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**Assessing Green Roof Policies in Leeuwarden:  
A Stakeholder-Based Examination to Identify Effective  
Approaches for Encouraging Adoption**

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## **Abstract**

This research focuses on the effectiveness of Leeuwarden's green roof policies and programs in relation to the city's governance structure. Significant environmental advantages of green roofs are outweighed by maintenance and cost challenges. The main research question of this study is: "Considering Leeuwarden's governance context, how can green roof policies and programs be more effective?" in order to identify recommendations that enhance green roof adoption in Leeuwarden. This involved investigating existing policies, governance challenges, and factors that can encourage installation. By addressing these issues and identifying effective solutions, the study aims to promote the widespread adoption of green roofs in the city. The data collection methods included semi-structured interviews with experts responsible for installing green roofs alongside extensive desk research. To guide this research, the Governance Assessment Tool (GAT), rooted in the Contextual Interaction Theory (CIT), was used as the overarching assessment framework. The results indicate the importance of improving collaboration and communication between actors, as there is low stakeholders' participation. It also identifies the limited involvement of upper governmental levels and the limited municipality's role in providing subsidies. Areas for improvement in the implementation of green roof policies and programs are identified based on the application of the GAT. The assessment highlights the need to improve current strategies and instruments, more effective collaboration between the government and other stakeholders, alignment of goals and perspectives, increased stakeholder involvement, and proper resource and responsibility allocation. Identified challenges include inadequate policies, insufficient stakeholder collaboration, reliance on subsidies, and financial constraints. The recommendations offered are increased involvement of higher governmental levels, encouragement of stakeholder participation, promotion of collaboration and trust, the establishment of clear goals, encouragement of adaptability, and allocation of adequate resources. Particularly, the municipality of Leeuwarden could promote the involvement of stakeholders to meet its sustainability objectives.

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# 1. Introduction

## 1.1. Background

As climate change and urbanization continue to affect cities, new challenges will arise. These challenges include the rise in peak precipitation (Getter, K., & Rowe, D., 2006), the need to conserve energy, generate renewable energy, prevent urban heat islands, and prepare for increased rainfall and water storage (van der Meulen, 2019). Numerous studies show that green roofs have advantages in addressing some of the problems (Tan et al., 2017). Recognizing its significance, several cities in the Netherlands have taken proactive measures, including Leeuwarden, the capital of the Dutch province of Friesland. This city is attempting to become more climate adaptive by 2035 (Gemeente Leeuwarden, 2020). Climate adaptation refers to the adjustments made to the economy, society, or environment in response to real or anticipated climate changes and their resulting effects (UNFCCC, n.d.).

A suggestion for adapting cities to climate change and for cooling urban areas is the use of growing vegetation on roofs known as "Green Roofs", which replace some of the vegetation that was destroyed when the building was built (Metselaar, 2012). When green roofs are compared to conventional roofs, green roofs enhance stormwater control by lowering runoff and enhancing water quality, save energy, reduce the urban heat island, lengthen the life of roofing membranes, lessen pollution in the air and noise, keep carbon, increase urban biodiversity by creating habitat for plants and animals, provide a more visually appealing setting for living and working, and increase return on investment (Rowe, 2011).

Green roofs are frequently considered in water-sensitive urban design systems, due to their potential to influence urban water runoff quantity and quality (Razzaghmanesh et al., 2014). Green roofs provide a retention capacity where water absorption is interim, and the slow runoff results in flood peak postponement (Lee et al., 2013). Source control of runoff is a key approach in European sustainable urban drainage systems (SUDS) and, more generally, in urban rainwater harvesting. Installing green roofs is regarded as a best management practice (BMP) to reduce runoff flows in urban areas (Razzaghmanesh et al., 2014). The municipality of Leeuwarden follows up on this last procedure by offering financial assistance to homeowners who install green roofs (Gemeente Leeuwarden, 2022).

## 1.2. Problem Statement

Literature indicates that green roofs provide numerous environmental advantages, such as enhancing biodiversity, postponing storm peaks to drainage networks, reducing water runoff volume, and cleaning air pollutants as well as runoff quality (Li & Yeung, 2014). Green roof implementation in several urban areas faces challenges, including high initial construction expenses, high maintenance costs, and roof leakage issues (Shafique et al., 2018). To develop effective policies that are well-received, it could be beneficial to seek input and understanding from relevant stakeholders regarding their viewpoints (Weible, 2006). To assess the policy from users' and stakeholders' perspectives. In order to tackle the aforementioned obstacles and encourage the implementation of green roofs in Leeuwarden, it is crucial to ascertain efficacious policies and strategies that can furnish incentives and assistance for proprietors, contractors, and other relevant actors.

### **1.3. Research Objective**

The objective of this study is to make recommendations for policies that will increase the adoption of green roofs in Leeuwarden and improve the general effectiveness of current regulations. This will be accomplished through investigation into various aspects of the city's green roof governance and identifying crucial elements that affect its adoption. Understanding current policies, challenges to their implementation, and elements that might encourage the widespread adoption of green roofs will be the main topics of the analysis.

This study seeks to answer multiple research questions to offer insightful analysis and policy suggestions to Leeuwarden decision-makers who are working to promote green roofs and create a more sustainable urban environment.

### **1.4. Research Questions**

The thesis attempted to answer the following research questions in order to achieve the research objective.

#### **Main Research Question:**

Considering Leeuwarden's governance context, how the green roof policies and programs can be more effective?

#### **Sub-questions:**

- 1- What policies and programs are currently in place in Leeuwarden for green roof implementation?
- 2- What governance challenges are hindering the green roof policy in Leeuwarden?
- 3- Based on the identified challenges, what governance factors can help to improve the installation of green roofs in Leeuwarden?

### **1.5. Thesis Outline**

After introducing the key elements of this study, Chapter 2 covers a literature review on green roofs, urban water retention, green roof adoption barriers, and the governance of green roof implementation. Chapter 3 describes the methodology, including research strategy, data collection, conceptual framework, data analysis, data triangulation and validation, and ethical consideration. In chapter 4, I delve into the case study location, describing the Leeuwarden's geographical context, green roof adoption, and the policies and incentives towards climate adaptation. Chapter 5 presents the findings from the interviews and content analysis, and include results from GAT, answering the sub-questions. This knowledge is translated into Chapter 6, which discusses and compares the results from previous studies with the case of Leeuwarden. Subsequently, interview results based on GAT are analyzed. Chapter 7 concludes the study, emphasizes its contribution, and reflects on the process, and ends with recommendations for improving green roof installation, research limitations and future research directions.



## 2. Literature Review

### 2.1. Green Roof History

Urban areas have had green roofs for more than a century, and they have become very important in recent years. They have historical roots that go back to the Roman Empire and other ancient civilizations like Babylon. With green roofs installed on more than 10% of homes, Germany is the global leader in green roof technology (Li & Yeung, 2014).

### 2.2. Green Roof Materials and Components

A green roof's various layers serve the same purposes as a natural soil: they provide the necessary nutrients, store water, allow for transpiration, and provide drainage in between (Lazzarin et al., 2005).

Green roofs typically have four layers of construction which can be seen in Figure 1. A protection layer directly above the roof construction serves to protect the roof from moisture. This layer includes some combination of waterproof membranes and root barriers. A drainage layer that may include small moisture-retention reservoirs and voids resides directly above the protection layer to allow excess moisture to flow out of the green roof and either into downspouts or some form of storage. The growing media (soil) layer resides above the drainage layer, usually separated by a dense mesh fabric cloth. This media layer is typically a light-weight combination of sand, aggregate, and organic matter (Sailor, 2008).

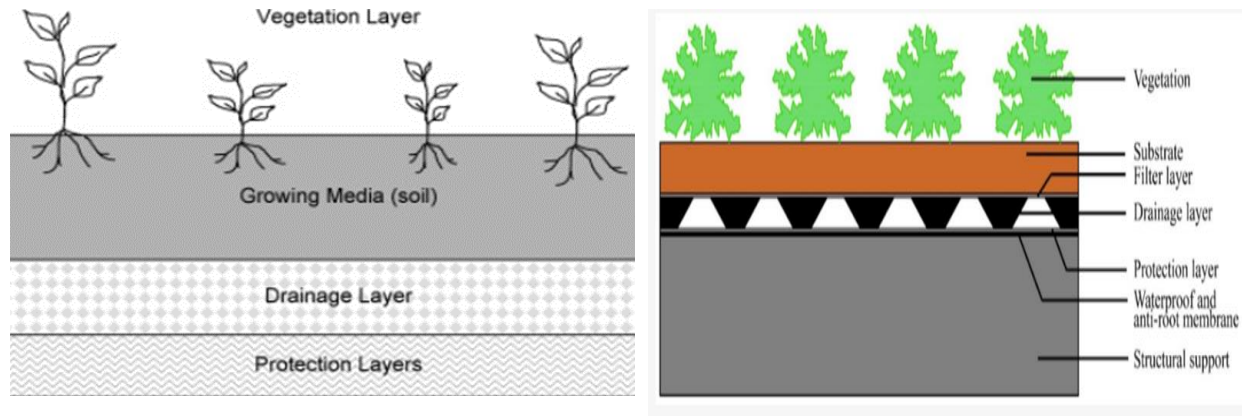


Figure 1: Green roof layers  
(Cascone, 2019; Sailor, 2008)

### 2.3. Type of Green Roofs

Intensive roofs and extensive roofs are the two categories under which green roofs have been classified. With a substrate depth of more than 20 cm, the former, which is thicker and heavier, can grow a broader range of vegetation, including small trees, shrubs, and bushes. However, extensive roofs require fewer resources and can support lighter plants (Saadatian et al., 2013).

## **2.4. Green Roof and Urban Water Retention**

Urban areas have experienced more floods recently as a result of urbanization (Talebi et al., 2019). Cities are mostly constructed of impervious materials like concrete, tarmac, and stone, which has a negative impact on rainwater storage and increases surface water runoff. Among others, wastewater overflows and increased runoff are caused by a lack of storage space, which leads to flash flooding. Green roofs have a specific role in reducing the wastewater systems pressure via two approaches: decreasing the amount of runoff and postponing the stormwater (Getter & Rowe, 2006). By decreasing the number of impermeable surfaces in built areas, green roofs can aid in reducing the possibility of storms and maximum water flow in urban areas. (Graceson et al., 2013).

The extent of green roof impact on decreasing the stormwater runoff depends on the soil substrate's depth, the amount of water in it, the amount of precipitation, or the pattern of precipitation over the study duration. It might also depend on the slope, vegetation, and other factors such as roof age. Due to varying study conditions (e.g., weather) and varying numbers of incidents (study duration) that were taken into account to determine the storage amounts, it is difficult to evaluate precise runoff decreased values (given as a percentage of precipitation) (Berndtsson, 2010).

## **2.5. Green Roof Adoption Barriers**

Academic literature has identified different types of barriers that prevent the adoption of green roofs. According to Zhang, G. & He, B. (2021), a number of factors, including a lack of government policy, outdated technology, incorrect economic benefit estimates, and individual unwillingness, can limit green roof installation. Sangkakool et al. (2018) identified three main variables that affect the potential for green roofs in Thailand to spread. While their ability to reduce urban heat islands is the most crucial facilitating factor, inadequate financial support, as well as a skilled labor shortage, pose significant implementation barriers (Sangkakool et al., 2018). Two studies on green roof adoption in Malaysia revealed that only a small number of buildings currently have green roofs, which is a low installation rate. According to this two research, there are nine factors that contribute to the slow adoption rate of green roofs, including a lack of internal expertise, a lack of instructions, a lack of government motivations, the difficulty of installation and maintenance, the cost of materials, failure in the past, and the risk of fire (Ismail et al., 2012; Sanmargaraja et al., 2019).

In the study area of Lagos, Nigeria, there are also a number of obstacles preventing the widespread use of green roofs, including higher building and upkeep costs, a lack of government legislation, inadequate government motivation, and a lack of technical knowledge and skills. The study discovered that approaches like suitable government policy, government-driven incentives, and supporting research and development in green roofs should be used to promote the adoption of green roofs in the study area. Overall, the government should be at the forefront of promoting the adoption of green roofs through guidelines and motivation given the public benefits of these structures (Berndtsson, 2010).

Zhang et al. (2012) found that the most commonly mentioned constraints in implementing green roof systems were “lack of promotion from the government and social communities among the public and private sectors,” “lack of incentive from the government towards the owners of the existing buildings,” and “increase in maintenance cost.” These constraints are encountered throughout the entire building life cycle, from design and planning to upkeep and administration, and are closely correlated with the inadequacy of government policy. The authors suggest that the

government should provide proactive support by implementing relevant policies and regulations to encourage the implementation of green roof systems (Zhang et al., 2012).

Based on the previous research, it can be stated that various barriers, such as lack of government policy, inadequate financial support, and concerns about cost and maintenance can hinder the adoption of green roofs. The government's proactive support is needed to promote the adoption of green roofs through relevant policies, regulations, incentives, and research and development. The promotion and adoption of green roof systems also require a holistic approach that addresses the obstacles throughout the entire building life cycle, as government policy is a crucial factor in promoting the adoption of green roofs. Hence, my research aims to provide recommendations that can support the policymakers in enhancing the adoption of green roofs in Leeuwarden and making current policies more effective by identifying current policies and programs' implementation challenges.

