September 25, 2018

Participating in Vertical Gardens:

A stakeholder analysis on the implementation of vertical gardens in the urban environment

Master Thesis

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MSc Urban Environmental Management

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Preface

This master thesis is a piece of patience, troubled minds and a surprising will to continue. It is a paper that was produced with a love for greener cities, for trees, for bees, and a curiosity to understand the relevance they have for others around me. However, none of these things had mattered were it not for the support, love and care of the following people. First, I would like to thank De Dakdokters and Friso Klapwijk specifically, who gave me their trust to do this research, joining their quest in making cities a more healthy and happy place to live in. For me, their trust was a precious gift that I've tried to treat with much care and hope not to have disappointed. Arriving at their office to dive in my headphones-on-don't-disturb-me-bubble felt like coming home, (almost) every time. Hand-in-hand with their support comes Herman Kok, my supervisor and ever smiling support on the other side of our Skype-calls, who was able to guide me through the process of *thesising*. Herman helped me to approach the stumble-blocks on a thesis-road with the casualness of ordering a pizza. Optimism triumphed after each Skype-call we had. And on that same medium, I've found another committed supporter in my second supervisor Domenico Dentoni. His warm and often concise feedback showed me the weak and strong points in my research in the blink of an eye. Thank you all for helping me to trust my own qualities.

The following friends and family did not choose me as a thesis-brother, -friend, -son or -lover, but decided to deal with it when I became one. Thank you PaMaLo, for your unconditional support and trust. It is a space of much love and comfort I find when I come to the Leidse, every time. Thank you Kasper for the endless cups of tea and light words in tougher times (I think being roommate to a master thesis student is one of the worst things one can do to a friend, but you carried the burden as only you do). Thank you Jim for dragging me to a library now and then, sharing the enlightening ice-skate sessions with me and your support in the end. Thank you Joy, for the autonomy you helped me find and pleasure and possibilities that come with agreeing that life sucks. Thank you Joris and Josefien for taking the time to discuss the terror and beauty of quantitative data. Thank you Oreane for offering your Milano palace to us, making it possible to touch and feel the Great Bosco Verticale. Thank you Vera, thank you Elspeet, for swine and fish in the final episode. Thank you Andhim. And thank you Nienke. It has been quite a ride, and you chose to join me in that rollercoaster wagon, giving advice in strong turns, holding my hand in each looping and comforting me during every freefall. I love you.

During this thesis, I've learned some things about science and non-science, a thing or two about vertical gardens, but one thing stands out: writing a thesis is not something you do alone.

Jaap van den Biesen
21st of September 2018
Amsterdam

(picture on cover: Bosco Verticale in Milano. By author, 2018)

Abstract

At no time before the earth's surface has known such a large share of urban area. Continuous urbanization will double the number of urban residents before 2050. Studies show the quality of urban life is under pressure. Vertical gardens are believed to provide positive effects to the quality of urban life, but implementation so far is limited. Literature shows that the implementation of complex projects is strongly depended on its stakeholders. By means of a stakeholder analysis, this study explores what constitutes the attitudes of stakeholders on the implementation of vertical gardens. Three main factors are explored: their attitude towards the effects of vertical gardens, towards other stakeholders and towards critical success factors (CSF) for project implementation. Stakeholders are studied by semi-structured interviews and a questionnaire. The results are analyzed with a two-mode social network analysis.

This study finds that the studied stakeholders expect much of the participation of municipalities. They consider a supporting role of the government crucial for successful implementation. Also, they are risk averse, stress the importance of proven technology and value increasement of property value, some requiring a return on investment. When asked to value the effects of vertical gardens, stakeholders prefer general effects such as improving the well-being of residents, greening the city and its esthetics, over the more specific effects, such as mitigation of air- and noise pollution, heat stress and providing water retention. It is these latter effects of which they think to have a lack of knowledge and trust.

As this study is an exploration on the different attitudes of stakeholders, researchers are invited to follow-up this study to check the representation of the population of these findings. This study also advises local governments to experiment with different systems, investing in research on the effects and a return on investment. Further research should also include creating a framework in which these effects and different vertical garden systems can be compared.

Keywords: vertical garden, stakeholder analysis, critical success factors, attitude, two-mode network analysis, betweenness centrality

List of Acronyms

CSFs	Critical Success Factors
EGLS	Elevated Ground Level System
LWS	Living Wall System
NGO	Non-Governmental Organizations
ROI	Return on Investment
SNA	Social Network Analysis
UHI	Urban Heat Island

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1. The Urban Quality of Life

1.1. Urban Challenges

With the contemporary layout of the modern city, the quality of urban life is under pressure. The list of challenges that urban residents face is long. The increase of extreme precipitation and rising temperatures cause pressure on the stability and security of urban living conditions. Heat stress (e.g.: the Urban Heat Island effect) and air pollution endanger human health. Floods due to extreme precipitation cause infrastructural problems. And drought and waters scarcity put the urban resources under pressure. Diminishing biodiversity decreases the resilience of the urban and surrounding ecosystems. It may be clear that today's urban challenges require action to sustain and to improve the urban quality of life. But how?

Only recently, climate mitigation and adaptation is becoming a part of urban governance. An important innovation in these policies is integrating vegetation in the urban landscape. "Green for grey" is a method to increase the cities' resilience and respond to the challenges of urbanization and climate change (Groot et al., 2015, p. 1). This study explores the attitudes of stakeholders towards one of such innovations: the vertical garden, an innovation with intriguing qualities, but so far only limited implementation. More specifically, this study examines how the stakeholders' attitudes towards the effects of vertical gardens, towards other stakeholders and towards critical success factors constitute their attitude towards the implementation of vertical gardens. In other words: how do these isolated opinions influence their overall view on the implementation of vertical gardens?

1.2. Problem Statement

Given the long list of positive effects of vertical gardens, the question arises: why are vertical gardens not yet at a large scale implemented in our cities? Vertical gardens are believed to mitigate air- and noise pollution, reduce heat stress, have the capacity to buffer rainwater, and affect people positively. One would expect that with such a list of benefits one vertical garden project after another would be realized. However, currently this is not the case. A large scale implementation is not occurring. The question arises which preconditions would enable implementation of vertical gardens. And what conditions are needed for who? This study examines the attitudes of stakeholders towards the implementation of vertical garden projects. The problem statement can therefore be summarized as the following:

Although vertical gardens seem to offer relevant solutions to urban challenges, there is only limited implementation of such systems. Currently, little insight exists in the attitudes of stakeholders towards the implementation of vertical gardens. Therefore, it is unclear what their attitudes are and how these are constituted.

1.3. Research Objectives

By conducting qualitative and quantitative research, this study explores the attitudes of stakeholders towards the implementation of vertical garden projects. By focusing on specific aspects of the implementation of vertical gardens, it is attempted to develop a deeper

understanding of what constitutes the stakeholders' attitude towards implementation. It is not an aim of this study to gain representative data for the entire social network around vertical gardens, as too little is known on the dynamics around this relatively new innovation. Instead, the study aims to map the different narratives of experts directly or indirectly related to vertical gardens.

1.4. Research Questions

Both the scientific and societal aims of this study require an approach that combines scientific literature with day-to-day practice and experience in the field. The research questions aim to combine exploring earlier studies on vertical gardens and starting a dialogue with the stakeholders that work with (related) topics every day. These stakeholders, being part of an enterprise, organization or governmental institution, are considered key in the implementation of vertical gardens. Thus, the main question of this study explores their position:

- To what extent do the stakeholders' attitudes towards effects, towards other stakeholders and towards critical success factors constitute their overall attitude towards the implementation of vertical gardens?

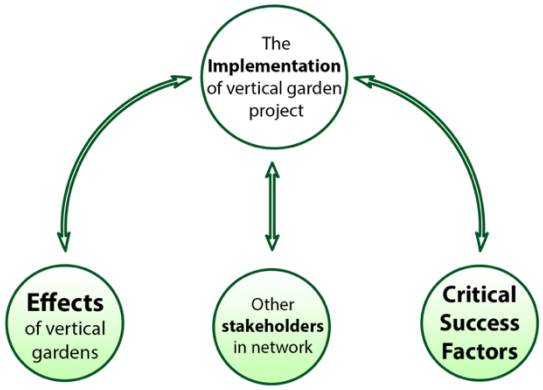

Figure 1 | Schematic drawing of connection of attitudes, as posed in the main research question

The first of these aspects concerns the effects of vertical gardens. A study called 'Cost–benefit analysis for green façades and living wall systems' found that different functionalities of a vertical garden positively affect multiple stakeholders (Perini & Rosasco, 2013). However, they found that for a single stakeholder the cost-benefit analysis of a vertical garden is currently negative. Simply put, most benefits do not end up with a single stakeholder (2013, p. 119). It raises the question how and by who these positive effects could be experienced and whether that affects their general attitude towards the implementation of vertical gardens? No study has been conducted on this topic, yet.

As a second aspect, the role of different stakeholders may be influential. Literature shows, that the success of complex projects is strongly influenced by its involved stakeholders (Gable & Shireman, 2004; Liang et al., 2017; Varvasovszky & Brugha, 2000). What positions within the stakeholder network are relevant? Who should be doing what? Do the attitudes of stakeholders towards other stakeholders in the network shape the attitude towards implementation?

As a third, a closer look may be needed at factors that are considered crucial for successfully implementing vertical gardens. Liang et al. (2017) introduced critical success factors (CSFs) to

stakeholder analysis of complex projects. Relating project success with the attitude of stakeholders towards critical success factors showed to help understanding the preconditions of project implementation. How do the attitudes of stakeholders towards critical success factors influence their attitude towards in implementation of vertical gardens?

