constraints Resistance to change Planning challenges Unclear responsibilities for maintenance Lack of organizational alignment	*None/Low/Medium/High*
Governance and Regulatory *etc.*	Political influence Lack of supporting policies *etc.*	*None/Low/Medium/High*

Table 9. Example barrier identification framework

Category	Enabler types	Impact level
Organizational	Collaborative governance models Early stakeholder involvement Proactive planning Early-stage green integration Integrated organizational approach Management tools for horizontal coordination Coordinated strategic planning Mediatory agency Efficient project prioritization Organizational capacity building Leadership	*None/Low/Medium/High*
Governance and Regulatory	Regulatory changes Political support	*None/Low/Medium/High*
etc.	*etc.*	

Table 10. Example enabler identification framework

After assigning the threat and impact levels, municipalities can strategically use the frameworks to link enablers with barriers and determine effective mitigation strategies. It is recommended to prioritize addressing barriers with 'High' and 'Medium' threat levels, as these may have the most significant results. By carefully selecting enablers with 'Medium' or 'High' impact levels that are most appropriate for addressing specific barriers, municipalities can apply practical solutions that effectively mitigate these challenges. When linking enablers, municipalities should consider whether multiple barriers could be addressed simultaneously, maximizing the efficiency of the mitigation strategies.

Finally, this identification framework itself serves as an effective enabler, acting as a 'Tool and framework for implementation.' By offering a structured method to analyze and address barriers, the framework contributes to overcoming the most frequently mentioned challenge, Fragmentation in coordination and responsibilities. It provides an initial step for organizing key stakeholders and aligning efforts across different departments, to address the high threat barriers proactively. Therefore, the framework can facilitate better collaboration and ensures more coordinated approaches to urban greenery projects.

4.3. Validation

After conducting the research and collecting the results, a validation meeting was organized with three expert advisors working in the urban greenery field. This meeting was designed to validate the accuracy and reliability of the results on the barriers, enablers and mitigation strategies identified during the research.

The validation session for this research was conducted with advisors from Brink instead of municipal employees, to gain an external, but expert, perspective on the findings. These advisors, who regularly collaborate with municipalities on urban greening initiatives, provided valuable insights and helped to validate that the results align with real-world practices. The goal was to gather feedback on whether the results addressed the needs and priorities of municipalities, the main stakeholders in this research.

The validation meeting started with a presentation on the findings on the barriers, enablers, and mitigation strategies. After the presentation, a discussion took place in which the experts shared their insights and perspectives on the results. The experts provided their opinions on the identified barriers, enablers, and mitigation strategies, they could either confirm the findings or suggest new insights. This section will further discuss the outcomes of the validation meeting. The experts will be referred to as Expert 1, 2 and 3.

Barriers
First, the results on the barriers were discussed. All three experts agreed with the identified barriers, the most frequently mentioned barriers were also the barriers that they experienced the most. Fragmentation in coordination and responsibilities was confirmed by the experts as a significant challenge, they state that there is often a lack of clarity and accountability regarding which department should initiate greening projects.

Besides that, the barriers Lack of supporting policies and Lack of regulatory standards was a point of discussion between Experts 1 and 2.
- Expert 1 pointed out that without supporting policies for greening, it's difficult to make real progress. Therefore, this expert believes that establishing these policies is the first essential step to ensure that the initiation and implementation of greening initiatives will be more successful.
- Expert 2 highlighted that specific national regulatory guidelines for urban greening are missing. While there are laws in place for construction and real estate, similar regulations for greening are not yet established, making legal enforcement challenging. Therefore, according to this expert establishing such guidelines could be a strong starting point.
    - o Expert 1 reacted to this that strict enforcing regulations can be challenging to implement, since the effectiveness often depends on the specific characteristics of locations.

This discussion concluded with an open question of whether the focus for urban greenery should be on developing municipal policies as guidelines or establishing enforceable legal frameworks on national level.

Expert 3 highlighted that addressing the barrier Lack of awareness should be the main priority for municipalities. According to this expert, focusing on raising awareness is essential for effective implementation of more urban greenery.

Enablers

The discussion on the enablers was not long as the experts all agreed on the findings of the enablers. Expert 3 highlighted the importance of engaging the community in maintaining urban greenery. The other experts also mentioned that such participatory approaches are often used as effective strategies for municipalities to improve public involvement and public support for greening initiatives. Additionally, the enabler Raising awareness was highlighted again during this discussion as important enabler. They pointed out that awareness needs to be promoted across multiple levels, involving politicians, decision-makers, municipal employees and residents, to create more support for urban greenery.

Mitigation strategies

For the discussion on the mitigation the experts agreed on the significance of the interconnections among both enablers and barriers. They note that not only enablers have the potential to address multiple barriers simultaneously, but barriers themselves can also influence one another, with some barriers negatively influencing the effects of others. For example, Lack of supporting policies has a negative effect on Fragmentation in coordination and responsibilities, as well as on Lack of funding for greenery. Expert 1 emphasized that developing supporting policies could be a successful approach for addressing many barriers, highlighting that without specific policies it is unclear how to address the barriers. If there is a policy in place, everyone involved in the decision-making for greening initiatives can work with the same framework and guidelines. This way, supporting policies can serve as a foundation for achieving success for urban greenery. Experts 2 and 3 agree with the statement from Expert 1.