## **2.6. Governance of Green Roof Implementation**

Green roofs are considered to decrease the percentage of the adverse environmental impacts of urbanization. Different policies around the world have been developed to promote their installation, and several studies have been conducted globally to evaluate their impacts.

Governments are frequently regarded as the main source for the creation and execution of policies. They play a key role in creating, executing, and applying policy instruments; however, they cannot function alone and require a variety of governance plans. Successful policies typically incorporate input from a wide range of stakeholders throughout the policy process. Both the private sector and social performers participate actively in the creation and execution of policy at all levels of government. The duties and obligations are distributed across all levels of governance as well as between governmental and non-governmental institutions (Jacob and King, 2019).

Most scholarly literature recommends integrating a multiplicity of ingredients in the policy mix, which is crucial to reaching out for an effective policy to stimulate green roofs. Among the mentioned ingredients are direct and indirect financial incentives, mandatory laws and regulations, and recognition of environmental benefits and reduction of risks, which might also be described as sharing knowledge and raising awareness. Table 1 presents green roof regulatory measures.

Wilkinson et al. (2022) analyze the strategies used by international cities (London, Singapore, Rotterdam and Stockholm, Sydney and Melbourne) to increase the implementation of green roofs. Detailed analysis and location visits, and qualitative techniques were used in the study to compare the effectiveness of mandatory and voluntary approaches. The most effective strategy was used in Singapore, which combined financial incentives with a largely voluntary program. The bylaw strategy for new construction with a minimum gross floor area of 2,000 m<sup>2</sup> adopted by Toronto, came in second. The City of London program, which used a fully voluntary approach and a more free-market scenario, was ranked third in terms of effectiveness. The voluntary strategy used in Rotterdam had more generous tax breaks and subsidies. At last, Green Space Factor (GSF) did not have sufficient time in Stockholm to assess its success in promoting the adoption of green roofs. This analysis demonstrates how complicated our cities and their societies are, making it oversimplified to claim that a voluntary or mandatory approach will always result in more living architecture. Globally, city authorities can either green roofs mandate or take a market-led voluntary approach, in which the market decides whether to install.

Table 1: Green roof regulatory measures  
(Liberalesso et al., 2020; Shiah, 2011)

Policy measures	Regulatory and Incentive Measures	
Direct Incentives	Financial aid Wave fees Bonusing based on the density Streamlining with a fast-track	Tax reductions <ul style="list-style-type: none"> <li>• Tax property</li> <li>• Storm water fee</li> <li>• Other tax reduction</li> </ul> Financing <ul style="list-style-type: none"> <li>• Subsidies</li> <li>• Reduction of interest rate</li> </ul>
Indirect Incentives	Utility fees are being diminished	Sustainability certification Agile administrative process
Regulatory Requirements	Land boundaries, permits, and minimum requirements Land scaping requirements Omitting of restricting regulations Make green roofs mandatory for public buildings	Obligation by law Construction permit

Chen et al. (2022) collected information from various sources, including 124 green roofs rewards policy texts from 88 towns and an eight-country dataset of green roof spatial distribution. ArcGIS Pro was used for spatial analysis, and word frequency analysis was used to examine various incentive policies. The findings revealed that there is a noticeable imbalance in the division of green roofs in towns, along with major regional variations and clustering characteristics in water systems, and that most cities lack a wide variety of incentives for installing green roofs. Governments or non-government organizations have favored two kinds of promotions: obligatory laws and regulation, along with funding (subsidy, grant, or rebate). Green roofs require an evaluation system, and the evaluation criteria ought to demonstrate variety and regionality, considering how green buildings are supported.

Shiah et al. (2011) discusses municipal green roofs policies and programs and how they differ based on the environment, politics, social factors, and resource availability. This study looked at different green roof policies, including those in Toronto Portland, and Chicago, and took lessons from them. Table 2 outlines the seven steps for installing green roofs in towns with limited green space.

Table 2: Steps for installing green roofs in towns with limited green space  
(Shiah, 2011)

Step 1	Raising public awareness of green roofs
Step 2	A community engagement pilot project for a green roof
Step 3	Development of a city's green roof program and policies
Step 4	Ongoing technical advancement of green roofs
Step 5	Municipal demonstration projects with prominent green roofs for buildings used for public use.
Step 6	Municipality support in the form of training and technical programs
Step 7	Implement green roof initiatives and regulations such as permitting density rewards, energy-saving programs, expedited green building approval processes, grants and direct investments, regulatory actions, loans with low interest rates, and tax

According to Savarani (2019) cities all over the world have recently adopted a variety of strategies to encourage green roofs adoption. Legislation mandating the adoption of green roof has been passed in several cities, including Copenhagen, San Francisco, and Toronto, for new building development or renovations. Washington, DC, among other cities, offers tax credits or rebates for green roof installation projects. Some other cities, such as Austin and Portland, have changed their zoning regulations to offer density rewards or other zoning rewards to builders who go after green roof projects. At last, those who install green roofs may qualify for stormwater fee reductions from some cities such as Minneapolis, Nashville, Philadelphia, Portland, Washington. This study divided policies into six different categories. A green roof should be installed situations, like when a new structure is constructed or an existing building is renovated, in the cities listed under "Green Roof Mandates." Cities that offer green roofs as a choice for complying with general green construction or sustainability policies and regulations yet do not particularly obligation they are classified as "Sustainability Mandates." Cities that provide tax incentives or refunds to residents who set up green roofs are listed in the third category, Rebates, Tax Abatements, and Refunds. Cities that provide density and Floor Area Ratio (FAR) incentives to designers who go after green roofs are listed in the fourth category, Zoning Incentives. The fifth category, Grant & Loan Programs, lists cities that provide full or partial funding for green roof development in the form of grants or loans. Finally, cities that offer credits toward sewer fees in exchange for installing green roofs are listed in the sixth category, Reduction in Stormwater Charges (Savarani, 2019)

Shafique et al. (2018) discusses the policies implemented by various countries to promote the application of green roofs in urban areas. These policies include bonuses or reductions in water or property fees to encourage residents to install green roofs for environmental reasons. Different countries have recommended laws and policies to promote green roofs, such as Japan, Switzerland, Canada, and the United States. These policies provide incentives for building owners to apply green roofs, such as receiving repayment for a percentage of the total cost of the green roofs or a decrease in property fees for every square foot of green roof applied (Shafique et al., 2018)

Ngan (2004) discusses different types of policy approaches related to green roofs in Germany as one of the most successful countries in this regard:

**Incentives:** Cities such as Berlin and Hamburg provide financial incentives to encourage the installation of green roofs. These incentives can include grants, tax breaks, or subsidies, which assist with reducing the initial costs and make green roofs feasible for building owners.

**Guidelines:** Green roof design, construction, and maintenance guidelines are provided by government agencies and local governments in cities such as Frankfurt and Cologne. These guidelines serve as a resource for architects, engineers, and building owners to ensure that green roofs are properly installed and meet certain standards.

**Planning regulations:** green roofs have been incorporated into the urban planning regulations of cities such as Leipzig and Freiburg. These regulations may require a certain percentage of rooftop space to be allocated for green roofs, ensuring that sustainable design practices are integrated into the urban landscape.

**Public projects and demonstration sites:** Cities such as Düsseldorf and Nuremberg have established government-funded public projects and demonstration sites to demonstrate the benefits and feasibility of green roofs. They aim to raise public awareness, educate the public, and encourage private building owners to consider green roofs.

These policies, which have been implemented in a number of German cities, aim to foster a favorable environment for the widespread adoption of green roofs by encouraging sustainable design practices and contributing to environmental sustainability. (Goya Ngan, 2004)

The analysis of 143 green infrastructure incentive policies from 113 cities around the world is covered by Liberalesso et al. (2020), who also note that Europe and North America have the highest concentration of these policies. Financial subsidies and legal obligations are the most prevalent types of incentives, with the latter being the second most common globally. Additionally, the text offers instances of obligation by laws from South America, North America, and Asia. Green infrastructure installation can be encouraged by incorporating various incentive policies. Cities worldwide can develop effective policies by learning from successful green infrastructure incentive programs (Liberalesso et al., 2020)

As can be seen, the effectiveness of the green roof policies varies depending on the local conditions. I will discuss these key findings to identify knowledge gaps, and my research directions to enhance our understanding of the most effective policy mechanisms for promoting the adoption and performance of green roofs.

In summary, this preliminary literature review included various green roof policies and their effectiveness in encouraging installation. The preliminary literature review will be reworked into systematic and far more comprehensive literature in the course of this research plan roof being implemented. This will offer concepts, typologies, and perspectives on the outcomes of various policies and contextualize my research on green roofs in Leeuwarden.

## **3. Methodology**

### **3.1. Research Strategy**

This research is qualitative, structured interviews were conducted with several experts responsible for the processes of green roofs installation. These experts were identified based on their expertise in the municipality and academia.

### **3.2. Data Collection**

Different methods were conducted because information from a desk research and interviews with relevant stakeholders was combined. Once answers to each sub-question are obtained, a precise answer to the main question will be obtained. Data collection methods used for answering each sub-question is shown in Table 3.

#### **3.2.1. Desk Research**

The research data for this study was gathered using two steps. For the first step, a comprehensive review of reports, policy documents, and relevant websites was conducted using search engines Scopus and Google Scholar. The search period covered two months (from April to May 2023). The research terms used to narrow down and target relevant sources related to the research were: green roof laws and policies, urban water retention, green roof adoption barriers, mandatory or voluntary approaches to green roofs, nature-based solutions in urban areas, and economics of green roofs. This approach allowed me to gather information and existing insights, making the process more thorough.

#### **3.2.2. Interviews**

Semi-structured interviews were conducted to collect qualitative data about how stakeholders in Leeuwarden assess the green roof policy. Participants in semi-structured interviews are free to express their opinions and provide in-depth responses while still giving the conversation a structure.

The interviewees have the chance to elaborate on their answers and offer their opinions on how policies and green roofs should be implemented. Based on the research questions, the GAT, the literature review, and in consultation with the supervisor, the interview questions were developed (Appendix B).

Table 3: Data collection methods per sub-question

Sub-questions		Data collection method	Explanation
1	What policies and programs are currently in place in Leeuwarden for green roof?	<ul style="list-style-type: none"> <li>• Desk research</li> <li>• Interview</li> </ul>	<ul style="list-style-type: none"> <li>• Identify stakeholders involved in green roof implementation.</li> <li>• Assess problem perspectives and goals using the GAT, informed by experts input and online resources.</li> <li>• Analyze strategies and tools employed, incorporating insights from interviews and online data.</li> <li>• Examine responsibilities and resources using the GAT, integrating experts interviews and information from Municipality's websites and policy documents.</li> </ul>
2	What governance challenges are hindering the green roof policy in Leeuwarden?	<ul style="list-style-type: none"> <li>• Interviews</li> <li>• Revision of secondary sources</li> </ul>	<ul style="list-style-type: none"> <li>• Conduct interviews with local stakeholders, including policymakers, business owners, and residents, to gather their perspectives on the effectiveness of green roof installation.</li> <li>• Seek suggestions from stakeholders on how to improve the green roof installation in Leeuwarden.</li> <li>• Assess the extent to which various problem perspectives are considered in the existing green roof policy using the GAT.</li> <li>• Examine the alignment and support among different perspectives and goals within the policy framework, utilizing the GAT.</li> <li>• Identify opportunities to reassess goals and explore the potential for optimizing multiple objectives using the GAT.</li> <li>• Evaluate the disparity between goal ambitions and the current status quo or business-as-usual practices in Leeuwarden, leveraging the GAT.</li> </ul>
3	Based on the identified challenges, what governance factors can help to improve the installation of green roofs in Leeuwarden?	<ul style="list-style-type: none"> <li>• Analyzing interviews and best practices research</li> <li>• Comparative analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Utilize the GAT to perform a comparative analysis of green roof policies and programs in Leeuwarden, considering the Levels &amp; Scales.</li> <li>• Incorporate stakeholder perspectives, ensuring the inclusion of diverse viewpoints, and integrating the Actors &amp; Networks using the GAT.</li> <li>• Develop recommendations based on the analysis of stakeholder insights, best practices, comparative analysis, and cost-benefit analysis, guided by the GAT.</li> <li>• Enhance the implementation of green roofs in Leeuwarden by ensuring a comprehensive evaluation of the governance framework, addressing the Responsibilities &amp; Resources, in coordination with the GAT.</li> </ul>



A total of seven people were interviewed, including five experts at the municipal level, one expert from the waterboard and one from the academia (who was also a green roof owner) The stakeholders who were interviewed are presented in Table 4, along with their respective expertise.