The schematic drawing in Figure 1 illustrates the connections this study addresses. The following sub-questions together help to come to a substantiated answer to the main research question and the issues discussed above:

- What are the effects of vertical gardens in the urban environment?
- How can stakeholders be identified?
- How to measure attitudes of stakeholders?

These questions are expected to find their answers in contemporary literature, as much of these topics has been researched. The following questions will guide the empirical part of the study:

- What stakeholders are affected by or concerned with the implementation of vertical gardens in the urban environment?
- What are the attitudes of these stakeholders concerning vertical gardens and their effects in the urban environment?
- How do these stakeholders perceive the relevance of involvement of or partnerships with other stakeholders?
- What do these stakeholders consider to be the most relevant critical success factors (CSFs) for the implementation of vertical gardens in the urban environment?

Together, these answers guide the study towards an answer on the main research question of this study and help to assess what the attitudes of stakeholders are and which factors are considered important for implementation of vertical gardens.

1.5. Research Approach

In the next chapter a literature study explores the topic of urbanization and its challenges, discusses vertical gardens and its effects and elaborates on stakeholder analysis and research methodologies. The relevant concepts are discussed in the light of recent scientific publications. In Chapter 3, the methodology of the fieldwork is explained, describing the relation between the literature study and the collection and analysis of qualitative data. In Chapter 4, first the results of the collected data are presented, and then the analysis and interpretation of these results. Chapter 5 presents the conclusions and recommendations of the study.

2. Literature Review

2.1. Introduction

This chapter provides an overview of concepts and theories on the urban quality of life, vertical gardens and stakeholders analysis. Diving into each of these topics provides the scientific background of this research and clarifies the relevance of this study. The following paragraph addresses the need for climate adaptation and mitigation in the urban environment. Paragraph 2.3 explains how vertical gardens could play a role in this; the potential values and functionalities of vertical gardens are listed and explained. Paragraph 2.5 explores the concepts and theories around stakeholders. Together, these paragraphs embody the foundation for this study.

2.2. The Urban Challenges of Urbanization

In The Netherlands, the last 25 years have shown a new trend in demographics. Where in the 80s, residents moved to rural areas close the cities, recently a reversed phenomenon has unfolded: urbanization, "the increase of the urban population share from the total" (Unguru, 2017, p. 48). The urban areas have grown significantly, while the rural areas have seen a decrease in inhabitants (de Beer et al., 2007). This trend of urbanization is not a Dutch particularity. Globally, cities are growing rapidly. Urbanization has become a worldwide phenomenon, a megatrend (UN-Habitat, 2005; Unguru, 2017).

There are many causes for this tendency, but generally said, people are attracted by the cities' promises of wealth, opportunities for living and jobs. By moving to urban areas, they hope to improve their quality of life (Keivani, 2010). And in terms of economic growth, this is spot-on. Cities in low-income countries contribute up to 55% of the gross national product, in middle-income countries this is 73% and in high-income countries this is 85% (UN-Habitat, 2006, p. 48). More recent numbers show an 80% production of global GDP by cities (UN-Habitat, 2016, p. 143). Also, cities offer efficient usage recourses, information sharing, political power and cultural development. However, it is also exactly the quality of life, that is pressured in an urban area.

In 2005, cities were the largest contributors to greenhouse gas emissions and the most important consumers of resources. They consumed 75% of the world's resources and produced up to 80% of global CO2 emissions (UN-Habitat, 2005). Cities are significant contributors to the global climate change. And it is these same cities, where residents are highly vulnerable for the many challenges and risks that climate change brings.

2.2.1. Urban Challenges

The current trend of urbanization is expected to continue for the coming decades. While urbanization is often associated with economic growth, it should also be assessed in a wider context of human development. Urbanization is not by definition an improvement of quality of life (Unguru, 2017). On the contrary, urbanization, "namely the increase of the urban population share from the total" (2017, p. 1), may be closely related to major environmental issues. Challenges such as increasing urban heat island effect, greenhouse gas emissions and reductions of energy sources can be attributed to dense urbanization (Besir & Cuce, 2018). Various studies have connected these phenomena.

Urbanization is caused by a cities promise to create wealth. People from rural areas are drawn to the urban environment by the offer of greater life opportunities (Keivani, 2010, p. 7). However, these attractive aspects of the urban life, may cause disappointment. Keivani (2010) lists the contemporary major challenges that urbanization brings. In this study, these challenges are categorized in social, economic and environmental fronts. Keivani lists:

- **The emission of greenhouse gases (GHG)** and the impact this may have on a global scale. On a world scale, cities consume 75% of the world's resources and as a consequence produce 80% of CO2 emissions (UN-Habitat, 2005). In Europe, the emissions of greenhouse gases by buildings take up to 36% of the total energy consumption (Cuce, 2017).

- **Natural disasters** that affect the safety and living conditions of urban residents. Of which some of these disasters may be caused by GHG, such as heat waves, hurricanes and floods (Keivani, 2010). These forces of nature are only more dangerous if the special planning and design of cities are not properly adapted (Keivani, 2010, p. 10). Keivani illustrates the destructive effect natural disasters can have on cities with the devastating effects of the tsunami's on Haiti and Indonesia in recent years (2010, p. 10). But also less dramatic forces of nature can have severe influence on the urban quality of life. The Netherlands experienced a rare heatwave in the summer of 2018 for example. Although it may be too early to tell whether this could be attributed to climate change, it does give an impression on how severely such changes can influence the urban way of living. 'Code Oranje' [Code Orange] was given for the country as a whole, influencing the cities quality of life as further explained below (KNMI, 2018).

- **The Urban Heat Island effect**: causing higher temperatures in urban areas than its surrounding areas, due to the physical characteristics of the urban environment. During the aforementioned heatwave in The Netherlands, it was reported that temperatures in Amsterdam were expected to be at least 4°C higher, than its surrounding rural areas (Parool, 2018). Different studies support these phenomena. A study comparing the urban areas of New York City with its surrounding rural area measured a temperature difference of 2°C. Such differences are caused by the physical difference of landscapes (Cuce, 2017).

Figure 2 | Code Orange during heatwave summer 2018. Title translation reads: 'Code Orange for extreme heat in the entire country, except the Wadden-area". In the text that follows a description of heat during night and day is given. Also there is a mentioning of a National Heat Protocol (KNMI, 2018)

- **Air pollution** caused by combustion and erosion that accompanies human activities. In Chinese cities, facing severe air pollution, some studies indicate this claims some 300,000 lives prematurely, every year (Keivani, 2010, p. 10). Also in The Netherlands, cities struggle with air quality. During the heatwave of 2018, urban residents were warned for smog in the entire Randstad. A combination of the urban heat island effect and air pollution causes to increase the levels of pollutants (Luchtmeetnet, 2018).

Figure 3 Air quality in Rotterdam. Showing poor quality of air (red) around highways and industrialized areas (Luchtmeetnet, 2018)

- **Noise pollution**: "Noise is any sound which is unpleasant, unwanted or so loud that it causes or can cause disturbance or irritation" (Gupta et al., 2018, p. 300). The production of noise in close distance of human presence, has grown rapidly with the trend of urbanization. Traffic, industries and other human activities cause significant levels of noise in the urban area. When *noise* becomes *noise pollution* it has reached a level in which it can cause

temporary or permanent damage to the health of people or animals. Noise pollution, especially nocturnal noise, can have serious negative long-term effects on people, specifically on children, pregnant women and elderly people (2018, pp. 300–301). It is estimated that in The Netherlands about 1,5 million people are affected by severe noise pollution on a daily basis. At night, people are mainly disturbed by scooters, trucks, cars and -of course- their neighbors. As traffic is a main contributor to noise pollution, sources are found at highways, but also around roads in the urban area. The map in Figure 4 shows

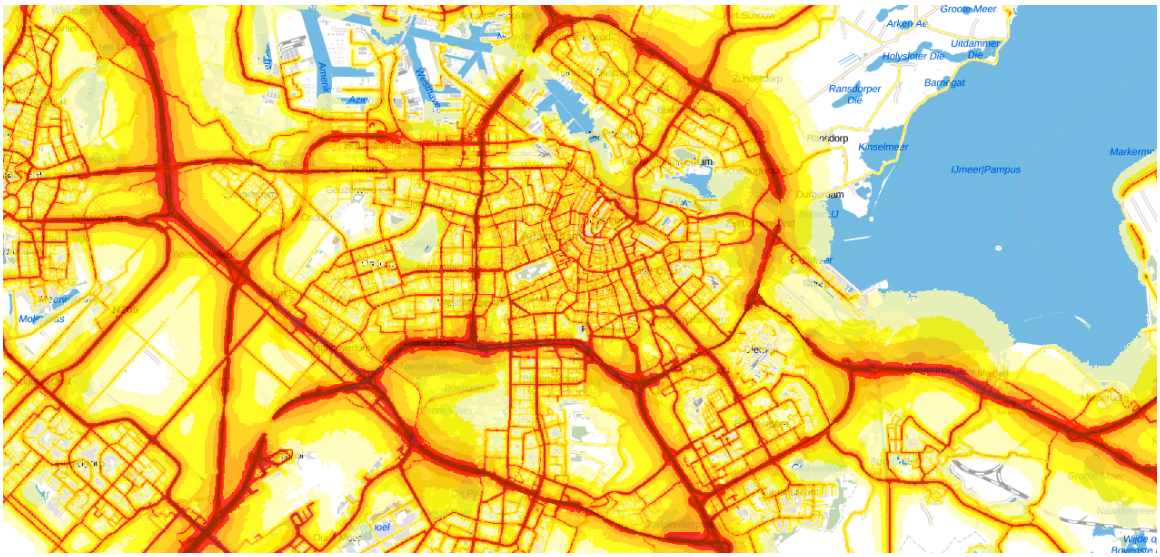

Figure 4 | Noise levels produced by traffic, ranging from 45dB (light yellow) to ≥75dB (dark red) (RIVM, 2016)

the noise pollution caused by traffic. Although highways seem to cause most traffic noise, the impact of these sources is limited. Residential areas where smaller roads pass closely to houses, the effects are much more severe (RIVM, 2016).