Additionally, the experts mentioned that they often prefer to develop mitigation strategies themselves, together with the municipalities. The strategies have to be tailor-made to fit the specific aspects and needs of each municipality. Every municipality is different and has its own characteristics and challenges, this requires unique and specific mitigation approaches that probably will not be the same as the ones provided in this research. However, the experts found the overview of the mitigation strategies insightful, as it showed what can be done with different strategies.

Concluding insights

The main insights from the validation meeting indicate that this research provides an overall clear and complete picture. There were no comments about inaccuracies or different experiences. The three most highlighted aspects from the barriers and enablers are the importance of missing regulations, raising awareness and participation, and addressing supporting policy as the first step. Finally, Expert 2 concluded the meeting by saying: *"The overview of the barriers and enablers is especially useful to keep on hand during our work. It can serve as a guide for which questions to ask municipalities and what to be aware of in advance. Since each municipality is so different, having a broad overview like this is very helpful."*

5. Discussion

The discussion chapter consists of four sections: first, section 5.1. focuses on the interpretation of the results. After that, section 5.2. explains the relevance of the research. Section 5.3. addresses the limitations of this research, and finally, in section 5.4 the recommendations for practical implementation and future research will be provided.

5.1. Interpretation of results

This section will discuss and interpret the results from Chapter 4.

5.1.1. Literature review and interviews

First, the findings of this research show an overlap between the barriers identified in both the literature review and interviews, most of the barriers, especially the significant ones, are mentioned in both data sources. This provides a strong indication that the challenges faced by Dutch municipalities in implementing urban greenery are consistent across different contexts. However, the interviews also provided new insights for the barriers, not only by highlighting new types of barriers but also offering more context and background on the cause of barriers. Remarkable differences in the barriers results are found in the categories Research and knowledge, and Participation. While the literature review highlighted many barriers related to Research and Knowledge, this category was just mentioned twice in the interviews (Respondent 7, 8). An explanation for this difference could be that municipalities are not aware of the knowledge they might lack, while for scientist the knowledge gaps are more evident. In contrast, Participation was mentioned more in the interviews but just once in the literature review. The reason for these differences possibly comes from the gap between theoretical perspectives and real-world experiences.

The enablers show more variation between the findings from the literature review and interviews. The results from the interviews provide new and specific insights into the opportunities for successful implementation of urban greenery. Many enablers are more unique and specific, which leads to less consistency in the responses. There are more situations where only one respondent mentioned an enabler, compared to the barriers. While barriers, such as Lack of funding or Fragmentation in coordination, seem to be more general and common in different cities, the identified enablers are more variable and unique. This reflects the difference in strategies, priorities, policies, and resources in municipalities (Kumar et al., 2024; Zhao et al., 2024). Therefore, the enablers represent practical actions that municipalities can adapt to their needs and priorities, in order to make them effective and relevant to their local context. This will be discussed in more detail in section 5.1.3.

5.1.2. Barriers and enablers

The articles and interviews highlight the urgency for implementing more urban greenery, and particularly the interviews show that there are many dedicated people working on this issue. However, the results on barriers still present a significant challenge for successful implementation of urban greenery. The main barrier identified in both the articles and interviews is Fragmentation in coordination and responsibilities, which highlights the importance of improving the collaboration between municipal departments for the decision-making on urban greenery. However, the right approach to improve this remains a bit unclear from the results. The results show that many barriers are interconnected and influence each other, this results in the question: where should municipalities begin when addressing the barriers?
For example, policies and knowledge on greenery can both influence the fragmented coordination within municipalities. By implementing supporting policies or introducing knowledge exchange platforms barriers related to fragmentated coordination can be addressed (Kabisch et al., 2016;

Respondent 7). Furthermore, decisions regarding space allocation, maintenance and funding are highly dependent on Social and psychological barriers, especially in terms of the level of awareness and support for urban greening initiatives (Li et al., 2020a; Respondent 2). When there is insufficient awareness and support for urban greening initiatives, it often results in limited space and funding being allocated to urban greenery projects. These multiple connections and dependencies between the barriers makes it difficult to exactly determine where municipalities should begin. The best approach will also depend on the specific characteristics of each municipality and the barriers they face (Kumar et al., 2024; Zhao et al., 2024). This complexity makes it challenging to identify a clear starting point, but it also suggests that multiple different approaches can be successful and effective.

Enablers are mentioned 110 times in this research, highlighting many opportunities to address barriers and improve the urban planning and decision-making processes for successful urban greenery implementation. In total 44 types of enablers are identified. While some enablers overlapped between the articles and interviews, the interviews introduced 17 new enablers to the existing list of enablers from the literature. This addition significantly expands the range of possibilities to address the barriers.

The most mentioned enabler is Community engagement. While this research initially focuses on initiatives led by municipalities, the findings from the scientific articles and interviews both emphasize the importance of other forms of governance as well. For example, enablers like Community engagement and Collaborative governance models can play an important role in achieving successful greening projects. These results highlight the need for a combination of top-down government-led urban planning and bottom-up citizen participation. Furthermore, the different enablers on community involvement can address multiple types of barriers. For example, the enabler Community-driven maintenance can help to overcome different maintenance-related barriers, such as capacity constraints (Respondent 8) or financial barriers (Salm et al., 2023). This highlights again that enablers are not limited to addressing barriers within a single category.