Table 4: Interviewee stakeholders

Stakeholder Category		Organization	Description
Expert 1	City Government	Municipality	Sector Sustainable Environmental Quality   Team Advice & Development
Expert 2		Municipality	Alderman of Leeuwarden for energy & climate, circular economy, mobility, nature, agriculture, heritage, and real estate
Expert 3		Municipality	Former alderman of Leeuwarden for energy & climate, circular economy, mobility, nature, agriculture, heritage, and real estate
Expert 4		Municipality	Neighborhood Affairs Sector- Responsible for providing subsidies in Leeuwarden Municipality
Expert 5		Municipality	Booster Team Climate Active Zwolle   partner of Climate Campus
Expert 6		Waterboard	Spatial planner at Wetterskip Fryslan
Expert 7	Academia	University of Twente	Ph.D. student (with green roof thesis) and owner of a green roof in Leeuwarden

### 3.3. Conceptual Framework

Since my study will be based on the perceptions of stakeholders from a governance perspective, my selection focuses on a framework that looks at perceptions and opinions of stakeholders. Due to its application in the European and more specifically the Dutch context, I have selected the GAT, rooted in the Contextual Interaction Theory (CIT). The GAT has been used in this research to comprehend the governance context for the processes in the chosen case.

CIT and GAT are appropriate for this research because they provide a theoretical framework as well as a practical tool for analyzing the governance context, stakeholder dynamics, and factors influencing the effectiveness of Leeuwarden's green roof policies. These approaches will enable us to gain insights, identify challenges, and make recommendations for increasing the use of green roofs and improving current policies in the Leeuwarden context.

Stakeholder characteristics are considered in the CIT, with an emphasis on individuals and their related processes. According to CIT, the characteristics of the various process stakeholders can be used to understand multi-actor processes. These qualities include resources (capacity and power), cognitions (how they interpret the situation), and motivations (what drives their actions) (Lordkipanidze et al., 2020).

The expression "motivation" In the framework of CIT encompasses the actor's individual motivation, character, and mindset as well as their specific relationship to potential sources of outside pressure. The significance of the issue to each of the parties involved (implementers and

targets) determines the effectiveness of the implementation. Actors will disregard the policy if they do not believe it to be vital or do not have enough drive to do so (Javakhishvili & Jibladze, 2018). The actors engaged should have sufficient knowledge of the policy that is being used for it to be effectively implemented. Power in the CIT model is equivalent to resources like money, people, and time, as well as capacity and control (Javakhishvili & Jibladze, 2018).

A significant barrier to implementation is the shortage of resources. The CIT emphasizes the implementation of policies, a dynamic and collaborative process in which the actors can be both those who implement or target people. Encouraging is the responsibility of the implementers, according to Bressers and colleagues, who view the policy as a project that can or cannot be carried out (Javakhishvili & Jibladze, 2018). Stakeholders are affected by numerous outside variables from a complex context in addition to being intrinsic to the actors and the process. The aforementioned context includes a structural, wider, and a specific layer (See Figure 2).

The specific context includes elements like, for instance, the geographical features of the location where the project takes place, as well as other factors like the case history or previous choices. This creates a theoretical basis for the process that affects which actors take part, how much they engage, and with what legal requirements and sources. The structural context is the next layer, which is what the GAT focuses on. In broader contexts, political system characteristics, as well as cultural, economic, and technological development, are present (Lordkipanidze et al., 2020).

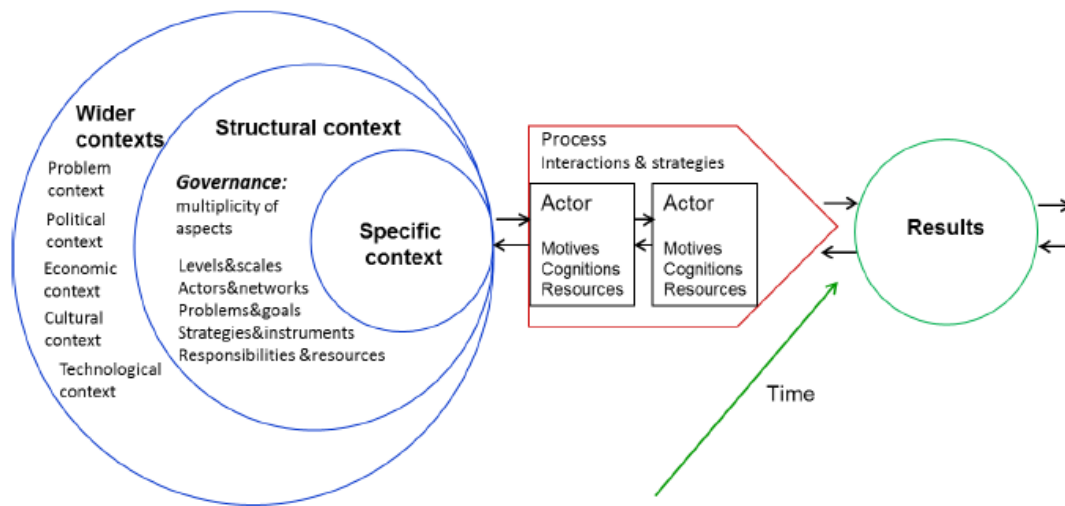


Figure 2: Multi-layered contexts of the CIT (Lordkipanidze et al., 2020)

The CIT can be useful in addressing my research questions by providing a framework for understanding how communication and interaction between various stakeholders (e.g., policymakers, program implementers, residents, and experts) shape the policies and programs related to green roofs in Leeuwarden. Moreover, CIT can help to provide a comprehensive understanding of the contextual factors that influence the implementation of green roof policies and programs in Leeuwarden and provide recommendations for improving communication and interaction between stakeholders to promote the success of these initiatives.

### 3.3.1. Governance Assessment Tool

The GAT is used to assess the degree to which the governance context is supportive or restrictive for the realization of chosen policies and projects. It is rooted in the Contextual Interaction Theory, which studies operational decision-making and implementation processes from three actor characteristics: motivation, resources, and cognition. The tool is designed to systematically describe what the governance context looks like and identify the factors that influence it. It poses guiding questions to help assess the governance context (Bressers et al., 2016).

GAT separates the semi-normative characteristics and the descriptive-analytical components of the governance context. The five descriptive-analytical components, multi-level, multi-actor, multi-faceted, multi-instrument, and multi-resource based are referred to as the “dimensions of governance”. The above five parameters define the governance system and are the criteria used to rate the effectiveness of the governance. The term “semi-normative” denotes that the normative contents of the qualities are derived from and dependent upon the policies that are being evaluated (Casiano Flores et al., 2021). Extent, coherence, flexibility, and intensity are the four semi-standard characteristics. In combination, the dimensions and characteristics evaluate how favorable the environment is for putting the policies for research into practice. By asking questions, the four criteria are defined.

Government assessment tool matrix is demonstrated in Table 5 which contains of five dimensions and 4 criteria. The following make up the five governance dimensions of GAT (Bressers et al., 2016).

1. Levels and scales: considering that all scales have a general multi-level nature (which need not be administrative; it could refer to spatial, hydrological, or political scales).
2. Actors and networks: considering a multi-actor role for the appropriate network or networks.
3. Problem perceptions and goal ambitions: considering a multifaceted identity for issues and objectives.
4. Strategies and instruments: considering a multi-functional character for the actors’ strategy.
5. Resources and responsibilities: considering a complicated multi-resource implementation basis

The questions they ask help to define the four criteria (Bressers et al., 2016):

1. Extent: Are all five dimensions taken into consideration that apply to the project being targeted?
2. Coherence: Do the components of the measurements of governance work in harmony rather than in opposition to one another?
3. Flexibility: Are several paths to reaching them allowed, encouraged, and supported by considering opportunities and threats as they present themselves?
4. Intensity: “How strongly do the elements in the dimensions of governance urge changes in the status quo or in current developments?”

The four criteria are specified with specific questions for each of the five dimensions of governance, resulting in a matrix of assessment for the green roof adoption in Leeuwarden. This matrix serves as the GAT’s central component.

Table 5: The government assessment tool matrix with its main evaluative questions

(Bressers et al., 2016)

<b>Government Dimension</b>	<b>Extent</b>	<b>Coherence</b>	<b>Flexibility</b>	<b>Intensity</b>
<b>Levels &amp; Scales</b>	How many levels are involved and dealing with an issue? Are there any important gaps or missing levels?	Do these levels work together, and do they trust each other between levels? To what degree is the mutual dependence among levels recognized?	Is it possible to move up and down levels (upscaling and downscaling) given the issue at stake?	Is there a strong Impact from a certain level toward behavioral change or management reform?
<b>Actors &amp; Networks</b>	Are all relevant stakeholders involved? Are there any stakeholders not involved or even excluded?	What is the strength of interactions between stakeholders? In what ways are these interactions institutionalized in stable structures? Do the stakeholders have experience in working together? Do they trust and respect each other?	Is It possible that new actors are included or even that the lead shifts from one actor to another when there is pragmatic reason for this? Do the actors share in ‘social capital’ allowing them to support each other’s tasks?	Is there strong pressure from an actor or actor coalition towards behavioral change or management reform?
<b>Problems Perspective &amp; Goal Ambitions</b>	To what extent are the various problem perspectives considered?	To what extent do the various perspectives and goals support each other or are they in competition or conflict?	Are there opportunities to reassess goals? Can multiple goals be optimized in package deals?	How different are the goal ambitions from the status quo or business as usual?
<b>Strategies &amp; Instruments</b>	What types of instruments are included in the policy strategy? Are there any excluded types? Are monitoring & enforcement included?	To what extent is the incentive system based on synergy? Are trade-offs in cost benefits and distributional effects considered? Are there any overlaps or conflicts of incentives created by the included policy instruments?	Are there opportunities to combine or make use of different types of instruments and is there a choice?	What is the implied behavioral deviation from current practice and how strongly do the instruments require and enforce this?
<b>Responsibilities &amp; Resources</b>	Are all responsibilities clearly assigned and facilitated with resources?	To what extent do the assigned responsibilities create competence struggles or corporation within or across institution? Are they considered legitimate by main stakeholders?	To what extent is possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?	Is the number of allocated resources sufficient to implement the measures needed for intended change?

### 3.4. Data Analysis

To derive valuable insights and address the research objectives, the data from semi-structured interviews and document review were rigorously analyzed. In order to provide a thorough understanding of stakeholders' perceptions and preferences regarding green roofs and related policies in Leeuwarden, the data analysis used qualitative approaches.

The research questions of this study have been analyzed through the lens of CIT and with the assistance of GAT in the following way:

*What policies and programs are currently in place in Leeuwarden for green roofs?*

In order to promote the use of green roofs, this question focuses on the physical environment in Leeuwarden as well as the policies and programs already in place. By asking this question, I can learn more about the actual environment in which green roof installation takes place as well as the laws and regulations that might have an impact on it.

For assessing green roof initiatives and policies in Leeuwarden, I use the GAT. It assesses the governance dimensions, through qualities. By looking at the levels and stakeholders involved, the strategies and instruments used, and the distribution of responsibilities and resources, people can use the GAT tool to gain an in-depth comprehension of the effectiveness of current policies. Policymakers, researchers, and other stakeholders involved in green roof initiatives can learn a lot from this assessment.

*What governance challenges have been identified that hinder the green roof policy in Leeuwarden?*

The social environment in Leeuwarden and the stakeholders involved in the installation of green roofs are the main topics of this question. By answering posing this question, I can better comprehend the governance environment in which green roof installation occurs, as well as the perspectives of stakeholders who might have various interests or concerns regarding green roofs. The GAT can be used to fully comprehend the governance problems preventing Leeuwarden from putting its green roof policy into practice.

*Based on the identified challenges, what governance factors can help to improve the installation of green roofs in Leeuwarden?*

This inquiry focuses on the cultural environment in Leeuwarden as well as the practices and concepts surrounding the implementation of green roofs. By posing answering this question, I can gain a deeper comprehension of the governance environment in which green roof installation occurs as well as any chances or potential barriers to enhancing the adoption of green roofs.

The improvement of the installation of green roofs in Leeuwarden depends on governance factors. These factors can be recognized and methodically addressed using GAT. With the help of the GAT, which offers a structured framework for evaluating and improving governance-related aspects, Leeuwarden's green roof installation can be improved with the help of recommendations and strategies based on solid data.

### 3.5. Data Triangulation and Validation

Data triangulation and validation strategies were meticulously employed in this thesis to enhance the credibility and reliability of the research findings. This involved the use of multiple data sources and methodologies to corroborate and validate the study's outcomes.

**Triangulation of Data Sources:** Primary data from in-depth interviews and secondary data from literature reviews and documents were combined to provide a comprehensive understanding of the research context. This approach ensured a well-rounded perspective on green roof initiatives in Leeuwarden.

**Methodological Triangulation:** Two distinct analytical methods, Contextual Interaction Theory (CIT) and the Government Assessment Tool (GAT), were utilized. CIT uncovered qualitative insights from interviews, while GAT quantitatively assessed governance dimensions. Their integration provided a comprehensive analysis.

**Cross-Validation and Convergence:** Findings from CIT and GAT analyses were cross validated to ensure consistency. Comparing and contrasting insights from these methods enhanced the robustness of interpretations and conclusions.