Together, these urban challenges illustrate the serious consequences for large numbers of people living in densely populated urban areas. Vertical gardens are expected to address most of these issues. Perini et al. state: "In general terms the main benefits connected to a green building envelope regard: environmental practices, economics, and social aspects, such as the greenhouse gases output reduction, climate change adaptation, air quality and indoor and outdoor comfort conditions improvement, urban wildlife (biodiversity), etc." (Perini et al., 2013, p. 110). But what is a vertical garden? The next paragraphs discuss its definition, various systems and its effects.

2.3. Vertical Gardens

Vertical gardens exist in many shapes and forms. Their definitions are diverse and so are their effects. This study does not aim to give a detailed insight to all variants, but to get a *feel* for the topic, the following paragraphs give a taste of the general characteristics and the main attributed effects.

2.3.1. DEFINING A VERTICAL GARDEN

In current literature, the topic of vertical gardens is discussed with a diversity of wording. In some studies, the word *green wall* or *green façade* is used (Besir et al., 2018; Hurtado Jaramillo et al., 2018; Ottelé, 2011; Perini et al., 2011, 2013). In others, authors speak of a *vertical greenery system* or in short *vertical greenery*. Only in very few studies, the word *vertical garden* is

used (Perini et al., 2013). Considering the diversity of systems, this latter description of vertical vegetation feels most appropriate. Therefore, this study chooses to use this word. But it should be taken into account that these words are just descriptive terms to describe more or less the same topic.

The question arises: what does a vertical garden look like? And how does it work? In the study of Ottelé (2011) the a first basic distinction is made to describe a traditional and a modern versions of a vertical garden. The traditional vertical garden is simply ground rooted. This means that although the plants may cover a wall vertically, their roots are still planted in soil at ground level. These plants are creepers, and climb directly on a wall, or with the use of some sort of supporting grid. The modern approach to the vertical garden uses technologies to be able to lift the root level to higher parts of a wall. This could be achieved potting soil of different varieties of artificial substrates, such as rockwool (Ottelé, 2011, p. 9), see also Figure 5.

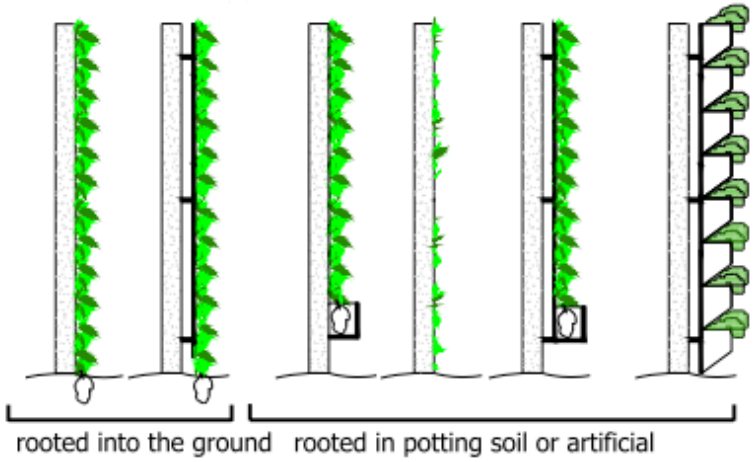

Figure 5 | Schematic illustration traditional and modern systems (Ottelé, 2011, p. 9)

This figure shows that within the two categories, different set-ups exist. As said, the fundamental difference between the two categories lies in the position of the substrate or soil and thereby the roots. For the system set-up in which the plants grow, this has a significant impact. The modern systems need to provide far more and complex services, than the traditional. Where in the latter the plants can find nutrients and water in the natural soil, the modern versions cannot. This means that nutrients and water need to be added by an irrigation system and monitored constantly. Of course, such requirements influence the costs, maintenance and complexity of a project. Why choosing these systems? In the next three paragraphs, three versions of a vertical gardens will be discussed. The first is the traditional set-up, in which these creeper-systems are described, discussing their pro's and con's. In the other two paragraphs the two extremities of the modern systems are discussed: the Living Wall Systems (LWS) and the Levelled Systems (LS).

2.3.2. CREEPERS

Figure 6 | Creeped house in Milano, by self-clinging climbers (photo by author, 2018)

Creepers, or climbers, can be considered as traditional vertical gardens. These plants have a strong tendency to grow upwards towards the light. There are two different categories of climbers: 1) self-clinging climbers: plants that need no support system to climb a wall; this category is able to climb a wall without any human interventions. As long as the wall has some sort of rough surface, these plants will find their way up. Category 2) concerns climbers that do need support: these plants do tend to climb, but are not suited to climb a wall or similar kind of construction. This means that the latter category needs a support system that is attached to a wall, with some distance – depending on plant species. (Ottelé, 2011, p. 17).

While choosing between these categories may lie within the preferences of stakeholders of vertical garden project, some persistent misconceptions about climbers also influence these decisions. Around self-clinging climbers, there is a widespread belief that these plants are harmful to a wall. They are believed to damage cement joints with their roots or damage paint.

2.3.3. LIVING WALL SYSTEMS

Figure 7 | Interior vertical garden, London (photo by Friso Klapwijk, 2018)

Living wall systems (LWS) are a technological innovation of the last few decades. The French artist and botanist Patrick Blanc gave these systems world fame after his first creations in Paris,

in 1988 (Wilkinson, 2017). Since then, many innovations have created a wide variety of systems to the market. In this paragraph, the most popular variations are discussed and explained. But first the question arises: what exactly is a living wall system? And where does it differ from climbers and the elevated ground-level systems?

Living wall systems are what they promise to be: plants integrated in vertical systems that are attached onto or inserted into a wall, making the wall seem *alive*. The systems that are behind this magic are diverse, but have several things in common: they need an irrigation system, they need artificially added nutrition and they need close maintenance. Providing these services is challenged by rules of nature, of which gravity may be one of the most challenging aspects. Because how does one assure equal irrigation and nutrition on a large wall? And should a system avoid soil or substrate being washed of blown out? Below, several approaches of these issues are illustrated with some examples.

LWS Pre-grown panels

Figure 9 | Installing pre-grown panel by Sempergreen (Sempergreen, 2018)

To overcome the challenges gravity creates, pre-grown panels are one out of several solutions. The panels are pre-grown in a controlled set-up. The plants are rooted in so-called hydroponic systems. A hydroponic system is unlike a soil-based system free of natural soil. Plants use soil as mechanic root support. This support can also be provided by other materials, such as rockwool. As long as water and nutrients are fed into the artificial substrate, the plants can thrive in a soil-less environment (Urban Greening, 2017). Pre-grown panels use such system. In The Netherlands, Sempergreen is one of the main providers of these systems. Their system consists of modular panels of about 60cm^2 that can be connected together. For a period of several years, the plants are pre-grown elsewhere in a layered rockwool system. When installed, the panels are fully grown, and give an instant covering effect. With an irrigation system the plants are watered on a daily basis. The irrigation system is also used to provide liquified nutrients when needed (Sempergreen, 2018).

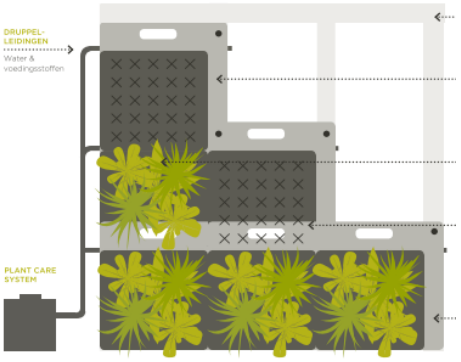

Figure 8 | Schematic drawing of pre-grown panels by Sempergreen (Sempergreen, 2018)

LWS Based On Gabions

Figure 10 | Gravel filled gabions by Optigrün (Optigrün, 2015)

Where the pre-grown panels may be very light, the gabions are anything but. The metal cages filled with gravel are a relative heavy weight in the categories of vertical gardens. The gravel however, provides a much more spacious and dynamic feeding ground for its plants than the rockwool counterparts. The system that was offered by the German company Optigrün has similar dimensions with a 65cm^2 surface. Just as the panel system, the gabions are irrigated by an irrigation system. Because of the weight however, the preconditions of wall support are much more significant. That, among other reasons, is the reason why the organization currently stopped producing the system (Optigrün, 2015).