The second most mentioned enabler is Raising awareness, which is an interesting enabler because of its multifunctionality. It can have a positive impact on all the barriers, either directly or indirectly. In the articles and interviews this enabler is often discussed in broad and general terms, most of the time by just emphasizing the importance of raising awareness. Some sources explained it in a bit more detail, such as improving education, using social media, and distributing informational guides, primarily focusing on raising awareness by residents (Li et al., 2020a; Respondent 8, 13). During the validation meeting it was discussed that it is also important to raise awareness on other levels, including politicians, decision-makers, municipal employees. Therefore, municipalities should take into account these different levels when developing a specific approach for raising awareness.

5.1.3. Interconnectedness of barriers and enablers

The analysis of barriers and enablers highlights the interconnectedness between these elements, adding complexity to urban greenery implementation. This interconnectedness creates both challenges and opportunities for addressing barriers effectively. By exploring these connections, this research makes an important contribution to the literature, addressing a specific area that has been underexplored in existing studies. Previous studies often focus on barriers and enablers separately, without considering how they interact within the decision-making processes of urban greenery. By highlighting these interconnections, this research offers a detailed understanding of how enablers can address multiple barriers, which can support municipalities in mitigating barriers.

When exploring the possibility of formulating mitigation strategies, two difficulties were experienced: the interconnectedness of the barriers and enablers, and the specific context of municipalities. First, the results highlighted that many enablers and barriers are connected and influence each other. The enablers showed a widespread and positive effect on multiple barriers, making it difficult to formulate clear and specific mitigation strategies. Secondly, the effectiveness of mitigation strategies depends on the unique context of municipalities, such as the differences in organizational structures, local factors and experienced barriers. Therefore, specific mitigation strategies are difficult to develop as municipalities need the flexibility to adjust them to their local context. However, the interconnectedness of barriers and enablers also presents opportunities. It offers flexibility to adapt the mitigation strategies to the specific needs and goals of the municipalities.

To address the need for flexibility, developing standardized mitigation strategies is not desirable. Instead, a barrier and enabler identification framework can serve as an alternative approach. The research findings on barriers and enablers are used as a comprehensive overview in this framework. The framework can serve as a checklist for municipalities, to guide them through every stage of their urban greenery projects. It helps them to better understand the barriers and enablers they might face. This approach is not only valuable during the preparation phase, but also provides valuable insights into lessons learned during the evaluation of a project. Additionally, this framework addresses the lack of awareness among municipalities about the barriers and enablers they might face. By providing this structured framework, municipalities can make more informed decisions and improve the success of urban greenery implementation. Furthermore, the experts from the validation meeting supported this framework. They highlighted that working with a detailed overview of the barriers and enablers is valuable and helpful for their work. Therefore, the framework can also serve as a supportive tool for companies that advise municipalities.

5.2. Research relevance

The relevance of this research is twofold, contributing to both research and practice.

Academic value

This research significantly improves the academic understanding of urban greenery implementation by bringing together the fragmented and multidisciplinary knowledge. Besides offering a comprehensive overview of the barriers and enablers faced by municipalities, it also analyses how these factors interconnect, providing insights into strategies for overcoming barriers. By exploring these connections, this research contributes to academic insights on how to address the complexities of decision-making in urban greenery initiatives. This comprehensive analysis bridges the gaps in the existing literature and provides a foundation for future research by presenting more details on how enablers can effectively mitigate barriers.

Practical value

From a practical perspective, this research offers valuable guidance for municipalities by bridging the gap between theory and practice. The results are based on both scientific articles and real-world experiences from interviews, to ensure the applicability to municipal decision-making. By providing comprehensive overviews, this research helps to establish more awareness on the benefits, barriers, and enablers related to urban greenery. Additionally, the developed identification framework can help municipal stakeholders to better understand and mitigate the barriers related to implementing urban greenery. By emphasizing adaptable strategies and the potential of enablers, this study offers decision-makers guidance to overcome challenges, promoting more effective and successful urban greenery initiatives.

5.3. Limitations

Although the findings provide valuable results on barriers and enablers for implementing urban greenery, it is important to recognize key limitations regarding the methodology, scope and applicability. Recognizing these limitations is essential for interpreting the result correctly and for identifying future research opportunities. It is important to highlight that despite these limitations, the results remain valid for answering the research questions, as will be elaborated in the Conclusion chapter.

First, the generalizability of the results may be a limitation. In this research, no distinctions were made between the findings from different municipalities or the different professional roles of the interviewed respondents; the data was analyzed as a single dataset. Respondents provided insights based on their personal experiences, which could be influenced by their professional roles. For example, urban planners might highlight more organizational barriers, while ecology advisors might focus more on financial and social barriers. Additionally, this research did not take into account the possible differences in context among the five Dutch municipalities included in the interviews. Differences in municipal contexts could possibly influence the applicability of the findings. Without considering these differences, the generalizability of the results may be limited.