**Peer Review and Expert Feedback:** External validation was sought through peer review and expert feedback. Their input enriched the analysis process and contributed to more accurate results.

**Limitations and Reflexivity:** Researchers' potential biases were acknowledged and managed through reflexivity. Regular documentation and reflection on perspectives ensured the research-maintained objectivity.

Through these rigorous validation techniques, the study aimed to provide a trustworthy and comprehensive analysis of the governance dynamics surrounding green roof initiatives in Leeuwarden.

### 3.6. Ethical Considerations

In my research, I followed the ethical guidelines for social sciences and the standards set by the MEEM program of the faculty of BMS at the University of Twente. Human participation in the research was obtained through the interview process. I recorded the interviewees' responses to ensure smooth data collection and analysis. I considered all relevant privacy issues and fully informed the interviewees, obtaining their consent for the interviews.

Prior to participating in the study, all survey participants were requested to provide informed consent (Appendix A). They were also informed of their right to withdraw from the study at any time without penalty. Before the interview, I sent the questions and consent forms to all interviewees via email to facilitate question review and consent. They verbally agreed to participate in the interviews, use the data for research purposes, record the interviews, and anonymize their names.

## 4. Case Study Location: Leeuwarden

### 4.1. Geographical Location

The Dutch province of Fryslan’s capital city, Leeuwarden, is on track to become more climate adaptive by 2035, as many cities around the world are currently working to become more climate adaptive. Due to its location between the higher elevation of the lands in Fryslan’s eastern region and the high area of the Wadden Sea coast on the west side, Leeuwarden faces some difficulties. As demonstrated in Figure 3, due to its geographic location, Leeuwarden, in particular, plays the role of a “bathtub,” periodically receiving water discharge from both the west and east areas (Groen Blauwe Diamant, 2023).

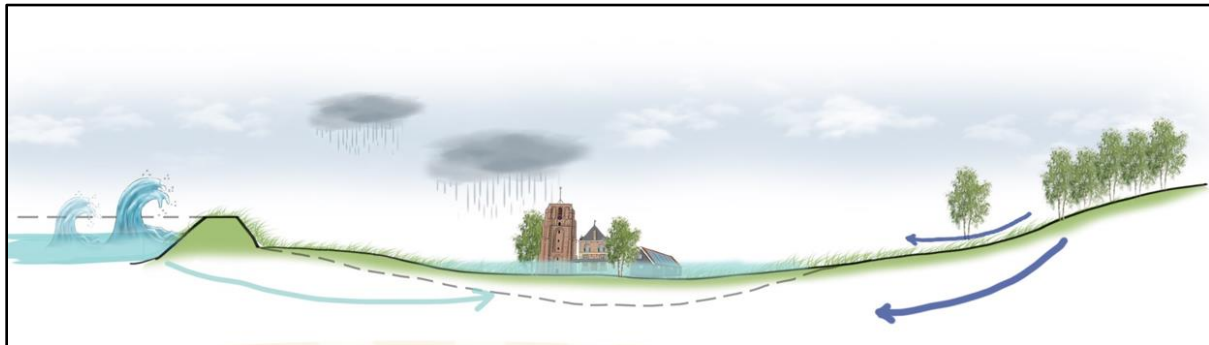


Figure 3: Fryslan’s role as a “bathtub”  
(Groen Blauwe Diamant, 2023)

Leeuwarden is a mid-size city with 238.4 km<sup>2</sup> area, and estimated population of 127,088 (City Population, 2023). The location of Leeuwarden in relation to the Wadden Sea can be seen in Figure 4.

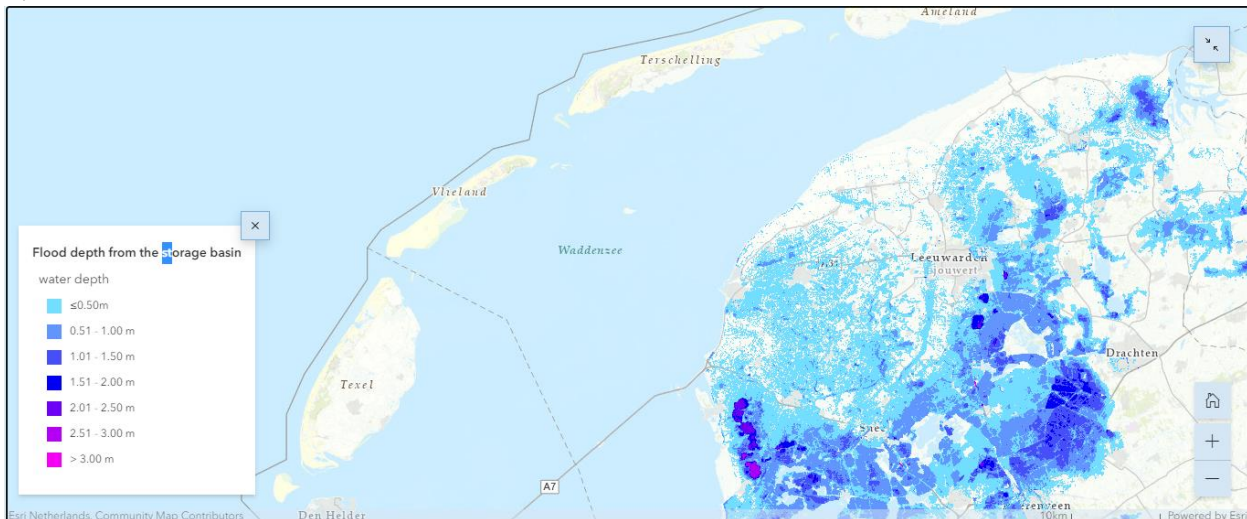


Figure 4: Leeuwarden’s location  
(Frisian Climate Atlas, 2023)

Based on interview results the Netherlands benefits from a lot of surface water, which makes it possible for rainwater to flow freely, in contrast to Germany where green roof installations are more common. Different regions place different emphasis on green roofs due to variations in water availability and management.

In comparison to other Dutch cities, such as Rotterdam, Leeuwarden has implemented green roofs relatively less frequently. The demand for green roofs is lower in Leeuwarden, which is distinguished by its swampy terrain, substantial agricultural areas, and existing green spaces, and as a result, there are fewer installations there.

## 4.2. Green Roof Adoption

Green roof subsidy plan initiated in Leeuwarden in 2019. Since this plan started until now a total number of 209 green roofs with a total area of 6,490 m<sup>2</sup> are adopted from 2018-2023 and it is continuing. From this numbers one of them are intensive and all the rest are extensive. Total number of adoptions each year are presented in Table 6.

Table 6: The statistics of yearly adoption of green roofs in Leeuwarden

No	Year	Adoption number
1	2018-2019	25
2	2020	38
3	2021	39
4	2022	76
5	2023	31
Total		209

Most of them are private places like roofs on houses and lofts, and approximately 2% of businesses, are public. Not all of Leeuwarden's 60,000 buildings are suitable for green roofs due to their extreme slopes exceeding 45 degrees. However, about half of the roofs are flat but all flat roofs cannot carry the weight of green roof. Many of these flat roofs already have solar panels installed, showing that although solar energy is widely used, green roof adoption is less common.

In addition to buildings, the bus shelters in the city are placed with green roofs. Global is the company that implemented bus shelter green roofs for municipality. The shelters in Leeuwarden are equipped with aluminum trays that are filled with sedum plants. The total area of m<sup>2</sup> depends on the width and depth of the shelters, which differ. In Leeuwarden, there are two types of bus shelters: 1) with a depth of 1.20 meters and a width of 1.40 meters per grid, 2) with a depth of 1.72 meters and a width of 1.40 meters per grid.

In accordance with these findings, it is crucial to evaluate the opportunities and difficulties associated with the installation of green roofs in Leeuwarden.



### **4.3. Green Roof Policies and Incentives**

There are several climate adaptive subsidies in Leeuwarden, including Rain Barrel, Green Gardens, Green Roofs, Blue-Green Roofs, Rainwater Utilization Installations, and Water Recycling Systems. An agreement to grant public subsidies for the construction of green roofs is one of the most used methods to achieve the public benefits of green roofs. In the Netherlands, for instance, a green roof policy is part of a plan for improving a city's natural capital (the Delta Program), which aims to enhance cities' living standards and make them future- or climate-proof (van der Meulen, 2019)

Many municipalities in the Netherlands may offer a direct subsidy for green roofs and/or facades. Several municipalities have a subsidy scheme, which may come from a "different pot" such as the water board or energy conservation; inquiries with that municipality should provide a definite answer.

#### **4.3.1. Green Roof Subsidy Condition**

Individuals who will install the green roof themselves or hire a professional can apply for a subsidy. In either case, they need to fulfil the following conditions:

- A citizen or business owner in the Leeuwarden municipality
- An individual who has the property or has permission to reside in it as a tenant from the owner.
- The green roof must be at least 6 square meters in size.
- Stone-like substrates must comply with the 'BRL 9341' assessment guideline or a quality mark of comparable value. The roof, supporting structure, and other modifications adhere to the Housing Act, the 2012 Building Decree, the Building Regulations, and the Leeuwarden municipality's aesthetics policy, as applicable.

Half of the total costs are covered by the subsidy. A maximum of €10,000 is permitted per plot (Gemeente Leeuwarden, 2023).

#### **4.3.2. Different Type of Roof Covering Costs and the Lifespan**

Roof replacement does not have to be prohibitively expensive. Roofing costs begin around € 30 per m<sup>2</sup>. The overall cost is determined by the dimension of the roof and the sort of roof covering. In Table 7 you can compare the average prices per m<sup>2</sup> of roofing material and their lifespan based on the latest information of Homedeal website which is an online platform in the Netherlands that connects homeowners with professionals and contractors for various home improvement and renovation projects. This enables homeowners to compare prices, services, and reviews to make an informed decision (Homedeal, 2023).

Table 7: Comparing the price and average lifespan of different types of covering (Homedeal, 2023)

Type of Covering		Average price per m <sup>2</sup>	Average lifespan
1	Roof tiles	€50 - €80	30 – 80 years
2	Reed	€160	25 years
3	Slates	€30 - €130	30 – 100 years
4	Aluminum	€75	50 years
5	Buyer	€120	100 years
6	Zinc	€60	125 years
7	Green roof	€30-120	Extends the service life by 40 – 50 years
8	Bitumen	€50-90	30 years
9	EPDM	€70 - €110	40 years
10	PVC	€60 - €100	30 years

#### 4.3.4. Green Roof Cost

An average of a green roof cost is between € 30 and € 130 per m<sup>2</sup>. Installing the green roof results in nature closer while also extending the life of the roof covering by 40 to 50 years. This is due to the fact that green roofing necessitates the use of an EPDM or bitumen substrate. Furthermore, the inclination angle should not be greater than 45 degrees. Moss, succulents, or ornamental grass make up the greenery. Green roofing, unfortunately, cannot be installed on corrugated sheets, plastic, zinc, or roof tiles.

## 5. Results

### 5.1. Results from the GAT Application

The findings of a governance assessment conducted to assess the efficacy of green roof policies and programs in Leeuwarden are presented in this report. The assessment concentrated on several governance-related aspects, such as involvement levels and scales, actors and networks, problem perspectives and goal ambitions, strategies and instruments, and roles and resources. In order to gather viewpoints and assessments on each dimension, interviews with those involved in the implementation of green roofs were conducted. The analysis's main goal is to highlight governance issues and suggest potential solutions for the successful installation of green roofs in Leeuwarden. Table 8 summarizes the obtained results based on expert interviews.

Table 8: The GAT results

Governance Dimensions	Quality of governance regime			
	Extent	Coherence	Flexibility	Intensity
Levels & Scales	Low	Low	High	High
Actors & Networks	Low	Very low	Moderate	Low
Problems Perspective & Goal Ambitions	Low	Low-Moderate	Low	Low-Moderate
Strategies & Instruments	Low	Low	Moderate	Moderate
Responsibilities & resources	Moderate	Moderate	Moderate	Low
Final Assessment	Low	Low	Moderate	Moderate

#### 5.1.1. Levels & Scales

##### Extent

Government involvement in implementing green roof policies in Leeuwarden spans a spectrum, ranging from very low engagement at the national and subnational levels to moderate involvement by the Leeuwarden municipality, with limited participation from water boards. Leeuwarden is in the early stages of green roof adoption, and in Zwolle, although there's notable support, a dedicated policy for green roofs is currently absent. In general, the extent in levels & scales is generally assessed as low based on the statements of experts. According to Expert 1, there are four levels of government to consider when evaluating the contribution of each level to the implementation of green roof policies and programs in Leeuwarden: the national government, subnational (province) government, municipality, and water board. The involvement at national level is very low. The involvement of subnational level (the province) is also very low. However, the involvement of municipality of Leeuwarden is moderate. As part of its initiatives to address climate change and encourage climate adaptation, the municipality offers subsidies to encourage the installation of green roofs. The involvement of water boards is not very high. Moreover, they don't appear to be entirely in support of the municipality of Leeuwarden's efforts to implement green roofing.