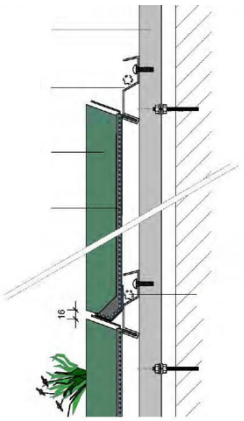

Figure 11 | Schematic illustration gabion (Optigrün, 2011)

LWS With Planter Boxes

Figure 13 | Planter box system by Gsky (photo by Klapwijk, 2018)

A very different approach is chosen with the planter box systems. These systems exist in various variants, but have as a shared characteristic that they are soil based, and make use of individual containers that are aligned together. The benefit of such system is its 'natural' approach, using natural soil as substrate and positioning the plants in a slight angle. Also, the system requires less irrigation as water is captured within in the boxes, and cannot move downwards. A final benefit of such system is found in its maintenance, as mature plants can be installed as a replacement of deceased plants. In the Netherlands, different variants of this system are offered. Gsky offers a system that uses universal cultivation boxes. Compared with the gabion system, the boxes are relatively light. But the boxes are heavier than a panel system.

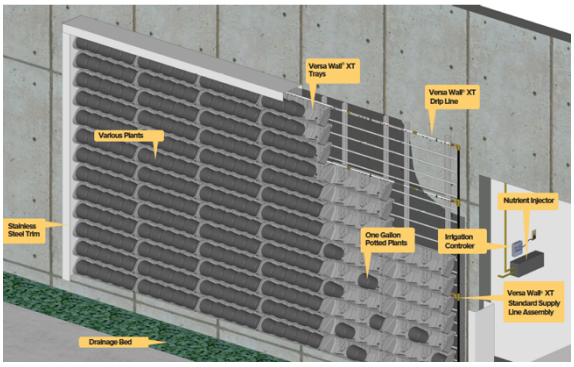

Figure 12 | Schematic illustration of Gsky system (Gsky, 2017)

LWS With Felt Pockets

Figure 15 | Detail of felt pocket system (Projekta, 2018)

Similar to the planter box and gabion system, the felt pocket system organizes the plants individually. This relatively light-weight system contains its plants within cutouts in the outer felt layer. Due to its flexible characteristics the system is capable of being placed on curved surfaces. In The Netherlands, this system, called the Wonderwall, is installed by Copijn. Just as the rockwool systems, these set-ups need frequent irrigation. This irrigation is provided by a dripline, that runs between each panel (Projektna, 2018). See also Figure 14.

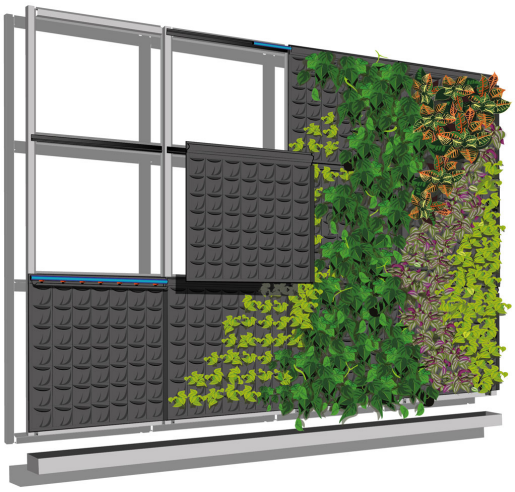

Figure 14 | Schematic illustration of Terapia Urbana Fytotextile (Projektna, 2018)

2.3.4. Elevated Ground-Level Systems

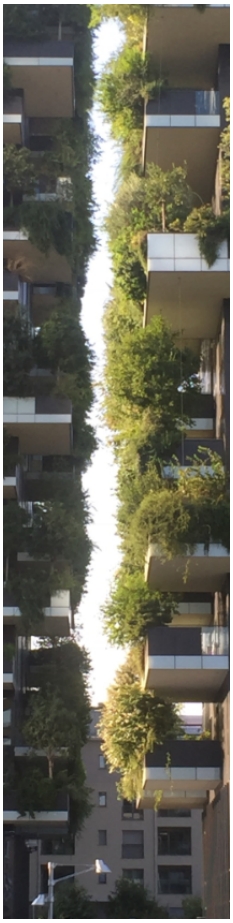

Figure 16 | Bosco Verticale in Milan (photo by author, 2018)

Vertical gardens as discussed in the previous two paragraphs are designed to cover a façade as much as possible. Both the creeper and the living wall system are attached to existing walls and are measured by square meters. An elevated ground-level system (EGLS) has a different approach to be organized vertically. One could consider an EGLS as divided areas of horizontal surface, distributed over different vertical levels on the outside of a building. Figure 16 shows Bosco Verticale, a revolutionary approach to organizing vertical green, finished in 2014. The building has since then become an icon of the city of Milano. Its architect, Stefano Boeri, is invited to build these towers in many dense urban areas all over the world. For Eindhoven and Utrecht, the architect will build similar towers in the upcoming years (Boeri, 2018).

Figure 17 | Schematic drawing Bosco Vertical (Boeri, 2018)

The available horizontal surface in dense cities is limited for creating green spaces. This approach aims to maintain as much of the several qualities of vegetated area, such as high biodiversity and water retention capacity, per square meters. It also connects green spaces to living areas. Integrating plants more into the lives of residents, as can be seen in Figure 17.

2.4. Effects of Vertical Gardens

Urban challenges are not new in the urban planning paradigm. As a response to many of the above challenges, the topic of urban green has rocket-launched in the recent years. Vegetation is believed to have many positive effects for the urban quality of life. But within this tremendous energy and enthusiasm for the topic of urban green, it may be difficult to stick to the cold facts. As the pace of business may show impressive powers, it also risks to overrun the evidence-based knowledge and insights, resulting from extensive research in controlled and uncontrolled set-ups. Much research has been done to the effects of vertical gardens in the urban area of which this chapter will give an overview (Besir et al., 2018; Hop & Hiemstra, 2013; Marchi et al., 2015). However, most of these effects are measured within controlled set-ups, and not in an urban context. Also, the diverse types of vertical gardens make comparable data not only sparse but also scattered over different systems (Azkorra et al., 2015).

2.4.1. AIR QUALITY IMPROVEMENT:

Literature shows that vegetation can be used to reduce the amount of air pollutants (CO2, NOx, PMX and VOC's). Generally put, there are two ways in which a plant influences the air-quality. The first, is the conversion of pollutants that follow from combustion in cars and industry. NOx for example, is converted to nitrate NO3- and nitrite NO2- by plants. The second way to filter the surrounding air is by the ability to filter fine dust out of the air, so-called particulate matter (PMX). Particulate matter is caused not only by combustion, but also the wear of human activities, of i.e. tires or machines. The sort and dimensions of vegetation however, determine much of the effectivity of the plant's capacity to purify the air (Ottelé, 2011, pp. 32–33). "In general, the more hairy and the rougher the leaf surface is, the more fine particles can be absorbed" (2011, p. 33). These effects can have significant effects to the wellbeing of inhabitants. Ottelé states: "The improved air quality by vertical gardens has direct benefits for people who suffer a long disease (Ottelé, 2011, p. 34).

2.4.2. ECOLOGICAL ASPECTS:

A vertical garden could be considered as a mini-ecosystem. The building a vertical garden is attached to is no longer just a wall, but it is now a place that has diverse functions within a bigger food structure. It has its own energy flows, water storages and functions as a habitat and feeding ground for birds, bees, bats and smaller insects. For these animals it provides ecological services such as breeding and resting. "Incorporating nest boxes into vertical garden concepts (linking of functions) will increase the impact of these measures relatively to when applied separately (Ottelé, 2011, p. 36).

2.4.3. PROTECTION AGAINST DRIVING RAIN & SUN RADIATION

Vertical gardens are often treated with suspicion when it comes to building preservation. As said creepers are considered to be dangerous for the quality of a brick wall, as it is feared that the plant may damage its joints. However, literature shows that a well maintained wall is better preserved when a vertical garden is attached to it, whether it be by vertical substrate or climbers. "Well developed vertical gardens (closed foliage) form an effective protection against driving rain, because it prevents rain from reaching the surface of the façade. (…) Also, 50% of the solar energy was absorbed and 30% was reflected by the foliage" (Ottelé, 2011, pp. 39, 40, 47). The protection against both rain and sun thereby contribute to the quality and lifespan of the original wall. A recent study compared the functionalities of panel systems and planter box

systems. It showed that both systems can absorb rainwater during smaller precipitation events. For larger rainfall, the buffer system is too limited. By means of evaporation, the panel and planter box systems have a cooling potential of 18 kWh/m²/year and 11 kWh/m²/year respectively (van de Wouw et al., 2017, p. 232).

2.4.4. HEAT STRESS

Vertical gardens affect their surrounding temperature in threefold and as such create a local micro-climate. They function as a water buffer, as a blockade of sunlight and they cause a stagnant air-layer. The water buffering causes the process of transpiration and evaporation. Plants keep their inner-temperature stable by active transpiration and evaporation. Hereby water is longer buffered than on hard surfaces such as a brick or glass wall (Besir et al., 2018, p. 924). The water added to the air causes its surrounding temperatures to lower and create a pleasant living area. By blocking the sunlight on the vertical structure, reduces the indoor temperature of the building. In winter times, this effect functions in the opposite direction, by reflecting indoor heat radiation. As a third effect, a stagnant air layer is created between the plants and the wall. Just as double or triple glass, the stagnant air provides an insulating effect (Ottelé, 2011, pp. 38–39).

2.4.5. SOUND ABSORPTION & NOISE REDUCTION

Several studies found that vertical gardens can have an insulating and/or sound reducing effect in urban areas. The insulating effect reduces external sounds reaching internal spaces of houses and offices. The sound reducing effect describes the effect of sound being affected by the physical shape of the plants in the vertical gardens (Besir et al., 2018, p. 936; Perini et al., 2013, p. 112). Plants can absorb, reflect and diffract noises, depending on their shape and positioning. This means that by selecting the right plant types and positioning them properly, plants could improve the living area of people. "In test setups, lower and midrange frequencies were reduced by the substrate used in the vertical garden setups. It was found that the leaves of plants reduced the reflection of higher frequencies" (Ottelé, 2011, p. 45). Compared with other common building materials, vertical gardens showed a similar or better acoustic absorption of sound. Even more, "its effects on low frequencies (…) were better than those of some current sound-absorbent materials at low frequencies (Azkorra et al., 2015, p. 55).