Secondly, the sample size and diversity of the data can present limitations for this research. 14 interviews have been conducted, this sample size might not be large enough to represent sufficient diversity, which increases the risk of biases in the results. Furthermore, the respondents were employees from the five largest municipalities in the Netherlands, this may not fully represent the experiences and perspectives of municipal decision-makers across different cities. These two aspects result in the limitation that the diversity of municipalities may not be fully captured, especially smaller scale cities are underrepresented in this research. Additionally, the literature review consisted of 25 relevant articles. Despite the carefully conducted systematic literature review using PRISMA guidelines, many articles were excluded from the literature review. Therefore, insightful information could be excluded from the research. Finally, the sample size of the validation meeting consisted of only three experts. Although these experts provided valuable insights, their feedback might not represent the overall perspectives of expert stakeholders involved in advising municipalities in urban greenery projects.

Furthermore, the results from the articles are based on studies within Europe, and the interviews are conducted only with Dutch municipalities. Therefore, the findings of this research might be too specific to the Dutch or European contexts. This can limit the applicability of the conclusions for cities in other regions with different contexts.

Finally, the complexity of applying the framework and enablers can cause potential limitations for this research. The identified enablers and the set-up of the identification framework might be complex and difficult for the stakeholders to use, especially if multiple departments or stakeholders need to collaborate for the successful implementation, as this is the biggest barrier identified. This research did not explore the specifics on how easy the results can be applied in practice.

5.4. Recommendations

Recommendations for future research result from the limitations, as well as new topics that can provide interesting areas for further research. Future research can add important missing details or can help to expand and build on the results from this research.

First, to improve the generalizability of the findings, future research can consider the different contexts of municipalities and the different professional roles of interview respondents. This

approach would enable a more detailed understanding of how specific municipal contexts, and the responsibilities of various roles might influence the results. By examining these factors, future research can determine whether the barriers, enablers, and proposed strategies are universally applicable or whether their relevance differs based on different urban contexts and roles. This would strengthen the applicability and generalizability of the findings for a broader range of municipalities.

Secondly, it would be valuable to explore the applicability and relevance of the findings from this research for smaller-scale cities. This would help to determine if the barriers, enablers, and strategies identified in this research are also applicable and effective for smaller and less urbanized cities. Additionally, future research that focusses on cities outside Europe could provide insights into how differences in, for example, culture and politics influence the decision-making process of implementing urban greenery. Exploring these topics could show how relevant the findings from this research are for cities outside the current scope, which can offer valuable insights into the applicability of the results.

The focus of this research is on implementing urban greenery on public land, owned by municipalities. However, there is also significant potential for implementing urban greenery on private land within cities. Future research could investigate how collaborations between municipalities and private parties could increase urban greenery on this private land. This could significantly increase the potential places for green areas in cities, which makes it an interesting topic for future research. Also, this research focusses on initiatives led by municipalities, further research could investigate the potential of greening initiatives led by other stakeholders. These future research topics can explore how successful these greening initiatives are to compare those results with the results from this research.

Another recommendation for future research would be to include different stakeholders in the interviews, focusing on stakeholders other than municipal employees. This allows future research to gather results from different perspectives. These different perspectives can provide other valuable insights into the barriers and enablers for urban greenery implementation, which may not be captured from the municipal perspective.

Furthermore, because 'Fragmentation in coordination and responsibilities' is identified in this research as the key barrier for effective implementation of urban greenery, future research could focus on identifying enablers or developing specific strategies that can mitigate this barrier. By exploring strategies to overcome this barrier, it is interesting to notice how this will impact the implementation of urban greenery.

A possible starting point for improving the coordination and collaboration could be through the implementation of the identification framework developed in this research. However, it is first necessary to conduct further research to evaluate the framework's applicability and relevance. Future research could explore whether this framework is effective for identifying barriers and enablers. The results from this study can serve as a foundation for future research to validate and improve the identification framework.

6. Conclusion

To address the challenges municipalities face during the decision-making of implementing urban greenery, this research identified the benefits, barriers and enablers that influence this decision-making. Additionally, this research explored how effective approaches can help municipalities to overcome these challenges. This chapter will answer the research questions, leading to a comprehensive answer to the main research question of this thesis.

The research started with exploring the benefits related to urban greenery by answering research question 1:

What are the benefits of urban greenery, and why is its implementation considered challenging for achieving these benefits?

The benefits of urban greenery are widespread and can be categorized into four categories: Climate adaption, Health and well-being, Biodiversity, and Economic. First, risks related to climate change such as heat stress, droughts and floods can be reduced by implementing greenery. The health and well-being benefits include both physical benefits, such as reducing noise, air and water pollution, and mental benefits such as reducing stress. For biodiversity the benefits will not only have effect on protecting the species but can also provide more habitats for the current and new species. Finally, implementing greenery can have a wide-spread effect on the economic situation in a city, by attracting tourism and increasing real estate values. While these results provides a complete overview of the relevant benefits for this research, additional specific benefits may be found if another detailed research is performed.

The process of implementing urban greenery, and at the same time achieving diverse benefits, is complex due to multiple factors, including the need for different types and scales of greenery, the physical characteristics of cities, socio-demographic preferences, and local contexts. These factors highlight that a one-size-fits-all approach is not efficient for the implementation of urban greenery. It is important that stakeholders implement tailored strategies to make sure that with implementing urban greenery the desired and necessary benefits are achieved.