Expert 3 states that the municipality is only at the beginning of green roof path, and there is no national nor regional policy. Based on the experience of a green roof owner (Expert 7) the involvement is limited to offering a subsidy (municipality) and there are not any other levels of government being involved. Based on Expert 2, it is mainly the local government (Municipality of Leeuwarden) that is involved and based on Expert 7 the involvement is limited to offering a subsidy (municipality). The municipality of Leeuwarden is only at the beginning, and it can do more to promote green roofs.

Expert 6 rates the waterboard's contribution to the implementation of green roof policies and programs in Leeuwarden as low. Their budget for these initiatives is not significant. They do, however, have some impact when the function switches from green to gray areas. In such cases, the builder is required to make up 10% of the newly added built area by either creating open water or by selecting a green roof option that has the same water storage capacity as ponds. The Waterboard can intervene in and provide guidance when a site's primary use shifts from green to housing or industry. Based on Expert 5, while there is notable support and participation from various government levels in Zwolle for green roof initiatives, there is currently a lack of a policy or program specifically devoted to this topic.

### **Coherence**

In Leeuwarden, collaboration, and trust among government levels for green roof initiatives vary, with the municipality being supportive while cooperation with other levels is generally low, resulting in an overall low level of trust and collaboration. Meanwhile, in Zwolle, there is a willingness to work together on green roofs, but budget-related challenges hinder effective resident involvement, suggesting a need for enhanced cooperation and problem-solving. The general results of experts' opinions, coherence in levels and scales is typically rated as low.

Based on Expert 1, the municipality of Leeuwarden is quite interested in and supportive of the implementation of green roofs when it comes to collaboration and trust among government levels. However, the collaboration and trust in the water board, province board, and federal government is low. The national government, the province board and the water board collaborate, and trust is low. However, they don't actively support the adoption of green roofs. As a result, while the province board's overall rating for collaboration and trust between government levels is still in the middle, it is low for the national government and water board. In General, the collaboration and trust among government levels in green roofs context in Leeuwarden are low.

Based on Expert 3, idea during the years that he was alderman of Leeuwarden for energy & climate, circular economy, mobility, nature, agriculture, heritage, and real estate there was little communication about this subject and based on Expert 2 idea it is mainly the local government (Municipality of Leeuwarden) that is involved. Based on Expert 4 everybody often works on their own projects and there is no sufficient collaboration between them.

According to Expert 6, there is a mixed level of trust and collaboration between the various government levels when it comes to implementing green roofs in Leeuwarden. The waterboard reports a high level of trust and cooperation in many programs. The waterboard's role becomes more advisory in situations where the municipality does not prioritize green roofs. They have participated in a research project focusing on green roofs and stormwater management in industrial areas, in collaboration with a few municipalities and educational institutions. Overall, despite good cooperation in some projects, there is still room for improvement when it comes to promoting green roofs throughout the region due to a lack of funding and priority issues. Meanwhile, Expert

5 from Zwolle, there is a willingness to work together on green roofs, but problems with budget compartmentalization make it difficult for residents to be effectively involved. Increasing cooperation and coming up with answers to these problems would be helpful.

### **Flexibility**

Flexibility within the governmental framework for green roof policy in Leeuwarden is notably high, with adjustments being relatively easy to make and a willingness to find solutions when issues arise during implementation, exemplified by the municipality's ability to adapt subsidy rules based on feedback from green roof owners. However, challenges like limited financing options and varying priorities among organizations can occasionally slow down the adjustment process. According to the opinions of experts, level and scale flexibility in general is typically rated as high. Based on Expert 1 the adjustment at the governmental level when facing issues with the green roof policy in Leeuwarden is quite easy, and it shows a high level of flexibility. The government have a willingness to adjust and find solutions when issues arise during the implementation process. This adjustment facilitates the overall implementation of the green roof policy. Based on Expert 2, the municipality has a subsidy stimulating green roofs (Klimaatbewust Leeuwarden). This subsidy is evaluated and revised every 1-2 years.

The quick reaction of the municipality is reported by an example from the experience of a green roof owner (Expert 7). Since he installed the green roof himself, the owner was initially ineligible for receiving the subsidy. However, they expressed their concerns and asked that the subsidy rules be reviewed. The municipality presented this idea to the council members, and after consulting with their legal department, they changed the rules and gave the subsidy to the owner and others in similar situations.

Based on Expert 4 the adjustment process at the governmental level when facing issues with the green roof policy in Leeuwarden is generally perceived as relatively easy. While there may be occasional challenges, the overall experience suggests that resolving these challenges and making necessary changes can sometimes be slow. Expert 3 claims that the challenges arise due to limited financing options for implementing this policy. While the municipality had some funds for subsidies, it is not a formal responsibility of municipalities, resulting in a lack of financial support from the national government.

According to Expert 6, altering regulations can potentially lead to a relatively straightforward adjustment of the governmental green roof policy. The inability of some organizations to significantly contribute to implementation efforts may be due to financial limitations. Adjusting is simpler for the municipality, but due to financial constraints, other organizations may need to put a higher priority on practical solutions like managing stormwater within current systems rather than expanding with green roofs.

### **Intensity**

The intensity of responsibility for implementing green roofs varies, with the municipality, particularly the local board of Leeuwarden, taking the primary role and wielding significant authority in Leeuwarden. However, in Zwolle, government levels play a more limited role, focusing on integrating green roofs into broader urban projects, with subsidies offering relatively low influence on resident behavior. Generally speaking, experts consider the intensity in levels & scales to be high.

Expert 1 mentions that the municipality, in particular the local board of Leeuwarden, is the primary level of government with the responsibility of implementing green roofs in Leeuwarden. The municipality of Leeuwarden is responsible for managing and directing the projects of green roof in its district. These particular government levels have a significant authority to support the installation of green roofs.

The municipality of Leeuwarden, which is responsible for the management of the district, has a direct impact on the decision-making process and is able to offer significant support and resources for green roofs projects. The influence and support of the municipality is essential for ensuring the adoption of green roofs in Leeuwarden. According to Expert 3, the responsibility primarily lies with private initiatives, as stated by the Municipal Executive (college van B&W)<sup>1</sup>.

Based on Expert 4 the Municipality of Leeuwarden takes the lead in implementing green roofs and is primarily responsible for their promotion. They offer practical support by providing financial incentives and subsidies to individuals interested in constructing green roofs. In a similar vein, in Zwolle, according to Expert 5, the responsibility for green roof implementation does not primarily fall on the government level. Instead, the focus is on integrating green roofs into diverse city projects and initiatives. Although its overall impact may be somewhat limited, active promotion and support are dedicated to the integration of green roofs into urban development projects.

Based on Expert 2, this is mainly the local government and based on Expert 7 the only influence they appear to have been by offering subsidies and occasionally promoting green roofs (or more general climate solutions like rain barrels and replacing bricks with greenery). This influence on changing behavior of inhabitants is low. The subsidy only covers about 8 to 15% of the installment costs, so one's motivation to install a green roof is probably not influenced by such a subsidy.

According to Expert 6, the municipality is the primary level of government in responsible for leading the implementation of green roofs in Leeuwarden. They do not have enough money to support the initiatives, though.

### **5.1.2. Actors & Networks**

#### **Extent**

The primary responsibility for implementing green roofs in Leeuwarden rests with the municipality, especially the local board of Leeuwarden, which has substantial authority and actively directs green roof projects. While other organizations like the 'Vereniging Circular Friesland' and businesses are involved, their roles tend to be more service-oriented or focused on inhabitants and SMEs rather than active promotion or policy engagement. In accordance with the statements of experts, extent in actors & networks is generally regarded as low.

Based on Expert 1 the municipality, particularly the local board of Leeuwarden, is the primary level of government which is responsible for implementing green roofs in Leeuwarden and directing and supervising the implementation of green roof projects in its district. Municipality has significant authority in supporting green roof implementation. The municipality of Leeuwarden, which is in charge of the district, has a direct impact on the decision-making process and can

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<sup>1</sup> The "college van B&W" signifies the top governing body, known as the Executive Board, in Dutch municipalities, comprised of the mayor and aldermen responsible for policy decisions and administration.

significantly support resources for involving in green roofs projects. The influence and support of the municipality are essential for ensuring the adoption of green roofs in Leeuwarden.

According to an Expert 3 idea no organization is excluded in the implementation process of green roof. In addition to the municipality the 'Vereniging Circular Friesland'<sup>2</sup> is also involved. But there is no written agreement about results. Expert 2 believes that the focus is mainly on inhabitants and SMEs (Small businesses). Based on green roofs owner (Expert 7) some gardener companies provide the service of installing green roofs, their involvement is more concentrated on providing the service rather than actively promoting or advocating for the implementation of green roofs on a larger scale or taking part in policy discussions. Subsidy responsible person mentions that businesses that specialize in constructing green roofs play a significant role in the implementation process.

Expert 4, in addition to confirming the idea expressed by Expert 7, also adds that businesses in Leeuwarden are implementing green roofs by advertising their business with raising awareness and promoting their services instead of implementing the specific programs that are described in the policy such as subsidy. Expert 6 adds that schools actively participate and contribute by helping with research projects to learn more about green roofs, in addition to the stakeholders that the other experts have already mentioned.

### **Coherence**

The interaction between stakeholders in green roof implementation in Leeuwarden is currently limited, characterized by unstable and informal interactions among a small and fragmented network of stakeholders, with the municipality primarily engaging with building owners and few businesses providing green roof solutions. However, there is potential for improvement through enhanced communication and collaboration among these stakeholders. Based on the opinions of experts, coherence in actors and networks is typically rated as being extremely low.

According to Expert 1, the interaction between stakeholders in green roof implementation in Leeuwarden is limited. The municipality mostly interacts with building owners, and there aren't many businesses that provide green roof solutions. There is little interaction with academic and industry stakeholders. The interactions are unstable and informal. To create a more cohesive network, communication and collaboration must be improved. The network of stakeholders involved in the implementation of green roofs is small and weak.

On their website, the municipality does, however, keep a list of suggested green roof providers, which makes communication with suppliers easier. Fragmented and competitive nature of the stakeholders' interactions in Leeuwarden's green roof implementation, makes the room for improving the collaboration. According to Expert 3 everything is done on a voluntary basis. There are just a few stakeholders and there is no question of a statutory duty. Based on Expert 2 there is no formalized and stable interaction between stakeholders, other than the moment inhabitants file for a subsidy.

Based on Expert 6 the level of interaction between stakeholders in green roof implementation is informal and stable. A coalition of about 50 organizations, including the water board, worked together on a national program to promote green gardens and decrease tile in neighborhoods six

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<sup>2</sup> refers to the "Circular Friesland Association," an organization dedicated to promoting and advancing circular economy principles and practices in the Friesland region of the Netherlands.

years ago. Although the formal collaboration has changed, stakeholders continue to support and share knowledge. Similar actions are now coordinated by the municipality, and even though there are no formal contracts, it is still possible to restart and expand the partnership if necessary.

### **Flexibility**

The flexibility for including new actors or changing leadership in the context of green roof implementation in Leeuwarden may initially appear limited, particularly due to the abundance of grasslands and associated lower priority for green roofs, but potential for such changes exists, especially with stronger leadership and increased subsidies from higher levels of governance, which could accelerate the adoption of green roofs. Flexibility in actors & networks is generally assessed as moderate based on the statements of experts.

Based on Expert 1 in terms of the facility to include new actors or change leadership among actors for practical reasons in the context of green roof implementation, green roofs might not be considered to have much overall significance. The Netherlands has a lot of grasslands, so installing green roofs is not a top priority, especially for older buildings where the cost of doing so can be high.

When it comes to adding of new actors, there are currently a small number of businesses in Leeuwarden that offer green roofs, and there is little facilitation for new actors to enter this market. But there is a chance for leadership changes if the issue relates to the policy actors responsible for the implementation of green roof policies. For example, at the national level or the province board level, new leaders can facilitate the green roof projects. It is possible to promote the involvement of new actors and accelerate the adoption of green roofs with stronger leadership and greater subsidies.

Therefore, even though there may initially be a limited ability to include new actors or change leadership among actors, the potential for new actors and leadership changes still exists, especially if higher levels of governance place a greater emphasis on promoting and supporting green roofs. According to Expert 3, there is overall agreement and support for this policy, but there is a lack of public funding and an absence of an established policy.

Based on Expert 6 the facility to include new actors or change leadership among actors for practical reasons is rated positively. According to the water board, the new politicians affect a high priority on encouraging neighborhood initiatives, concentrating on green spaces and crucial projects related to climate, biodiversity, and social impact. These initiatives have received positive feedback, and the political climate suggests that more energy and inspiring concepts could be used to further advance these causes. The current environment encourages inviting people to participate partially in these projects voluntarily rather than imposing strict rules or fees.

### **Intensity**

The main driving forces behind green roof implementation in Leeuwarden are the active involvement of green roofing companies and the local municipality. These actors collaborate to promote and implement green roof projects. Additionally, the commitment and enthusiasm of individual officials play a significant role in the success of these initiatives. Despite financial constraints, there is a proactive effort to seek external funding and elevate the ambition for green roof adoption in the region. Generally speaking, experts consider the intensity in actors & networks to be low.