Figure 18 | Testing absorption coefficient in a reverberation room (Azkorra et al., 2015, p.

2.4.6. SOCIAL IMPACT

"The skin of cities can be transformed into living landscapes where dwellers and nature can take advantage of numerous benefits that come from growing vegetation on and around buildings" (Ottelé, 2011, p. 4). This quote sketches a romantic image of the social benefits of vertical gardens. The image envisions an urban landscape that resembles an urban park, more than a city. Although this vision may be attractive, it also illustrates the difficulty to quantify and measure the effects of a square meter of vertical green. Literature shows that human wellbeing is improved by the presence of vegetation. People are attracted by living green. This phenomenon is called *biophilia* and was coined in 1984 in a publication of E.O. Wilson. He describes the phenomenon as the urge to attract to other forms of life (Wilson, 1984). Being close to other forms of life appears to have positive impact on the wellbeing of people. Some

research indicates that the presence of plants reduces stress levels and lowers blood pressure. When comparing urban and nature environments, "influences of nature involve a shift towards a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention/intake" (Ulrich et al., 1991, p. 201). Vertical gardens may have a positive impact on the wellbeing of urban citizens, but this impact may be hard to define per square meter vertical garden. However, a 'living landscape' as described by Ottelé may resemble a more nature-like environment. It may be expected that such environment could have a similar effect to the human wellbeing as the nature surroundings in the mentioned studies.

To conclude, the effects of vertical gardens show a diverse profile. Vertical gardens offer potential added value on many areas, but most of these effects are only measured within lab set-ups. It seems that research on vertical gardens has created a solid foundation, but needs much more attention to be extrapolated to the day-to-day urban life. However, the effects have a potential to influence many stakeholders. The next paragraphs discuss how these stakeholders can be identified and how these relate to each other within a social network.

2.5. Stakeholders

How can stakeholders be identified? The following paragraphs dive into the literature on this topic, discussing what stakeholders are, how to identify them and how they relate to each other. After the appearance of the book of Freeman in 1984, *Strategic Management: A Stakeholder Approach,* it became evident that stakeholder analysis is a crucial tool in understanding a project management. In an effort to help managers of organizations to determine who matter to them, and who do not, Freeman proposed his stakeholder theory. Freeman defined a stakeholder as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (R. E. Freeman, 1984). Practically that meant that stakeholders could be "persons, groups, neighborhoods, organizations, institutions, societies, and even the natural environment" (R. K. Mitchell et al., 1997, p. 884). Since then, many different tools have been developed to map, measure, indicate and connect stakeholders and their dynamics (Littau et al., 2010). But in general terms, a stakeholder analysis is used to organize and map the positions of involved actors in relation to an activity, project or issue, and to each other (Brugha & Varvasovszky, 2000, p. 341). The central question to stakeholder analysis is however, how to determine who is a stakeholder and who is not a stakeholder. Freeman's definition does not help to define the range in which the affected stakeholders should be identified, nor does it define what a 'stake' is (R. K. Mitchell et al., 1997, p. 885). Therefore the next paragraphs offer theories and tools that help to determine *who and what really counts*.

2.5.1. IDENTIFICATION OF STAKEHOLDERS

A next after defining stakeholders is building a framework that helps to identify them. How do you determine who is and who is not a stakeholder? Who matters and why? Without such a tool the pragmatic reality of stakeholder analysis is problematic. After all, the dimensions in which a group or individual could be affected by the achievements of an organizations goals are countless and may be even limitless. One could be close to the action as a client or producer, one could be negatively affected as a competitor, one could be forced to be involved with an organization as neighbor, one could be dependent as a seller, one could even be affected just as bystander, etc. etc. (R. K. Mitchell et al., 1997, p. 884). These identities do not tell anything about the relevance of a stakeholder. In the article *Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts* (1997) the authors attempt

to offer a solution to this limitation and create a framework to measure the relevance of a stakeholder to a firm. In other words: they designed a tool to help managers decide which stakeholders should deserve their attention. A stakeholder should be valued on its *salience*: 'the degree to which managers give priority to competing stakeholder claims', and not by its identity or the nature of the relation. Instead, they should be identified by the possession of the following attributes:

(1) "The stakeholder's **power** to influence the firm,
(2) The **legitimacy** of the stakeholder's relationship with the firm, and
(3) The **urgency** of the stakeholder's claim on the firm."
(R. K. Mitchell et al., 1997, p. 884)

Each of these attributes describe a characteristic of relevance to the firm, that together rank its salience (the degree to which managers give attention to stakeholder claims, as explained earlier). With *power*, the ability of a stakeholder to "impose its will in the relationship" is meant (1997, p. 865). In other words, the attribute power describes whether or not a stakeholder is capable to overrule the firm in achieving goals. The second attribute, *legitimacy*, is a far more complex aspect. Legitimacy refers to the social acceptance of someone's position and behavior. Or, in the words of Suchman (1995, p. 574): "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions". Legitimacy describes the rightfulness of claim to its position and behavior a stakeholder has. It can only exist and be measured in the context of its social structures. The last attribute, *urgency*, puts a dimension to power and legitimacy. It helps to ask: how important and relevant is this power and legitimacy in the moment in question? Mitchell et al. define urgency as "the degree to which stakeholder claims call for immediate attention" (1997, p. 867).

Together, these attributes provide a profile in which a stakeholder can be placed. In Figure 19, the eight profiles that can be derived from these three attributes are shown in a chart. It is the four stakeholders that cover two or three of the attributes that have sufficient salience, and should be given the attention of a manager. It is these stakeholders that matter (1997, p. 873).

On the practical identification of stakeholders, studies show that this can be done in both quantitative as well as in qualitative approaches. A quantitative approach would involve taking structured surveys among key stakeholders. These stakeholders are asked to rank the relevance of all potentially involved stakeholders. The salience tool can be used as a check, by incorporating questions on different aspects of a stakeholder. A risk of this methodology is that some stakeholders could be prematurely excluded by not being included in the initial questionnaire. Another risk of these premature judgements is that seemingly small stakeholders could exert disproportionate influence in decision-making (Brugha et al., 2000, p. 242). A qualitative approach could potentially mitigate these effects. By conducting interviews and group sessions, key-stakeholders are not only asked to list the relevant stakeholders, they can also discuss their different opinions and come to a more comprehensive list together. Whilst one can argue that the potential of missing a relevant stakeholder in a premature stage then still exists, literature shows that this approach is more comprehensive. On the other side, this approach is time-consuming for both the researchers and the stakeholders (Liang et al., 2017, p. 9).

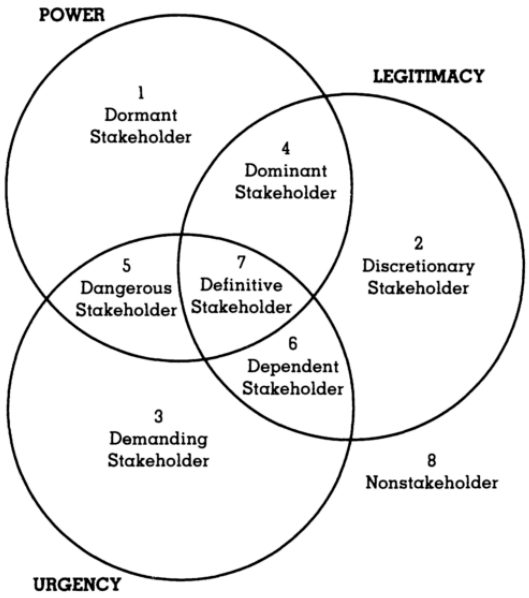

Figure 19 | Stakeholder Typology showing interrelation of attributes (R. K. Mitchell et al., 1997, p. 873)

2.5.2. SOCIAL NETWORK APPROACH

Once stakeholders are identified, the question remains how they relate. Understanding the dynamics between different stakeholders tells us much about the potential of an organization's goals (Gable et al., 2004). Measuring and mapping the closeness of these relations, creates a social network. The social network is "a specific set of linkages among a defined set of persons [or stakeholders in general], with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the persons involved" (J. Mitchell, 1969). In other words, understanding the links between the persons within in a network, may explain the dynamics of the whole.

The dynamics between stakeholders can be illustrated directly, by using a *single-mode analysis*. In such analysis, the direct relation between different *nodes*, the stakeholders, measures the intensity and also the dependability of these relations. The dynamics between stakeholders can also be measured indirectly, by using a *two-mode analysis* (also known as affiliation or bipartite networks). Now, the stakeholders are not related directly to each other, but only via a different type of nodes. These nodes could be all different kind of values and variables, relevant to the stakeholder network (Liang et al., 2017).