Next to the benefits, the relevance of urban planning and decision-making processes for successfully implementing urban greenery is discussed by answering research question 2:

What is the role of urban planning and decision-making processes in the effective implementation of urban greenery?

The role of urban planning is to provide foundational guidelines for integrating urban greenery into cities, these long-term visions help to effectively navigate how and where cities should integrate urban greenery. Decision-making is seen as a crucial next step, as it translates these broad urban planning guidelines into practical, local plans. Therefore, without the relevant guidelines for urban greenery in place, this translation is difficult. Municipalities have the main responsibility for decision-making and executing urban planning at the local level. However, they face multiple challenges during this process which can lead to ineffective decision-making and unsuccessful implementation of urban greenery initiatives. Therefore, both effective urban planning and decision-making are essential to ensure that urban greenery is implemented successfully.

Furthermore, the barriers and enablers are identified, which answers research questions 3:

Which barriers and enablers influence the decision-making process of municipalities for implementing urban greenery, according to scientific literature and decision-makers?

The results of these questions indicate that municipal decision-makers experience a wide range of barriers and enablers. They are categorized into seven different categories, listed from most to least occurring: Organizational, Governance and Regulatory, Social and Psychological, Financial, Research and Knowledge, Spatial, Participation. In total 182 barriers were identified and further sub-categorized into 36 different types of barriers. The three barriers occurring the most are Fragmentation in coordination and responsibilities, Lack of funding and Limited space allocation. On the other hand, 110 enablers are identified, sub-categorized into 44 different types. The three most mentioned enablers are Community engagement, Raising awareness and Car restraint policies.

When comparing the results from the literature review and interviews, it becomes clear that there is a significantly overlap between the barriers identified in the literature review and in the interviews. The only remarkable difference is that the literature review identified many barriers related to Research and Knowledge, but these were almost not mentioned as barriers in the interviews. The reason for this difference can originate from the gap between theoretical perspectives and real-world experiences. The enablers show more variation between the findings from the literature review and interviews. The identified enablers are more unique and specific, which leads to less consistency in the responses. This reflects the difference in strategies, priorities, policies, and resources in municipalities. Therefore, the enablers represent practical actions that municipalities can adapt to their needs and priorities, in order to make them effective and relevant to their local context.

Following the identification of barriers and enablers, their connections are explored to answer research question 4:

How can the enablers be strategically matched with barriers to support municipalities in overcoming challenges related to urban greenery implementation?

This question investigated the possibility of matching the identified enablers to specific barriers, to give structured guidance to municipalities for overcoming the barriers and improve their urban greenery projects. However, formulating clear mitigation strategies proved to be a challenging task. Firstly, because the effectiveness of the mitigation strategies is highly dependent on the specific context of municipalities. Secondly, because of the interconnectedness of the barriers and enablers, making it difficult to identify a clear starting point for action. The interconnectedness indicates that addressing one barrier or enabler may influence others, potentially leading to increased positive outcomes when the right strategies are chosen. Therefore, this interconnectedness also highlights the flexibility of mitigation strategies, making them adaptable to the context of the municipalities. While this research provides an initial set of mitigation examples, municipalities should adapt these strategies to fit their specific context.

Next to the mitigation strategies, the research introduces a barrier and enabler identification framework. This framework presents the lists of barriers and enablers identified in this research, to guide municipalities through their specific urban greenery challenges. The framework can serve as a checklist for municipalities, to help them better understand the threat of the barriers they might face, but also the impact of the possible enablers. This can help them prioritize which barriers to address first. Municipalities are often not completely aware of the barriers and enablers, therefore using this framework can help raise awareness and improve the decision-

making. Additionally, the framework itself serves as an enabler by providing a structured approach to engage key stakeholders and align efforts across different departments, promoting more coordinated urban greenery initiatives.

Ultimately, combining the results of these four research questions, results in the answer to the **MAIN RESEARCH QUESTION** of this master thesis**:**

> *How can municipalities effectively overcome the challenges encountered in the decision-making process for implementing urban greenery?*

To effectively overcome the challenges in the decision-making process for implementing urban greenery, municipalities should recognize that there is no one-size-fits-all solution. Each municipality encounters different specific barriers and have unique circumstances. Therefore, it's important to consider the specific local context when addressing the challenges related to urban greenery implementation. However, addressing the most identified barrier 'Fragmentation in coordination and responsibilities' presents a strategic starting point for many municipalities, as this is the most occurring challenge. By addressing this barrier, decision-making processes can be improved through better collaboration and coordination, leading to more successful implementation of urban greenery. Additionally, the enabler Raising awareness is recognized as a multifunctional enabler, with the capacity to simultaneously influence multiple barriers, making it a valuable enabler for municipalities to enhance the impact of their strategies.

Consequently, the mitigation strategies for municipalities should be tailored to the specific context of each municipality. Therefore, it is important that municipalities are aware of the benefits, barriers, and enablers of urban greenery to make informed decisions. The provided overviews in this research support this awareness by offering a clear understanding of these elements and how they interact. Additionally, the identification framework for barriers and enablers provides a practical and valuable tool for municipalities, to guide them through their specific challenges. By using this framework, municipalities can better understand and address the barriers and enablers, which will enhance their decision-making processes. Ultimately this will improve urban greenery implementation, mitigating the complex challenges arising from climate change and urbanization, resulting in more livable and climate-adaptive cities.