Based on Expert 1 the main actors driving green roof implementation in Leeuwarden are the companies that offer green roofing solutions, the local municipality and local board. These two groups are highly active in encouraging and implementing green roofs projects. The green roof businesses that provide green roofing provide the necessary products and services for the installation and maintenance of green roofs. They have a crucial role in driving the practical implementation of green roofs in Leeuwarden. Based on Expert 2's opinion, in order to promote and monitor the implementation of green roof initiatives, the local municipality or local board has a leadership role. In addition to having a responsibility to promote sustainable practices, they have the power to influence policies and rules that support the use of green roofs.

In order to promote the installation of green roofs in Leeuwarden, there is some collaboration between the local municipality and the companies that offer these roofs. Those people work together to promote the use of green roofs in the area. According to Expert 3, the enthusiasm and commitment of a single alderman or official is the primary factor influencing the implementation of green roofs in Leeuwarden. The success of initiatives involving green roofs is greatly influenced by their level of commitment.

Based on Expert 6 the main actor driving green roof implementation in Leeuwarden is the municipality. They have made the important decision to start a significant climate adaptation project, allocating significant funds for the upcoming years. The water board is also actively working with the province and the municipality to create a long-term water plan and is looking for more funding from Europe to support green initiatives like putting more green roofs in place and enhancing the appearance of industrial areas. Despite financial limitations, this collaborative strategy and the pursuit of outside funding show a proactive effort to raise ambition and accelerate the installation of green roofs.

### **5.1.3. Problems Perspective & Goal Ambitions**

#### **Extent**

The extent of consideration for various perspectives in Leeuwarden's green roof policies and programs is limited, with a focus on recreational rather than strategic goals. While green roofing can aid rainfall management, the existing policies do not fully integrate different viewpoints or stakeholder interests. Suggestions for improvement include involving owners' unions and emphasizing the advantages of green roofs. Extent of the issues according to the opinions of experts, problems perspective and goal ambitions are typically rated as low.

Since installing the green roof is one way to control runoff, it's worth considering its role in managing rainfall. The Netherlands already has an advanced sewerage system and an extensive water supply that effectively manages rainfall. Therefore, while it may not be an urgent concern to extend the sewer system in Leeuwarden with green roofing, exploring this option aligns with seeking cheaper and more environmentally friendly alternatives to traditional methods. Considering these factors, it seems that the current green roof policies and programs in Leeuwarden may only partially take into account different viewpoints and integrate the interests of various stakeholder groups. The recreational advantages of green roofing seem to be getting more attention than particular issues or general sustainability goals.

Based on Expert 1 the current green roof policies and programs in Leeuwarden don't consider wide range of perspectives. The focus on green roofing in the city is not driven by specific targets or ambitious goals. Instead of being a tactical operation with clear objectives or a strategic activity,

it seems to be more of a casual or recreational initiative. According to Experts 2 and 3, the existing green roof policies and programs in Leeuwarden have yet to fully consider all perspectives, indicating the presence of untapped possibilities and municipality try to incorporate the perspective of inhabitants and businesses. According to Expert 6, the current green roof policies in Leeuwarden do not fully consider all viewpoints, even though there are subsidies available and green roofs are explicitly not included in climate adaptation measures. Implementation can be improved by involving owners' unions and highlighting the advantages of green roofs.

### **Coherence**

The extent to which different perspectives and goals related to green roof implementation in Leeuwarden align and support each other is currently limited. The primary mechanism is an annual subsidy program encouraging alignment but with a focus on individual projects. There's a need for a more comprehensive strategy that includes broader goals, stakeholder participation, and better coordination among actors involved in green roof implementation to enhance support and integration among various perspectives and goals. Coherence of issues according to the opinions of experts, problems perspective and goal ambitions are typically rated as low to moderate.

Based on Expert 1 the extent to which different perspectives and goals related to green roof implementation in Leeuwarden support each other is limited. The main mechanism is a yearly subsidy program, where 20 property owners or businesses can apply for subsidies based on how many square meters of green roofs they intend to install. However, this strategy promotes financial assistance by encouraging a comprehensive alignment of perspectives and goals.

There is a lack of information regarding the specific goals and perspectives that are being considered or addressed through the green roof implementation. The current strategy appears to be more concentrated on promoting the realization of individual projects through subsidies. It would be beneficial to have a more comprehensive strategy that includes more comprehensive goals, participation of stakeholders, and coordination among various actors involved in the implementation of green roofs in order to increase the level of support and integration among various perspectives and goals. This would make it possible to support and align all perspectives and goals related to the installation of green roofs in Leeuwarden in a way that is more cohesive and synergistic. Based on Expert 3, the municipality began the green roof initiative approximately five to seven years ago. Additionally, Expert 4 highlighted the decision made during the same period to construct 150 green roofs within Leeuwarden over five years. This initiative's focus was specifically on green gardens, supported by subsidies to facilitate implementation. The city experienced a subsequent rise in green roof installations. However, the main objective of this effort appeared to prioritize encouraging numerous green roof installations through the subsidy program, rather than achieving a specific numerical target. The current estimate suggests around 20 green roofs are installed each year, making a gradual increase from the initial installation of five green roofs in the first year. This progression reflects the growing aspiration to integrate green infrastructure into Leeuwarden's urban landscape, as witnessed from the perspectives of both Expert 3 and Expert 4.

According to Expert 6, there is currently little support in Leeuwarden for various viewpoints and objectives related to green roofs. Subsidies are available, but alignment with climate measures is unclear, and some owners prioritize solar panels. Better support and integration of various objectives can be achieved by involving unions and emphasizing the benefits of green roofs.

## **Flexibility**

The flexibility to review and adapt policies and programs related to green roofs in Leeuwarden is limited, with the annual subsidy program being the primary focus and insufficient mechanisms for in-progress goal review and modification, emphasizing the need for a framework to ensure ongoing relevance and alignment with evolving sustainability and urban development trends. Flexibility with issues according to the opinions of experts, problems perspective and goal ambitions are typically rated as low.

Expert 1 argues that there are currently few opportunities in Leeuwarden to review the goals of policies and programs related to green roofs. The annual subsidy program is the main focus, where 20 property owners or businesses can apply for subsidies based on the square meters of green roofs they intend to install. Insufficiently explicit mechanisms for in-progress goal review and modification make it difficult to adjust to changing needs and priorities. Establishing a framework for in progress goal review, stakeholder consultation, and knowledge incorporation is crucial for improving the success of green roof initiatives. This would ensure that the goals remain relevant, ambitious, and aligned with evolving sustainability and urban development trends. Based on Expert 3 idea we only have a few nice examples.

## **Intensity**

The alignment between the goals of green roof policies and programs and the current policy in Leeuwarden remains unclear and undefined, with the allocation of a budget for subsidies serving as the primary indicator due to the absence of specific, measurable targets. While some experts believe that the goals complement current practices, others perceive that there is still significant progress needed in the implementation of green roofs. Intensity of the issues according to the opinions of experts, problems perspective and goal ambitions are typically rated as low to moderate.

Based on Expert 1 the difference between the goals of green roof policies and programs and the current policy in Leeuwarden is unclear and undefined. The allocation of a budget for subsidies acts as the main indicator because there are no clear objectives or measurable targets. This makes it difficult to assess the extent to which the current practices align with the intended goals. Setting specific, feasible goals will make it easier to monitor progress and guarantee that Leeuwarden's implementation procedures for green roof policies are accurate. However, Expert 3 believes that as they complement and support each other, the goals of Leeuwarden's green roof policies and programs are in line with current practices. The goals and methods are related rather than in disagreement with each other. Expert 2 believes that there is still a long way to go for green roofs.

### **5.1.4. Strategies & Instruments**

#### **Extent**

The inclusiveness of Leeuwarden's green roof policy is questioned, with limited interest from house owners and unclear monitoring and enforcement measures, according to Expert 1. However, Expert 2 believes the policy is inclusive and encourages a DIY approach, while Expert 3 suggests that the policy is in its early stages of implementation. According to the statements of experts, the extent in strategies & instruments is typically rated as low.

Based on Expert 1 the instruments used in Leeuwarden's green roof policy are not inclusive, as only a limited number of house owners are interested in pursuing green roofs. People who prefer

more green spaces in their neighborhoods are the main users of the policy. The effectiveness of the policy is low, a small number of projects each year use the available subsidies. The presence of monitoring and enforcement measures is unclear, making it difficult to assess their effectiveness. Raising awareness of the advantages of green roofs and involving a wider range of stakeholders are crucial for improving inclusiveness.

To make sure policy goals are achieved and installations follow standards, it is also important to establish clear monitoring and enforcement measures. This would help Leeuwarden implement a green roof policy that is more effective and inclusive. According to Expert 2 Leeuwarden's green roof policy is inclusive and encourages a do-it-yourself approach. It also includes effective monitoring and enforcement measures, and Expert 3 believes that they have just begun.

### **Coherence**

In Leeuwarden's green roof policies, incentives are seen as ineffective by Expert 1 due to unclear targets and limited impact, primarily motivating a small number of frontrunners. Expert 6 also rates the effectiveness as low, noting the presence of only a few green roofs in the area, while Expert 2 suggests no conflicts, and Expert 3 believes the initiative is just beginning. Based on experts' declarations, coherence in strategies and instruments is typically rated as low.

Based on Expert 1 incentives in Leeuwarden's green roof policies are currently thought to be ineffective. Although some people interested in green roofs have been encouraged by subsidies, the overall impact is still modest. It is unclear if there are conflicts or overlaps among the incentives because there are no specific targets for the percentage of green roof coverage and subsidy amounts per square meter. A small number of frontrunners have been effectively motivated by these policies, but distributional effects and cost-benefit trade-offs have not been considered. To ascertain the synergy within the incentive system and its alignment with more general goals, additional analysis is required.

Based on Expert 6 the effectiveness of the incentives in the green roof policies in Leeuwarden is rated as quite low, as there are only a few green roofs present. The hospital and a few other buildings in the Bilgaard area have green roofs, according to the water board, but overall, there seems to be little use of green roofs in the whole area.

### **Flexibility**

Expert opinions on the flexibility of instruments for green roof implementation in Leeuwarden vary. While Expert 3 emphasizes the importance of supporting initiatives that promote flexibility in combining different instruments, Expert 4 provides an example of successful flexibility by highlighting the installation of green roofs at bus stops, which serve both as shelter for passengers and a contribution to the city's overall greening. This example showcases how various instruments can be effectively integrated to achieve sustainability and enhance the urban environment. Based on the opinions of experts, flexibility in strategies and instruments is typically rated as moderate. According to Expert 3 they support any initiative that encourages the flexibility to mix different instruments and provides options when putting in place green roofs in Leeuwarden.

Based on Expert 4, it is a good thing that there are many green roofs at bus stops in Leeuwarden. These small roofs provide shelter for bus passengers and contribute to the city's overall greening. It has been an attempt to install green infrastructure in these public spaces to increase sustainability and enhance the environment for both residents and visitors. It provides an actual example of how different instruments can be effectively combined to implement green roofs.

## **Intensity**

The assessment of the expected level of change needed to improve green roof programs in Leeuwarden varies among experts. Some suggest that the current voluntary and incentive-based approach may require only a modest level of change, while others emphasize the need for significant changes, including standardizing applications, conducting research, and revising promotion and support strategies to boost green roof adoption. Intensity in strategies & instruments generally assessed as moderate based on the statements of experts.

Based on Expert 1, it is difficult to evaluate the expected level of change needed to enhance the programs focusing on the implementation of green roofs without a specific framework or set of criteria. At the moment, Leeuwarden's strategy is focused on offering subsidies to people who are interested in installing green roofs as incentives. There is no law or mandate asking a green roof on every roof in the municipality. Since it mainly depends on the voluntary participation of people who choose to pursue green roofing, the expected level of change required to enhance the programs may be relatively low. However, without further information or a specific framework for evaluation, it is difficult to provide a definitive rating for the expected level of change. According to Expert 3, a lot has to be done.

Based on Expert 6, the expected level of change required to improve the programs focused on green roof implementation in Leeuwarden is rated as significant. The water board suggests standardizing applications to specific house types in targeted areas and conducting research to find the best design and weight capacity in order to effectively promote green roofs. Adding solar panels and green roofs together could improve the implementation process even more. To increase the adoption of green roofs, significant changes in promotion and support strategies are required.

## **5.1.5. Responsibilities & Resources**

### **Extent**

Subsidies appear to be primarily the responsibility of the municipality, with different areas having different opportunities for cooperation and resource allocation, such as industrial compared to residential areas. The distribution of responsibilities and funds among various green roof projects still needs more organization and coordination.

The assessment of the clarity regarding the allocation of responsibilities and resources for green roof implementation in Leeuwarden varies among experts. Expert 1 finds it relatively clear, mentioning colleagues responsible for subsidies and informative websites. Expert 6 rates it as moderate, indicating that subsidies are primarily the municipality's responsibility, but there is variability depending on the project's location. Coordination and organization across different green roof projects could be improved. On the basis of the opinions of experts, the extent of the responsibilities and resources is typically rated as moderate.