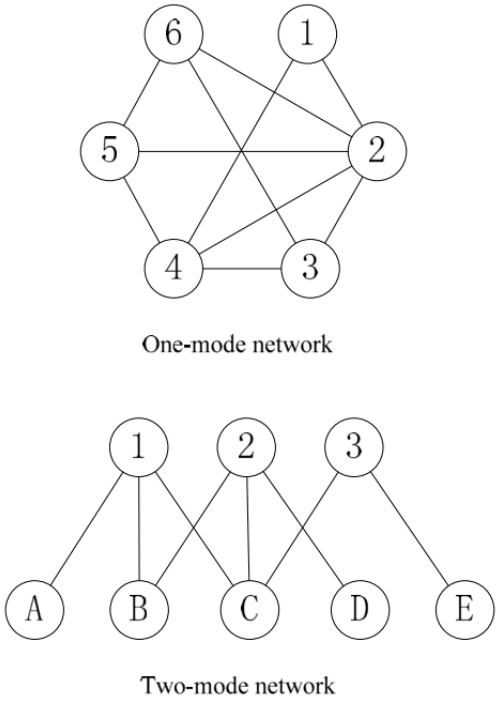

Figure 20 | Example of one-mode vs two-mode network (Liang et al., 2017)

The "Social Network Analysis" (SNA) methodology of Liang et al. (2017) organizes and connects stakeholders within complex projects, using a two-mode analysis. They aim to understand how different stakeholders relate to each other, via their values and to so-called critical success factors (CSF): factors that are considered by the stakeholders as crucial for a project's success. Their study shows that adding CSFs to a stakeholder analysis provides insights in how stakeholders influence a project. In other studies, the SNA has been used for stakeholder analysis. It was used to identify stakeholders in natural resource management (Prell et al., 2009), to do a stakeholder-associated risk analysis (Yang & Zou, 2014), and Liang, Yu & Guo used the SNA to do a stakeholder analysis on green building retrofitting. This shows that the SNA method is a diverse and adjustable method of analysis that has proven its usefulness in stakeholder analysis. As this study aims to measure the relations between stakeholders' attitude towards implementation and their attitude towards effects of vertical gardens, other stakeholders and CSFs, the SNA method appears to be a *match made in heaven*. The relations to be studied are a school example of a two-mode network analysis.

2.5.3. CENTRALITY

Over time, many methods of measures have been developed to distill information from a network of nodes. Freeman (1978) stressed the importance of being able to weigh and compare the relevance of different nodes within a network. Liang et al. (2017) discusses three measures: degree, betweenness and eigenvector centrality. Degree centrality focusses on the characteristics of a link between two nodes. It is useful to assess the direct context of a single node. Betweenness centrality counts the number of links a node shares with other nodes. It thereby measures the power or relevance of a node. These numbers can be compared with other nodes, and that gives the possibility to compare the power of different nodes within the network. Eigenvector centrality builds upon this measure of centrality, and measures the level of power nodes have around a single node. The more powerful its neighbors, the more relevant the node. Together with the attributes of Mitchell (1999), centrality helps to analyze the network by attributing relevance to the nodes.

3. Methodology

3.1. Introduction

This study aims to explore the relation between the attitude of stakeholders to the implementation of vertical garden projects, and their attitude towards its effects and critical success factors. As explored in the previous chapter, earlier studies have set their teeth in the practical aspects of vertical gardens, measuring their effects and discussing their feasibility. Social science studies have explored the theories and concepts of stakeholder networks and their relation to complex projects. This study builds on these studies and connects the two scientific domains. How do stakeholders perceive these effects? What is the pragmatic approach of stakeholders towards vertical gardens and other stakeholders? The literature review of previous chapter is a starting point to define the scope of this research. The methodology of Mitchell et al. (1999) helps to identify these stakeholders and the SNA methodology of Liang et al. (2017) guides to relate the attitudes towards the effects of vertical gardens, towards other stakeholders and the factors they consider crucial for project success. In this chapter, the steps to measure these relations are described in detail.

To give shape to the methodology chapter, the step-by-step approach of Liang et al. (2017) is used. Their five steps take us through the initial identification of stakeholders, evaluating their connections among each other and towards their attitudes and values, organizing the data derived from the interviews and questionnaire, and analyzing and discussing the results. Therefore, this study closely follows their steps where it seems appropriate, and adds other methodology where needed. The steps are the following (2017):

1. Step 1 | Identifying nodes of the network
2. Step 2 | Evaluating links of the network
3. Step 3 | Visualizing and projection of two-mode network
4. Step 4 | Analyzing the network
5. Step 5 | Discussing results

Together, these steps sketch the blueprint of this study. Within this blueprint, several different concepts and tools are used from different studies, building on the shoulders of those authors that paved the way to come to tangible outcomes.

3.2. Step 1 | Identifying nodes of the network

It is this initial identification of stakeholders that draws the borders of a study. But where does one start to determine who and what matters most? Liang et al. (2017) suggest that the usage of other studies may be useful to determine the outside borders of a network, and identify its nodes. For this study, a qualitative selection method is chosen, as described in Paragraph 3.4.2., using both the literature review and experience-based methods for the initial identification and to define the stakeholder categories around vertical gardens. By roughly assessing their salience a first selection can be made of who might matter most.

3.2.1. IDENTIFICATION

As stated above, for the initial identification of stakeholders, both literature review and explorative conversations are used to create a list of potentially relevant stakeholders.

Considering the limitations of this study, it is important to only roughly identify these stakeholders. For the literature review part, the studies discussed in Chapter 3 are analyzed on their mentioning of relevant actors, paying attention to any notion of the power, legitimacy and urgency attributes. These potential stakeholders will be listed in a chart, and then checked against or complemented with statements from experts, during the explorative conversations. As a result, an initial selection of interviewees provides a starting point for the fieldwork.

In a later phase, every interviewee will be asked to list other relevant stakeholders to be involved in the research and interviewed. This approach is called the "snowball-sampling" and helps to cross check the initial selection of stakeholders (Biernacki & Waldorf, 1981). If any stakeholder that is potentially relevant was missed in the literature review or in the explorative conversations, it can be added to the list of stakeholder categories at that stage.

3.2.2. SELECTION

The list of stakeholder categories does not provide interviewees or respondents for a questionnaire. Therefore, the explorative conversations will also be used to inform for organizations or individuals that may be willing to participate in an interview. The experts are expected to have valuable contacts as they work with organizations and people related to vertical gardens.

3.3. Step 2 | Evaluating links of the network

With a list of stakeholder categories and a list of contact details, the next step could be regarded as *the real deal:* the fieldwork. The respondents are interviewed with a recording machine and an item list to find out to what extent there is a relation between attitudes of stakeholders towards vertical garden projects, and their attitude towards its effects, other stakeholders and critical success factors.

3.3.1. INTERVIEWS

It is attempted to interview at least one stakeholder per category. The respondents will be interviewed during a one hour interview. Each of the interviewees will be asked about their knowledge on vertical gardens, their experiences, their willingness to participate and their relation to other stakeholders. The central aim of the interviews is to understand the stakeholders' attitude and perception of vertical gardens, position the stakeholders relative to other stakeholders and ask their opinion on crucial success factors for the implementation of vertical gardens.

The interviews follow a semi-structured set-up. The fundament of each conversation is the item-list with questions, see Appendix A. This list was shaped based on the explorative conversations and the literature review. The questions explore the core-values of each stakeholder and their organization, to understand the motivations that lie behind their activities. After discussing these values, questions follow that aim to understand their position, their attitude towards vertical gardens and their view on other stakeholders and potential partnerships.

Each of the interviews will be recorded with the permission of the interviewee. These recordings will be used for transcribing the conversation. It is made clear to the interviewee

that the recordings will not be shared, published or used otherwise, outside this study. The transcriptions of all the interviews combined are added to this document as an attachment. In this attachment, the transcriptions will be coded, as explained in paragraph 4.2.1.

During the interview, also three quantitative questions will be asked. These questions are part of the questionnaire, and aim to quantify and easily compare the stakeholder's position. This approach is discussed in paragraph 3.4.1.

3.3.2. QUESTIONNAIRE

A small questionnaire is included in the interviews to create a quantitative check on the qualitative outcomes. The quantitative questions ask the interviewees to rate the relevance of the three following aspects: 1) the different effects of vertical gardens to the urban environment, 2) the different stakeholders that could be involved in implementation, and 3) the crucial success factors that influence the positive output of a vertical garden project. They will indicate the relevance by rating the different variables on a Likert-scale; rating 1 – not relevant, to 5 – very relevant. See Appendix A for the detailed outline of these questions.

If possible, this questionnaire will also be sent to stakeholders that are not willing, or capable to do an interview. By filling in the questionnaire instead, their information adds for a comparison between stakeholders and helps to increase the number of respondents.

3.4. Step 3 | Visualizing and projection of two-mode network

3.4.1. DATA TREATMENT AND ANALYSIS

The written transcripts of the interviews will be attached to this document as a separate attachment. The written transcriptions, will be subject to a content analysis to select and distill valuable information from the interviews. This treatment is needed to be able to identify key themes and concepts from the interviews (Huberman & Miles, 1983, p. 289). Such analysis is called inductive analysis, in which a researcher treats a large, but foggy set of information, to become a thinner and more specific selection of data. This selection of data contains the key themes and concepts that are relevant to answer the research questions (Ritchie & Lewis, 2003, p. 203). Each of these themes will be discussed in sub-paragraphs in the Results chapter. The focus of these key-theme discussions will be on the similarities and differences between the statements of the respondents.

In addition to the description of these key-themes, the quantitative data will be added in charts. This is output from the questionnaire. The questionnaire data from the interviews and of those respondents that only filled in the questionnaire will be combined. The charts help to illustrate the tendencies of the responses, by showing the average ratings on the three themes: attitudes towards effects of vertical gardens, towards other stakeholders and towards critical success factors.