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Appendices

Appendix A. Semi-structured interview

Appendix A1. Interview format and questions

Allereerst wil ik je nogmaals bedanken voor deelnemen aan dit interview. Voordat we beginnen wil ik vragen of je het goed vindt dat dit interview opgenomen wordt?

Ik zal beginnen met mezelf even voor te stellen; Ik ben Anouk Slomp en studeer Construction Management and Engineering aan de TU Delft. Ik ben momenteel bezig met mijn afstudeeronderzoek.

Mijn thesis gaat over het vergroenen van de openbare ruimte in steden, waarbij ik onderzoek hoe Nederlandse gemeenten met deze vergroeningsprojecten omgaan. Ik wil in kaart brengen hoe stedelijk groen effectief kan worden geïmplementeerd. Daarom ben ik vooral geïnteresseerd in de uitdagingen en succesfactoren die gemeenten tegenkomen bij het initiëren van vergroeningsprojecten. Van de vele vergroeningsprojecten die tegenwoordig door gemeenten worden uitgevoerd, richt ik mij in mijn onderzoek op kleinschalige projecten in de al bebouwde omgeving van de stad en niet op nieuwe grootschalige stadsprojecten.
Het doel van het onderzoek is, om met behulp van deze inzichten adviezen en strategieën te ontwikkelen die kunnen helpen bij een succesvolle implementatie van stedelijke vergroening.

Ik heb een aantal vragen opgesteld, deze wil ik graag aan je stellen. Als u eventuele aanvullingen of extra informatie heeft die u belangrijk vindt, is dat meer dan welkom. Heeft u verder nog vragen, anders kunnen we beginnen.

Inleiding:
1. Kunt u iets vertellen over uw rol binnen de gemeente en wat u precies doet met stedelijke vergroeningsprojecten?
2. Kunt u kort de huidige vergroening projecten beschrijven waaraan u/de gemeente werkt?
   Focussen op kleinere vergroening projecten, niet op grote (her)ontwikkelingen.

Stedelijke planning:
3. Wat zijn de belangrijkste stappen in het proces voor het initiëren van stedelijke vergroeningsproject in uw gemeente?
   Stuur het antwoord naar hoe de samenwerking en communicatie verloopt voor de projecten.

Uitdagingen en obstakels:
4. Wat zijn de belangrijkste uitdagingen of obstakels waar u tegenaan loopt bij het initiëren van vergroening projecten?
5. Hoe heeft u deze uitdagingen aangepakt; zijn er strategieën die effectief zijn gebleken?

Succesfactoren:
6. Wat zijn daarentegen de succesfactoren voor het initiëren van vergroening projecten?
7. Heeft u voorbeelden van succesvolle strategieën of initiatieven voor de vergroening projecten?

Doelen en vergroeningsvoordelen:
8. Wat zijn de primaire doelen van de vergroeningsprojecten; welke van de vele vergroeningsvoordelen willen ze bereiken?

Geleerde lessen en conclusie:
9. Op basis van uw ervaring, wat zijn enkele belangrijke lessen die u geleerd heeft om stedelijke vergroeningsprojecten succesvoller te maken?
10. Is er verder nog iets dat u wilt toevoegen over vergroening projecten vanuit de gemeente of uw eigen ervaringen?

Extra vragen:
1. Hoe wordt bepaald welke gebieden of projecten prioriteit krijgen om te vergroenen?
   Na vraag 3 of na vraag 7
2. Hoe sluiten de vergroening projecten aan bij de algemene stedelijke ontwikkelingsplannen van de gemeente?
   Na vraag 8
3. Welk advies zou u andere gemeenten geven om hun stedelijke vergroening projecten te verbeteren?
   Na vraag 9

Appendix A2. Informed consent form

You are being invited to participate in a research study titled 'Greenery Governance: Enhancing Decision-Making for Urban Green Development'. This study is being done by Anouk Slomp from the TU Delft, in collaboration with the company Brink.

The purpose of this research study is to gain understanding surrounding the difficulties and success factors in the implementation of urban greenery. The interview will take approximately 45 minutes to complete. The data will be used to assess the current state of urban greenery initiatives, identify barriers and enablers, and draw conclusions for future improvement strategies. I will be asking you to answer a series of questions based on your experience and knowledge in this field, focusing on the decision-making processes, and specific examples from municipalities' efforts in integrating greenery into urban environments.