Based on the response given by Expert 1, it can be concluded that Leeuwarden's allocation of responsibilities and resources for the implementation of green roofs is relatively clear. According to the response her/his colleagues are responsible for offering subsidies, and there are certain websites where people can learn more and request about the viability of green roofing. The answer does not explicitly address the ease or complexity of the subsidy application process. According to Expert 3 a lot must be done.

Based on expert 6 the extent to which responsibilities and resources are clearly allocated for green roof implementation in Leeuwarden is rated as moderate. Subsidies appear to be primarily the responsibility of the municipality, while other opportunities for cooperation and allocation of resources may vary depending on the area, such as industrial areas versus residential areas. There is room for further clarity and coordination in the allocation of responsibilities and resources for different green roof projects.

### **Coherence**

Expert 1's response indicates that in Leeuwarden, the institutions involved in green roof implementation align well with their assigned responsibilities. Individuals find it relatively simple to install green roofs themselves, and there are also companies available for those who prefer professional assistance. However, this response lacks information on potential challenges or areas for improvement in terms of coherence. According to expert opinions, the extent of the responsibilities and resources is generally rated as moderate.

Based on Expert 1 the institutions involved in Leeuwarden's implementation of green roofs are well-aligned with the assigned responsibilities. The statement indicates that people find it relatively simple to install green roofs themselves, demonstrating a high level of alignment between the assigned responsibilities and the capability of individuals to undertake the implementation independently. Furthermore, there are companies available that can install green roofs, offering an alternative option for those who prefer expert assistance.

### **Flexibility**

These responses show varying opinions on the feasibility of pooling responsibilities and resources, with different experts emphasizing the importance of clear definitions and collaboration while acknowledging potential challenges in different contexts. Flexibility in responsibilities & resources generally assessed as moderate based on the statements of experts.

Expert 1 argues that in Leeuwarden, there is only a subsidy for green roofs; there are no measurable goals. So, they target and count the output of subsidies. It's our way of helping building owners make their roofs green. Both of those are their own responsibilities, as is the delivery of the green roof products. In the Dutch green roof market, sharing responsibility does not lead to compromising on accountability and transparency. According to Expert 3, to ensure feasibility in pooling responsibilities and resources for green roof implementation, it is important to establish clear definitions of responsibilities. This approach promotes accountability and transparency while facilitating effective collaboration and resource sharing.

Based on Expert 6 the feasibility of pooling responsibilities and resources in green roof implementation without compromising accountability and transparency is rated as possible, with more potential for industrial areas than residential areas. The water board suggests working together to secure additional funding from national and European governments to promote green initiatives in different areas but takes into account that industrial areas might be more suitable for it than residential ones. Coordinating resources for green roof projects across different regions may be difficult while maintaining a balance between accountability and transparency.

### **Intensity**

These perspectives highlight differing assessments of the resources available for green roof implementation, with one expert perceiving limitations and another recognizing the potential for

more substantial support. According to experts' statements, the intensity of the responsibilities and resources is typically rated as low.

Based on Expert 1 the resources allocated for implementing the required actions in place to bring about the desired change in Leeuwarden's green roof policies and programs are limited. The answer implies that there is an exact total of money set aside annually for the installation of green roofs, without any specified goals for the number of square meters. Instead of taking a comprehensive and assertive approach to increasing the coverage of green roofs, it appears that the resources are primarily aimed at people or organizations with an interest in having them.

Based on Expert 7 the number of resources allocated to implement the necessary measures for the desired change in green roof policies and programs in Leeuwarden is rated as potentially substantial. A portion of the funds set aside for climate adaptation could be used to support green roof initiatives in addition to specific subsidies for green roofs. This suggests that there might be additional resources available in addition to the specific subsidies.

## **5.2. Answers to Sub-questions**

### **5.2.1. What Policies and Programs Are Currently in Place in Leeuwarden for Green Roof Implementation?**

The city of Leeuwarden has taken significant steps towards promoting sustainable urban development through its climate adaptive subsidies program, and green roofs are one of the components of this program.

**Climate Adaptive Subsidies Program:** Through its climate adaptive subsidies program, which includes green roofs as one of its components, the city of Leeuwarden has made significant progress toward promoting sustainable urban development. It includes a number of programs to support environmentally friendly initiatives, including rainwater management, green gardens, blue-green roofs, rainwater utilization installations, water recycling systems, and green roofs.

**Green Roof Subsidy Plan:** The Green Roof Subsidy Plan was launched in 2019 as a component of the Climate Adaptive Subsidies program. In order to encourage property owners to invest in green roofs and support sustainable urban development, this particular plan offers financial incentives to people and businesses within the Leeuwarden municipality who decide to install green roofs on their properties. Applicants must fulfill several requirements to be eligible for the subsidy, such as being a resident of the municipality or a business owner there, owning a property or having permission from the owner to live there as a tenant.

Those who hire a professional installer or do the installation themselves are eligible for the green roof subsidy. The green roof must meet strict quality requirements for the roofing materials and installation methods, and it must be at least 6 square meters in size. Substrates that are like stone that are used in green roofs must comply with the "BRL 9341" assessment guideline or have a quality mark of comparable value. The roof, supporting structure, and other modifications also must comply to all applicable building codes as well as the municipality's aesthetics policy. The subsidy, which has a maximum grant of €10,000 per plot, pays for half of the overall costs of putting in a green roof.

**Integration in Municipal Infrastructure:** The city has taken steps to integrate green roofs into its public infrastructure in addition to private properties. The installation of green roofs on bus

shelters, which are furnished with aluminum trays filled with sedum plants, is an illustration of this integration. These programs show how committed the municipality is to using green roofs in both private and public areas.

### **5.2.2. What Governance Challenges Are Hindering the Green Roof Policy in Leeuwarden?**

Based on the interview results and insights from the literature review, the governance challenges hindering the green roof policy in Leeuwarden can be summarized as follows:

**Levels & Scales:** The literature review's findings on the lack of promotion and support from the government and social communities are consistent with the low level of involvement of government at the national and regional levels. This lack of participation makes it difficult to develop a comprehensive framework and support system for green roofs in Leeuwarden.

**Actors & Networks:** There is limited collaboration and interaction among stakeholders, and there is relatively little stakeholder involvement in green roof policies and programs. Fragmented interactions regarding the implementation of green roofs are caused by the weak stakeholder network. To address this barrier, the literature review emphasizes the need for proactive government support as well as the promotion of relevant policies and regulations.

**Problems Perspective & Goal Ambitions:** Currently, Leeuwarden lacks comprehensive policies or programs with defined goals for green roofs. The use of green roofs is hindered by initiatives that are informal or recreational and lack defined goals. To overcome this barrier, the literature review suggests improving demand among developers and extending awareness of the advantages of green roofs (Shafique et al., 2018; Zhang et al., 2012).

**Strategies & Instruments:** The current Leeuwarden strategy largely depends on an annual subsidy program, which hinders coherence between different perspectives and goals. Over a comprehensive strategy, financial support and particular projects are given priority. The literature review emphasizes the importance of government incentives for property owners and informational advertising campaigns to support green roofs (Zhang et al., 2012).

**Responsibilities & Resources:** Although there are limited financial resources, the municipality of Leeuwarden, which is the local government, is primarily responsible for implementing green roofs. According to the literature review, green roofs face several challenges that are confirmed by our research findings. These challenges include high initial costs, limited awareness of the construction principles among potential users, and substantial ongoing maintenance expenses. Additionally, there is the ongoing challenge of determining the most suitable green roof designs for various locations and climates (Shafique et al., 2018). My research further substantiates these existing issues in the context of our study area.

In general, there are several governance challenges preventing the implementation of the green roof policy in Leeuwarden, such as low levels of involvement from higher governmental levels, a lack of stakeholder collaboration, the lack of comprehensive policies and goals, reliance on a subsidy-centered strategy, and limited financial resources. More government involvement and coordination, improved stakeholder collaboration, the establishment of specific goals, and the allocation of adequate funding are required to address these issues (Shafique et al., 2018; Zhang et al., 2012).



### **5.2.3. Based on the identified challenges, what governance factors can help to improve the installation of green roofs in Leeuwarden?**

Based on the findings from the report and insights gained from the literature review, several governance factors can significantly improve the adoption of green roofs in Leeuwarden. These recommendations aim to address key challenges and maximize opportunities for success:

**Elevate Government Involvement:** Increase participation from higher levels of government, including the provincial and national bodies. Establish robust communication channels, coordination mechanisms, and support systems. This collaborative approach can facilitate the creation of a comprehensive framework for green roofs in Leeuwarden.

**Foster Collaboration and Trust:** Enhance collaboration and build trust between local governments, boards, and the national authority. Effective implementation of green roof policies and programs relies on improved communication, coordination, and shared efforts (Shafique et al., 2018).

**Encourage Stakeholder Engagement:** Broaden stakeholder involvement to include businesses, NGOs, academic institutions, and industry experts. Foster collaboration, interaction, and knowledge exchange to overcome barriers and accelerate green roof adoption (Shafique et al., 2018).

**Define Clear Goals:** Develop comprehensive policies with precise, measurable goals aligned with sustainability objectives. Regular goal reviews and adjustments, based on stakeholder input and evolving priorities, ensure inclusivity and effectiveness (Shafique et al., 2018).

**Promote Adaptability and Flexibility:** Establish a flexible governance structure capable of addressing emerging challenges and welcoming new stakeholders. Modify policies and procedures as needed to encourage innovation and participation in the green roof sector (Shafique et al., 2018)

**Allocate Resources and Support:** Increase resources, funding, and technical assistance for successful green roof construction and maintenance. Explore additional funding options, such as grants and incentives, to encourage property owners and businesses to invest in green roofs. Provide platforms for knowledge-sharing and capacity-building to facilitate implementation (Shafique et al., 2018).

Implementing these recommendations can enhance stakeholder engagement and create a conducive environment for green roof installation in Leeuwarden. This proactive approach can enable the city to achieve its sustainability goals while reaping the multiple environmental, social, and financial benefits of green roofs.

## 6. Discussion

### 6.1. Analysis of Previous Research Results Based on the GAT

In this section, I explore the governance landscape through key reference articles which their concept included in this thesis to solidify the results obtained from the interviews with prior research findings. These articles, each with their own distinct focus and insights, provide a diverse perspective on governance challenges and recommendations within the realms of climate projects and technological innovations.

Casiano Flores et al. (2021) recognize the importance of transdisciplinary science, cross-sector partnership, and innovation experiments as catalyst factors for climate project success (Casiano Flores et al., 2021). Based on my research, in the case of Leeuwarden, trans-disciplinary science, cross-sector partnership, and innovation are still in a starting phase.

Casiano Flores et al. (2020) emphasize the importance of multi-level collaboration in achieving climate goals and highlights the need for more extensive citizen participation. The article also explores the presence of these catalyst factors and their potential for improvement (Casiano Flores et al., 2023). My research findings in Leeuwarden showed that level of collaboration for green roof installation is weak and the main actor is municipality.

Sangkakool et al. (2018) highlight a growing trend toward 'greener' buildings in Thailand, with potential challenges in green roof adoption seen as manageable. However, there is a need for increased knowledge dissemination through educational and promotional campaigns. This research is the first to focus on factors influencing green roof adoption in Thailand, providing insights for stakeholders and policymakers (Sangkakool et al., 2018). The research in the Leeuwarden case showed that there is a lack of education or campaigns for raising awareness. It can be a good opportunity to adopt green roofs, as the only way to enhance green roofs is through people's enthusiasm.

Zhang et al. (2012) identify significant barriers to implementing extensive green roof systems in existing buildings in Hong Kong, including government and community promotion, lack of incentives for building owners, and increased maintenance costs. These challenges span the entire building lifecycle. To address them, the study calls for proactive government support, the promotion of relevant policies and regulations, and efforts to stimulate developer interest by highlighting benefits like cost savings. Media dissemination is recommended for public awareness. Further research is needed to develop effective strategies for overcoming these barriers and promoting sustainable urban environments (Zhang et al., 2012). This study also highlights the role of raising awareness in a place like Leeuwarden. As the main barrier for installing green roofs in Leeuwarden is their expenses, allocating more subsidies can also be helpful, as the existing amount of subsidy only covers a portion of the expenses.

Zhang & He (2021) identify three drivers, twelve motivations, and four barriers, along with their complex stakeholder interconnections. Their recommendations span policy, technical, economic, social, and scientific aspects, addressing specific barriers, such as government policy absence and economic benefit assessment (Zhang & He, 2021). As revealed by this research, the only policy in Leeuwarden is an annual subsidy that covers a portion of installation expenses. Increasing this amount and implementing a mix of policies, as mentioned earlier, can be helpful in the case of Leeuwarden.

## **6.2. Analysis of the Interview Results Based on the GAT**

The findings of the governance assessment reveal five key areas where enhancements can be made to improve the effectiveness of green roof policies and programs in Leeuwarden.

Firstly, fostering greater participation and collaboration among diverse government tiers emerges as a necessity. By formulating regional and national policies, a robust framework can be established to underpin the green roof implementation while elevating the governance landscape. Strengthened trust and communication across government levels would naturally yield a more synchronized and streamlined strategy.