The outcome of both the interviews and the questionnaire can be visualized by drawing a two-mode network. The stakeholders will be organized and mapped in relation to their attitudes towards effects, other stakeholders and critical success factors in Figure 21. Using this approach helps to understand the dynamics within vertical garden projects. It would not just show the connections between stakeholders, but will determine under which conditions these stakeholders are linked together. Figure 21 illustrates the relations within the stakeholder network, that is studied. Here the three topics are brought together, but for the analysis three separate charts will be made to give a more detailed view on the relations.

3.5. Step 4 | Analyzing the network

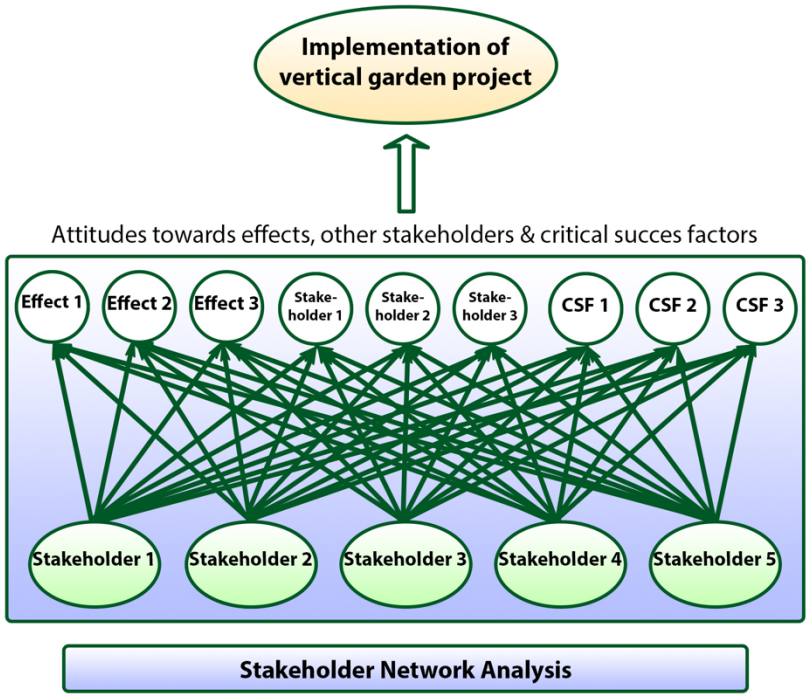

Figure 21 | Two-mode network approach on vertical garden projects

After presenting the results in a key-themes discussion, diagrams and charts, the next step is to mine information from these sets of information to describe the relationships within the network. For this study, a combination of two methods is used. The first being the concept of centrality, as defined by Freeman (1978). "The concept of centrality (…) is a prominent criterion for assessing the importance of nodes. Nodes need to be emphasized and assigned a high priority in the network, when they have a higher centrality value" (Liang et al., 2017, p. 7). As explained in the literature review chapter, there are several kinds of centrality used in stakeholder analysis. This study will measure *betweenness centrality*. This approach of centrality fits this study best, since it focusses on the connections between nodes and is used to assess the level of power a node has within a stakeholder network. The second method is to extend the inductive content analysis of the previous step towards a network analysis. After having discussed all key-themes and after presenting and analyzing the quantitative data, this last step focuses on the three relations that are subject to this study: the attitude of stakeholders towards 1) effects of vertical gardens 2) other stakeholders and 3) CSFs.

3.6. Step 5 | Discussing results

The outcome of the four steps of analysis is discussed and summarized in this last step. The relations between the stakeholders, their influence and the main outcomes on their attitudes will provide suggestions on further research, policies and management strategies.

4. Results

In this chapter the results of the study are presented following the steps of Liang et al. (2017). In addition to these steps, the relevant sub-questions will accompany the paragraphs to provide a clear structure towards the answer of the main question: To what extent is there a relation between the implementation of vertical garden projects, other stakeholders and their attitude towards its effects and critical success factors?

4.1. Explorative conversations & literature review

Which stakeholders are affected by or concerned with the implementation of vertical gardens in the urban environment? In explorative conversations several experts give their view on this question. Their statements are roughly analyzed with the method of stakeholder attributions of Mitchell et al. (1999). The outcomes of these conversations are presented in this paragraph. In addition, the literature review of Chapter 3 is used to check these outcomes. At the end of this first step, Table 1 gives an overview of the stakeholder categories that result from this analysis.

4.1.1. EC1 | DE DAKDOKTERS

De Dakdokters[1] is a Dutch organization that aims to improve the quality of life in the urban environment by creating green, water and recreational roofs. In eight years the company has developed itself into a specialist in green and water roof advice, design, construction and maintenance. Considering adding the vertical gardens to their services would make sense from an urban greening perspective.

In several conversations with their CEO a main topic of discussion was who they are currently involved with, would potentially be relevant when exploring vertical garden projects. The main actor he named were local municipalities. In earlier projects he had been often involved with municipalities in relation to permits, subsidies and agenda setting. He considered them to be very important in the success of green projects. Specialized gardening companies like the Dakdokters have an important role as they could not only offer and install vertical gardens, but also sit at the table in an early design stage. There, they have a role as advisor and as expert. Further mentioned were investors. These investors decide in an initial stage of a project what may be included in a project, what the prerequisites are and how these should be met. Currently, they have not much certainty on the sustainability of vertical garden systems and any return on investment. To summarize, the three main stakeholders and their attributes discussed were: 1) Municipality: power, legitimacy, 2) Specialized gardener companies: legitimacy, power, urgency, 3) investor: power, urgency.

Also the senior project developer of De Dakdokters had strong opinions in who would be relevant in vertical garden projects. As a project developer, he works often with architects, project developers, landscape architects, housing corporations and investors. All of these parties play a dominant role in decision-making, he stated. Architects and landscape architects can have a creative influence, as they can insert ideas in an early stage in a project. Housing corporations and investors do not have such creative input, but can state prerequisites for the initial design of project. Although project developers need to follow the input and demands of these four actors, they have a decisive role in the realization of project. They feed back on these

[1] The author of this study worked at De Dakdokters as an intern and set-up this research in close partnership

other actors and play an important role in final decision-making. The project developer provided a list of contact suggestions for interviews in these stakeholder categories (Attachment 2, 2018). To summarize, the main stakeholders and their attributes we discussed were: 1) Architects: power, urgency, legitimacy, 2) Project developers: power, legitimacy, urgency 3) Landscape Architects: power, legitimacy, 4) Housing corporations: power, legitimacy, urgency, 5) Investors: power, legitimacy, urgency.

4.1.2. EC2 | Dr. Ir. OTELLÉ, TU DELFT

In The Netherlands, several researches have been conducted on the topic of vertical gardens. At the TU Delft, Ottelé did extensive research on the effects and values of vertical gardens. He experimented with vertical gardens to measure the effect in controlled and uncontrolled set-ups. The gap between the private investment that is needed for a vertical garden and the public gain that results from it, was a main topic in the conversation. Ottelé is convinced that the government has the power and tools to overcome this gap. He mentioned the local municipalities as important players to execute that power. Also investors and project developers could have an influence in integrating vertical gardens in the construction or renovation of real estate. He was not sure to what extent these play a role already. He did know that in some cases landscape architects are asked to become involved in such projects, which could indicate that the construction of vertical gardens may be on the horizon (Attachment 2, 2018). To summarize, the main stakeholders and their attributes we discussed were: 1) National Government: power, urgency, legitimacy, 2) Municipality: power, legitimacy, urgency, 3) Project Developers: power, legitimacy, 4) Landscape Architects: power, legitimacy, urgency.

4.1.3. EC3 | Urban Planters

In London, an experienced designer and installer of vertical gardens, CEO of the company Urban Planters (EC3) shared his vision on the business. In an extensive conversation, during which we visited successful and unsuccessful vertical gardens, we discussed the values and functionalities of the vertical gardens. He was convinced that a vertical garden should be considered as a standard product that is bought by the owner or user of a building. He considered the role of other players minimal, and dismissed any partnership set-ups. Noteworthy, was his mention of the use of subsidies by the municipality. He had never done a project, where subsidy was involved. To summarize, the main stakeholders and their attributes that were discussed were: 1) Specialized Gardener Company: power, urgency, legitimacy, and 2) User: power, legitimacy, urgency.

4.1.4. EC4 | Greenwich University

Also in London, a professor from the Greenwich University, gave a tour on the experimental green roof and green wall sites of the university. He introduced the relevance of scientific knowledge to the boundary of stakeholder network. To summarize, the main stakeholder and its attributes that were discussed was: 1) Knowledge Institutions: legitimacy, urgency.

4.1.5. EC5 | ANNE-MARIE BOR, NEXT GREEN

As a specialist in green innovations, Bor was pleased to share her vision on the potential values of vertical gardens and the possible partnerships. The conversation helped to further select the relevant stakeholders. She mapped stakeholders for a similar project, focused on green roofs in the urban area. She stressed the importance of partnerships and integrated design to complex green projects. A complex project needs to connect its stakeholders in an early stage. The

national government plays an important role in this part of a project, as it should create incentives. But addressing the relevance of this front player role can be done by project developers, specialized gardeners and more stakeholders, such as insurance companies. To summarize, the main stakeholders and their attributes we discussed were: 1) National Government: power, urgency, legitimacy, 2) Municipality: power, legitimacy, urgency 3) Project developers: power, legitimacy, urgency, 3) Specialized Gardener Company: power, urgency, legitimacy, 4) Insurance companies: power, legitimacy, urgency.