As with any (online) research activity the risk of a breach is always possible. To the best of my ability your answers in this study will remain confidential. I will minimize any risks by having the interview data on my TU Delft OneDrive, using only job description (or reference to certain expertise) as information within the thesis. Collected personal data (name, email address, company name) will be kept in a secured file on the TU Delft OneDrive, it will not be published in any way, and it will be deleted after completing this thesis. Participants will be numbered and listed as 'Expert', 'Ecologist', 'Advisor, etc. Information will only be published on TU Delft repository; no external publishing will be performed.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to skip any questions. If necessary, data can be removed from the transcript, when asked, until the thesis is published in September.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: - The interview will be recorded (audio) and kept secure on the TU Delft OneDrive of the researcher, Anouk Slomp. - The information gathered will be transcribed using software and made anonymous. - The information mentioned in this interview will be referenced solely by 'Expertise' or 'Job description' in this thesis. - Recordings of original audio files will be destroyed after converting to text. - The interview transcription will not be inserted within the thesis itself.	☐	☐
4. I understand that I will not be compensated for my participation in this study	☐	☐
5. I understand that the study will end September 2024		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) (name contact information) and associated personally identifiable research data (PIRD) (job description, company name) with the potential risk of my identity being revealed.	☐	☐
7. I understand that some of this PIRD is considered as sensitive data within GDPR legislation, specifically company name and expert opinion on the topic.	☐	☐
8. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: - Contact information, name and company name will be kept secure in the TU Delft OneDrive of the researcher, Anouk Slomp. After completing the thesis, this information will be deleted. - This information will not be present in the thesis, the information will be anonymized. - Interview recordings (audio) will be deleted after transcription. The transcripts will be kept secure on TU Delft OneDrive of the researcher (Anouk Slomp) until end of thesis, these will not be published.	☐	☐
9. I understand that personal information collected about me that can identify me, such as my name and contact information, will not be shared beyond the study team.	☐	☐
10. I understand that the (identifiable) personal data I provide will be destroyed at thesis completion (September 2024).	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
11. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
12. I give permission for the de-identified transcript that I provide to be archived in TU Delft repository so it can be used for future research and learning.	☐	☐
13. I understand that access to this repository is only open to students and employees of the TU Delft, and additionally others in consultation with Responsible Researcher.	☐	☐

Signatures

_____   _____   _____
Name of participant [printed]   Signature   Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Anouk Slomp_____   _____   30-07-2024
Researcher name [printed]   Signature   Date

Study contact details for further information:

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Appendix B. Overview types of barriers and enablers

Appendix B1. Barriers

Table 11 presents the complete overview of the barriers identified in the literature review and interviews.

Category	Sub-category	Times mentioned	Mentioned by
Organizational	Fragmentation in coordination and responsibilities	24	Articles + Interviews
	Capacity constraints	6	Articles + Interviews
	Resistance to change	3	Articles
	Planning challenges	3	Interviews
	Unclear responsibilities for maintenance	2	Articles
	Lack of organizational alignment	2	Interviews
Governance and Regulatory	Political influence	12	Articles + Interviews
	Lack of supporting policies	9	Articles + Interviews
	Lack of regulatory standards	7	Articles
	Regulatory complexity	4	Interviews
	Lack of awareness or urgency by politicians	3	Articles
	Lack of political leadership	1	Articles
Social and Psychological	Conflicting perceptions	15	Articles + Interviews
	Lack of awareness	7	Articles + Interviews
	Uncertainty	3	Articles
	Lack of social urgency	1	Articles
	Safety concerns	1	Interviews
Financial	Lack of funding	18	Articles + Interviews
	Financial constraints for maintenance	10	Articles + Interviews
	Estimation and valuation difficulties	2	Articles
	Complexity of funding instruments	1	Articles
	Lack of a clear return on investment	1	Interviews
Research and Knowledge	Lack of knowledge	11	Articles
	Difficulty in quantifying benefits	3	Articles
	Lack of research	2	Interviews
	Knowledge-practice gap	2	Articles
	Abstract knowledge	1	Articles
	Lack of knowledge distribution	1	Articles
	Lack of localized knowledge	1	Articles
Spatial	Limited space allocation	18	Articles + Interviews
	Resistance to parking space removal	5	Interviews
Participation	Long participation process	3	Interviews
	Lack of community involvement	1	Articles
	Technical knowledge complexity in participation	1	Interviews
	Lack of trust in citizens	1	Interviews
	Maintenance neglect by citizens	1	Interviews

Table 11. Complete overview barriers

Table 12 presents the overview of the ten most mentioned barriers.

Sub-category	Times mentioned	Mentioned by
Fragmentation in coordination and responsibilities	24	Articles + Interviews
Lack of funding	18	Articles + Interviews
Limited space allocation	18	Articles + Interviews
Conflicting perceptions	15	Articles + Interviews
Political influence	12	Articles + Interviews
Lack of knowledge	11	Articles
Financial constraints for maintenance	10	Articles + Interviews
Lack of supporting policies	9	Articles + Interviews
Lack of regulatory standards	7	Articles
Lack of awareness	7	Articles + Interviews

Table 12. Ten most mentioned barriers

Appendix B2. Enablers

Table 13 presents the complete overview of the enablers identified in the literature review and interviews.