Secondly, the success of green roof projects depends on getting more stakeholders involved., a concept extensively explored in the co-creation paradigm (Casiano Flores et al., 2022) Incorporating citizens in climate adaptation initiatives, as highlighted in existing co-creation literature, holds considerable significance. Encouraging participation from NGOs and allied entities, alongside forging partnerships with industry, academia, and pertinent stakeholders, is pivotal. Formalizing stakeholder interactions and establishing enduring networks can stimulate knowledge exchange, innovation, and collective decision-making dynamics.

Thirdly, for comprehensive and sustainable green roof policies, it is crucial to consider several perspectives and align goals. All relevant perspectives would be taken into account and supported if policy goals were regularly reviewed, and diverse stakeholders were included in the decision-making process.

Fourthly, strategies and instruments need to be improved to maximize the effectiveness of green roof policies. Implementation would be more effective overall if monitoring and enforcement measures were strengthened, the effects of incentives were assessed, and potential conflicts or overlaps between programs were resolved. Lastly, assigning responsibilities and allocating adequate resources are essential for implementation success. The right steps could be taken to implement green roofs if the roles of the various actors were clearly defined, responsibility was maintained, and sufficient resources were allocated.

In conclusion, the implementation of green roofs in Leeuwarden can be significantly improved by improving governance aspects like involvement, collaboration, stakeholder engagement, perspectives, strategies, and resources. The city can get closer to achieving its sustainability goals and gaining the numerous environmental, social, and economic benefits connected with green roofs by addressing the identified challenges and implementing the suggested improvements.

## 7. Conclusions and Recommendations

### 7.1. Conclusions

In this section, I draw conclusions based on the analysis of interview data and an investigation into the governance challenges and elements affecting green roof policies in Leeuwarden. These conclusions are instrumental in assessing the current state of policy implementation and charting a path forward.

#### 7.1.1. Conclusion based on the GAT

**Levels & Scales:** My analysis reveals that the implementation of green roof policies and programs in Leeuwarden primarily relies on private initiatives rather than robust government intervention. The municipality bears the primary responsibility for implementation, but national and regional authorities remain minimally engaged. This lack of higher-level involvement poses challenges in developing a comprehensive policy framework for green roofs.

**Actors & Networks:** Stakeholder participation in Leeuwarden's green roof policies is limited, with local gardening companies driving installations without actively promoting policies. Collaboration among stakeholders is sparse, and historical working relationships are poorly documented. The inclusion of new actors and leadership changes face significant hurdles.

**Problems Perspective & Goal Ambitions:** Leeuwarden currently lacks well-defined policies or programs for green roofs with clear objectives. The focus leans more toward informal and recreational initiatives rather than strategic actions. A shift is necessary to integrate diverse stakeholder interests and establish specific, measurable goals. Procedures for continuous review, stakeholder consultation, and goal adjustment are vital for adapting to changing priorities.

**Strategies & Instruments:** The strategies and instruments for Leeuwarden's green roof policy remain in their nascent stages. Few homeowners' express interest in green roofs, leading to underutilized subsidies. Uncertainty surrounds monitoring and enforcement measures. A more inclusive approach involving various stakeholders and improved awareness is needed. Research and testing should refine policy effectiveness, but a defined framework or criteria are currently lacking.

**Responsibilities & Resources:** Roles and resources for green roof implementation in Leeuwarden lack clarity. While some responsibilities and information are well-established, others require further definition. The allocation of resources is limited, hindering comprehensive policy coverage. To enhance implementation effectiveness, clear role definitions and increased resource allocation are essential.

#### 7.1.2. Conclusion based on research questions

**Current Programs in Leeuwarden:** Leeuwarden's Climate Adaptive Subsidies Program has made significant strides in promoting sustainable urban development, encompassing green roofs, rainwater management, green gardens, blue-green roofs, rainwater utilization, and other eco-friendly initiatives. The Green Roof Subsidy Plan incentivizes property owners to adopt green roofs, demonstrating the city's commitment to greening both private and public infrastructure.

**Governance Challenges:** My analysis identifies critical governance challenges hindering green roof policy implementation in Leeuwarden. Limited involvement from higher-level governments, minimal stakeholder networks, a lack of clearly defined objectives, and overreliance on subsidies obstruct policy effectiveness. This narrow focus may impede a comprehensive and efficient policy framework. Moreover, insufficient funding for installation and maintenance poses a significant barrier.

**Governance Factors for Improvement:** To address these challenges and promote successful green roof implementation, several key factors should be considered. These include fostering trust and collaboration among government entities, facilitating stakeholder engagement, setting clear and adaptable goals, integrating diverse approaches, and ensuring adequate financial support.

By addressing these governance issues, Leeuwarden can move closer to achieving its sustainability goals and reaping the benefits of green roofs for the environment, society, and the economy. Implementing these recommendations will make Leeuwarden a model for other cities striving for sustainable urban development.

## 7.2. Recommendations

Four recommendations are made to improve the green roof policy implementation in Leeuwarden.

**Increase Subsidies:** Given the cost barrier, Leeuwarden should raise subsidies to encourage green roof adoption. Focus on affordability by providing free installation for green roofs up to a certain size. This strategy aims to attract a broader audience, beyond those solely interested in biodiversity.

**Mix Policies:** Implement a multifaceted policy approach by combining direct incentives, tax reductions, sustainability certifications, financial assistance, and reduced bureaucracy. Establish regulatory requirements like permits and landscaping standards. Consider mandating green roofs for new public buildings to drive adoption.

**Simplify Homeowner Programs:** Introduce a straightforward program for homeowners with predefined criteria and subsidies, tailored to different house types. Collaboration with commercial entities can enhance appeal and participation.

**Mandate Green Roofs:** Explore the possibility of mandating green roofs for new residential areas with numerous apartments. Balance enforcement with stimulation to encourage adoption, potentially through local government regulations.

## 7.3. Research Limitations

In this study, I applied the GAT questions as interview prompts, which presupposed a more comprehensive green roof policy and programme in Leeuwarden than actually exists. The primary policy plan in Leeuwarden revolves around a subsidy that covers only a modest portion of investment costs. Therefore, some interviewees found it challenging to address all questions comprehensively. Additionally, despite efforts to contact various types of experts, some individuals did not respond to interview requests, affecting the diversity of perspectives in this study.

## 7.4. Directions for Future Research

Future research should delve into understanding the reasons for the lack of interest among the general population regarding green roofs in Leeuwarden. Investigate factors such as awareness,

education, and perception of green roof benefits to inform targeted interventions and communication strategies. These findings can guide the development of effective campaigns promoting green roofs' sustainability, energy efficiency, and environmental benefits. Leeuwarden can then create awareness and acceptance of green roofs, encouraging broader adoption and participation throughout the city. Researchers may also consider examining successful models like Zwolle's citizen and government participation network for insights (Casiano Flores et al., 2023).

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## Appendix A. Consent Form

### Consent Form for “Assessing Green Roof Policies in Leeuwarden: A Stakeholder-Based Examination to Identify Effective Approaches for Encouraging Installation”

#### Research objective

The objective of this research is to provide recommendations that can support policymakers in enhancing the adoption of green roofs in Leeuwarden and making current policies more effective.

#### Ethical process

This research project has been reviewed and approved by the BMS Ethics Committee Humanities & Social Sciences of the University of Twente and the interviews in this study do not pose any significant risks to participants as we provide consent forms before the interview, and the topic of the study is not of a sensitive nature. Additionally, the questions in the interview are carefully crafted to avoid any potentially harmful or offensive content. If the participants feel uncomfortable, they can withdraw from the interview at any time. The tapes, digital recordings, or files used in the research will be destroyed at a specific stage in the research process. After the audio/video data has been transcribed and made anonymous following established guidelines, a secure destruction process will be carried out. This guarantees that the original tapes, digital recordings, or files are no longer kept or accessible, reducing the chances of unintentional exposure and protecting the privacy and confidentiality of the individuals involved.

*Please tick the appropriate boxes*

**Yes**    **No**

#### Taking part in the study

I have read and understood the study information dated [DD/MM/YYYY], 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.  Yes     No

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.  Yes     No

I understand that taking part in the study involves sharing information through methods like audio-recorded interviews, or written notes from observations. Questionnaires may be completed by either the participant or the enumerator. If audio or video recordings are made, they will be transcribed into text and eventually destroyed for privacy and confidentiality reasons.  Yes     No

#### Use of the information in the study

I understand that the information I provide will be used for preparing a thesis focused on providing recommendations to support policymakers in enhancing the adoption of green roofs in Leeuwarden and improving the effectiveness of current policies.  Yes     No

I understand that personal information collected about me that can identify me, such as [e.g., my name or where I live], will not be shared beyond the study team.

**Future use and reuse of the information by others**

I give permission for the *data that* I provide to be archived, so it can be used for future research and learning.

**Signatures**

_____	_____	_____
Name of the participant	Signature	Date

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

Golnaz Sajadinaini		
Researcher name	Signature	Date

**Contact Information for Questions about Your Rights as a Research Participant**

If you have questions about your rights as a research participant or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Humanities & Social Sciences of the Faculty of Behavioral, Management, and Social Sciences at the University of Twente by [ethicscommittee-hss@utwente.nl](mailto:ethicscommittee-hss@utwente.nl)

## Appendix B. Interview Questions

I am Golnaz SajadiNaini, a master’s student of Environmental and Energy Management at the University of Twente, and I am working on my thesis “Assessing Green Roof Policies in Leeuwarden: A Stakeholder-Based Examination to Identify Effective Approaches for Encouraging Installation” your insights will help me to gain a comprehensive understanding of the challenges and opportunities associated with green roof installations, and ultimately develop more effective policies and strategies to promote their adoption.

### Ethical aspects

In addition to this file, you are receiving an informed consent form that outlines the aims, activities, burdens, and risks of the research. Furthermore, I will ensure you that your involvement is entirely voluntary and that you have the right to withdraw from the research at any time without any negative consequences. To provide a comprehensive understanding as part of informed consent, I will use this data just for my academic research and assure you that your information will be treated with strict confidentiality and anonymity. Moreover, your answers will be anonymized.

### Research objective

The objective of this research is to provide recommendations that can support policymakers in enhancing the adoption of green roofs in Leeuwarden and making current policies more effective.

### Interview questions based on GAT

No	Dimension	Questions	Very high	High	Moderate	Low	Very low	Explanation
1	Levels & Scales	How would you rate the involvement of the different government levels (national, subnational, water board, etc.) in implementing green roof policies and programs in Leeuwarden?						
2		How would you rate the collaboration and trust among government levels when it comes to implementing green roofs in Leeuwarden?						
3		How easy is the adjustment at the governmental level when facing issues with the green roof policy? For example, to overcome challenges related to the implementation?						
4		Which level(s) of government in Leeuwarden is primarily responsible for leading the implementation of green roofs? How would you rate the influence that this particular government level has in supporting green roof implementation?						

No	Dimension	Questions	Very high	High	Moderate	Low	Very low	Explanation
5	Actors & Networks	How would you rate the extent to which all relevant stakeholders (NGOs, academia, industry, etc.) are involved in implementing green roof policies and programs in Leeuwarden? Are there any stakeholders excluded?						
6		How would you describe the level of interaction between stakeholders in green roof implementation? Are these interactions formalized and stable?						
7		How would you rate the extent to which the stakeholders involved in green roof implementation; do they have a history of working together? Do they trust and respect each other?						
8		How would you rate the facility to include new actors or to change leadership among actors for practical reasons?						
9		How would you rate the extent to which the involved actor or group of actors is driving green roof implementation? Who is the main actor?						
10	Problems Perspective & Goal Ambitions	To which extent are all the perspectives considered in the existing green roof policies and programs in Leeuwarden?						
11		How would you rate the extent to which the different perspectives and goals related to green roof implementation support each other?						
12		How would you rate the opportunities to review the goals of green roof policies and programs in Leeuwarden?						
13		How would you rate the difference between the goals of the green roof policies and programs compared to the current practices in Leeuwarden?						
14	Strategies & Instruments	How would you rate the inclusiveness and effectiveness of						

No	Dimension	Questions	Very high	High	Moderate	Low	Very low	Explanation
		instruments used in Leeuwarden's green roof policy, as well as the presence of monitoring and enforcement measures??						
15		How would you rate the effectiveness of the incentives in the green roof policies? Are there any conflicts or overlaps between the incentives?						
16		How would you rate the flexibility in combining different instruments in green roof implementation? Is there flexibility when choosing between programs?						
17		How would you rate the expected level of change required to improve the programs focused green roof implementation?						
18	Responsibilities & Resources	How would you rate the extent to which responsibilities and resources are clearly allocated for green roof implementation in Leeuwarden?						
19		How would you rate the extent to which the assigned responsibilities are aligned with institutions involved in green roof implementation?						
20		How would you rate the feasibility of pooling responsibilities and resources in green roof implementation without compromising accountability and transparency?						
21		How would you rate the number of resources allocated to implement the necessary measures for the desired change in green roof policies and programs in Leeuwarden?						