Category	Sub-category	Times mentioned	Mentioned by
Organizational	Collaborative governance models	6	Articles
	Early stakeholder involvement	5	Articles
	Proactive planning	4	Interviews
	Early-stage green integration	2	Interviews
	Integrated organizational approach	2	Interviews
	Management tools for horizontal coordination	1	Articles
	Coordinated strategic planning	1	Articles
	Mediatory agency	1	Articles
	Efficient project prioritization	1	Interviews
	Organizational capacity building	1	Interviews
	Leadership	1	Interviews
Governance and Regulatory	Regulatory changes	5	Articles
	Political support	5	Articles + Interviews
	Clear communication strategy	3	Articles
	Standardized regulations	3	Interviews
	Enhanced regulatory control	1	Articles
	Long-term policies	1	Articles
	Multi-level policy alignment	1	Articles
	Policy implementation alignment	1	Articles
	Multi-level policy alignment	1	Interviews
	Green-first approach	1	Interviews
Social and Psychological	Raising awareness	9	Articles + Interviews
	Develop common understanding	1	Articles
	Building support through trust	1	Interviews
	Social greening initiatives	1	Interviews
Financial	Innovative financial models	4	Articles
	Funding support	1	Articles
	Citizen engagement in funding	1	Articles
	Financial contribution private sector	1	Interviews
	Cost efficiency through standardization	1	Interviews
	Dedicated funding	1	Interviews
Research and Knowledge	Tools and frameworks for implementation	6	Interviews
	Knowledge exchange platforms	3	Articles
	Education programs	3	Articles
	Knowledge development	2	Articles
	Knowledge institutions involvement	1	Articles
Spatial	Car restraint policies	7	Articles + Interviews
	Multi-functional land use	1	Articles
Participation	Community engagement	11	Articles + Interviews
	Community-driven maintenance	3	Interviews
	Citizen engagement activities	2	Articles + Interviews
	Collaborative innovative approaches	1	Articles
	Qualitative participatory methods	1	Articles
	Different participation models	1	Interviews

Table 13. Complete overview enablers

Table 14 presents the overview of the ten most mentioned enablers.

Sub-category	Times mentioned	Mentioned by
Community engagement	11	Articles + Interviews
Raising awareness	9	Articles + Interviews
Car restraint policies	7	Articles + Interviews
Collaborative governance models	6	Articles
Tools and frameworks for implementation	6	Interviews
Early stakeholder involvement	5	Articles
Regulatory changes	5	Articles
Political support	5	Articles + Interviews
Proactive planning	4	Interviews
Innovative financial models	4	Articles

Table 14. Ten most mentioned enablers

Appendix C. Identification frameworks

These identification frameworks are based on the research of Deely et al. (2020). This research incorporates the identified barriers and enablers into these frameworks, offering a complete and comprehensive overview.

Appendix C1. Barrier identification framework

This framework can be used by stakeholders to identify the threat levels of barriers they might face when implementing urban greenery. By assigning a 'Threat level' in the right column, on a scale from None to High, the importance of these barriers can be clearly indicated. This will provide a better understanding of the possible challenges municipalities might face.

Category	Barrier types	Threat level
Organizational	Fragmentation in coordination and responsibilities Capacity constraints Resistance to change Planning challenges Unclear responsibilities for maintenance Lack of organizational alignment	*None/Low/Medium/High*
Governance and Regulatory	Political influence Lack of supporting policies Lack of regulatory standards Regulatory complexity Lack of awareness or urgency by politicians Lack of political leadership	*None/Low/Medium/High*
Social and Psychological	Conflicting perceptions Lack of awareness Uncertainty Lack of social urgency Safety concerns	*None/Low/Medium/High*
Financial	Lack of funding Financial constraints for maintenance Estimation and valuation difficulties Complexity of funding instruments Lack of a clear return on investment	*None/Low/Medium/High*
Research and Knowledge	Lack of knowledge Difficulty in quantifying benefits Lack of research Knowledge-practice gap Abstract knowledge Lack of knowledge distribution Lack of localized knowledge	*None/Low/Medium/High*
Spatial	Limited space allocation Resistance to parking space removal	*None/Low/Medium/High*
Participation	Long participation process Lack of community involvement Technical knowledge complexity in participation Lack of trust in citizens Maintenance neglect by citizens	*None/Low/Medium/High*

Table 15. Barrier identification framework

Appendix C2. Enabler identification framework

This framework can be used by stakeholders to assess the impact levels of enablers available for implementing urban greenery. By assigning an 'Impact level' in the right column, on a scale from None to High, the importance of these enablers can be clearly indicated. This will provide a better understanding of which enablers may be the most effective in mitigating the threats posed of barriers.

Category	Enabler types	Impact level
Organizational	Collaborative governance models Early stakeholder involvement Proactive planning Early-stage green integration Integrated organizational approach Management tools for horizontal coordination Coordinated strategic planning Mediatory agency Efficient project prioritization Organizational capacity building Leadership	*None/Low/Medium/High*
Governance and Regulatory	Regulatory changes Political support Clear communication strategy Standardized regulations Enhanced regulatory control Long-term policies Multi-level policy alignment Policy implementation alignment Multi-level policy alignment Green-first approach	*None/Low/Medium/High*
Social and Psychological	Raising awareness Develop common understanding Building support through trust Social greening initiatives	*None/Low/Medium/High*
Financial	Innovative financial models Funding support Citizen engagement in funding Financial contribution private sector Cost efficiency through standardization Dedicated funding	*None/Low/Medium/High*
Research and Knowledge	Tools and frameworks for implementation Knowledge exchange platforms Education programs Knowledge development Knowledge institutions involvement	*None/Low/Medium/High*
Spatial	Car restraint policies Multi-functional land use	*None/Low/Medium/High*
Participation	Community engagement Community-driven maintenance Citizen engagement activities Collaborative innovative approaches Qualitative participatory methods Different participation models	*None/Low/Medium/High*

Table 16. Enabler identification framework