Stakeholders		Exploratory conversations					Literature Review			
Code	Stakeholder	EC1	EC2	EC3	EC4	EC5	(Ottelé, 2011)	(Perini et al., 2013)	(Liang et al., 2017)	(Besir et al., 2018)
S1	Municipality	x	x			x	(2011, p. 237)	(2013, p. 117)		
S2	National Government		x			x	(2011, p. 237)	(2013, p. 120)	(2017, p. 9)	(2018, p. 914)
S3	Project Developer	x	x	x		x			(2017, p. 9)	
S4	Neighborhood			x		x				
S5	Architects	x	x		x		(2011, p. 237)		(2017, p. 9)	
S6	Housing Corporation / Real Estate owner	x							(2017, p. 9)	(2018, p. 920)
S7	User/resident	x		x		x			(2017, p. 9)	
S8	Insurance company					x			(2017, p. 9)	
S9	Investor	x		x				(2013, p. 113)	(2017, p. 9)	
S10	Non-governmental organizations				x	x			(2017, p. 9)	
S11	Landscape architect	x	x		x		(2011, p. 237)			
S12	Specialized gardening company	x		x	x		(2011, p. 238)			

Table 1 | Preliminary stakeholder categories as provided by the explorative conversations (ECs) and literature

4.2. Interviews

What are the stakeholders' attitudes and perceptions concerning vertical gardens in the urban environment? A total of eleven stakeholders were interviewed on their attitudes and perceptions towards vertical gardens, their role as a stakeholder, their idea on working with other stakeholders and the critical success factors for successfully implementing vertical gardens in the urban area. The conversations were diverse, as the stakeholders had different backgrounds and experience with vertical gardens. Consequently, also their responses had diverse and sometimes contradicting outcomes. In this paragraph the main topics that were discussed are presented, as well as the different positions that were displayed.

Quotes and references to interviews are translated from Dutch to English for this report. Each respondent is coded as explained in Appendix B. In-line references show the respondent code and the page of the quote. These references direct to the file: '180727 Attachment 1 | Interview transcriptions', that is part of this study and contains all transcriptions of the interviews. For reasons of privacy, this attachment is only accessible to the author and the supervisors of this thesis. Table 2 is an anonymized version of Table 1 in Attachment 1, and shows an overview of the selected stakeholders.

Respondent function	Stakeholder category	Date	R#
Program Manager Sustainability	Municipality	28/5	Q11S01R01
Program Manager	Municipality	30/5	Q20S01R02
Process manager	Advisor	06/6	Q09S00R03
Investment manager	Investor	07/6	Q00S09R04
Facility Manager	User/resident	18/6	Q00S07R05
Chief Public Space Design	Municipality	19/6	Q22S11R06
Business Unit Manager EU	Specialized gardening company	20/6	Q05S12R07
Acquisition Manager	Project developer	22/6	Q03S03R08
Planting specialist	Landscape architect	25/6	Q04S11R09
CEO Benelux	Specialized gardening company	26/6	Q02S12R10
Developer and environmental Manager	Project developer	04/7	Q01S03R11

Table 2 Anonymous list of respondents: Respondent function, stakeholder category, date of interview and reference number. Names and organizations can be found in Attachment 1. All interviews took place in 2018.

4.2.1. CODES

The transcriptions of each of the interviews are color-coded. The codes represent the key themes that are subject to the research questions. In Appendix B, the research questions are color-coded, similar to example below. By using the research questions as a starting point to define the codes, the codes closely relate to the aim of this research, as can be seen in the example:

To what extent do the stakeholders' attitudes towards effects, towards other stakeholders and towards critical success factors constitute their overall attitude towards the implementation of vertical gardens?

The example above shows how the main research question provides the codes for the coding process. In the Appendix B the other questions are coded similarly, and the meaning of each of the codes is explained. Together, these codes represent the main themes that are discussed in the next paragraphs. Attachment 1 contains the coded and complete transcriptions.

In relation to these key-themes, the two-mode social network analysis of Liang et al. (2017) is applied. With the diagram, the discussed relations are illustrated. As for measuring stakeholder salience, the transcriptions were scanned for remarks regarding the power, legitimacy and urgency of stakeholders. In several of the following key-theme discussions, an attribute scheme is added to illustrate the stakeholder salience.

4.2.2. ON EFFECTS AND VALUES

"I want to avoid just stacking stones and earning money, but instead, strive towards building a city that is desirable for the future" (Q11S01R01, p.2).

As a first topic, the respondents were asked about their core values. What motivates them personally to do the work their doing? And what is the mission of the organization they are working for? These values are expected to give an insight in their general attitude towards implementation. The quote above is from the first municipality official that was interviewed, describing his personal and professional core-values. Later in the interview, this appeared to correspond with his statements on how he wants to participate in vertical garden projects. Jokingly, he said he does not want to make "*green porn*", referring to a tendency of architect to just put some green here and there because that is expected. "Instead, it should be functional green, (…) including water storage and irrigation" (p.3).

Connecting idealism with functionality of green was a broadly shared attitude. The landscape architect shared passionately: "Working with plants is part of my way of living". However, integrating green in society is a functional activity, almost by definition: "Currently, there are so many [urban] issues such as heat stress, flooding, noise [pollution], air pollution, that it starts to make sense to think in ecosystem services. Integrating plants has meaning on all these topics" (Q04S11R09, p.19).

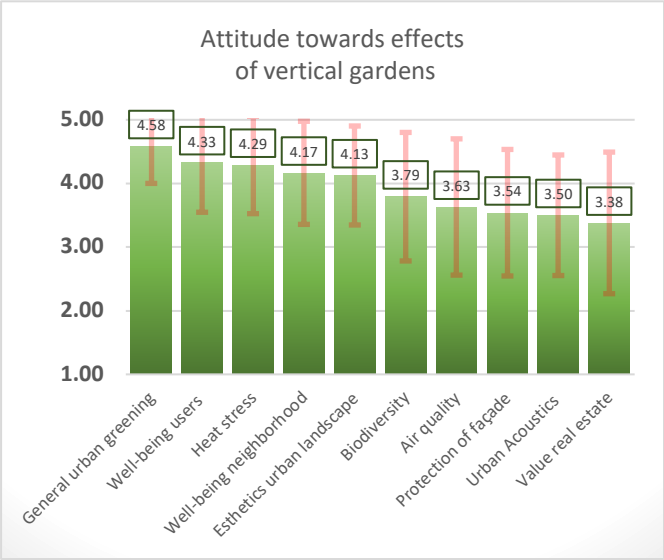

Figure 22 | Results from questionnaire on the effects of vertical gardens. Showing the mean and standard deviation. A Likert-scale in which 5 is rated as 'very relevant', 4 'relevant', 3 'neutral', 2 'irrelevant to 1 'very irrelevant'. Number of respondents: 22.

What these respondents do, is connecting their values with the potential effects of vertical gardens. During the interviews, the stakeholders were asked to prioritize the effects on a Likert-scale: Figure 22 shows the average results. These results indicate that adding green in general to a city is the most relevant effect of vertical gardens. Although this is quite a general statement, the motivation for adding green seems to come from the effects of vertical gardens that scored 'relevant' or higher: adding to the well-being of users, mitigating heat stress by isolation and heat reduction, and positively influencing the well-being of the neighborhood.

Six out of the eleven respondents explicitly shared a similar relation between their values and the functional aspect of integrating green in society. It seemed that for them, green was a tool to pursue their values. Other stakeholders shared a less explicit relation between working with green as such in the urban environment and their core values. But for all of them, these values seemed to lay a foundation in discussing the subsequent themes, such as systems, costs, and partnerships.

4.2.3. ON EFFECTS AND SYSTEMS

"My all-time favorite is the creeper. I have not seen a system that can beat them" (Q04S11R09, p.20).

In every interview, three different categories of vertical systems were discussed, see Figure 23. It was asked whether the respondents had any experience with any of these systems, and if they had any preferences in working with them.
Only, four out of the eleven interviewees had significant experience with vertical gardens. They had done projects that involved vertical gardens, installed them themselves or had included them in a design process. Of the seven other stakeholders, two had touched upon the topic, but for different reasons the vertical gardens did not make it into their projects. The remaining stakeholders, did not have any experience with vertical gardens yet, but were somehow related to urban greening or real-estate projects.

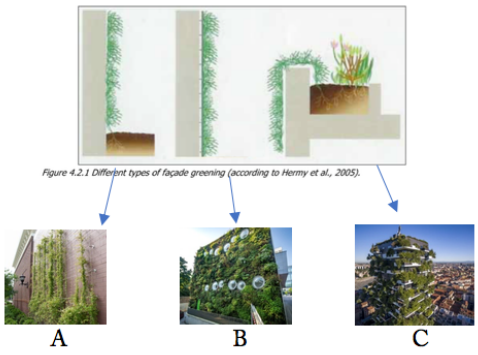

Figure 23 | The picture that was used when discussing different systems (Appendix A)

In discussing the different systems, some preferences were very clear: "Creepers make just so much more sense", one of the specialized gardeners said, "So many more successful projects were done with these systems. It's easy, and cheap to make them look great" (Q02S12R10, p.24). The landscape architect agreed: "My all-time favorite is the creeper. I have not seen a system that can beat them" (Q04S11R09, p.20). And, as animals were more likely to nest in them, creepers also added more biological value, he added. The creepers were widely celebrated. Most of the stakeholders preferred them over the much more expensive LWS alternative.


Figure 24 | Failing creepers (photo by author, 2018)

But next to this positivity, also some doubts were shared. The other specialized gardener brought up that these creepers may be much cheaper, but the risks that come with creepers are higher. When one plant fails, a whole part of the wall dies, see Figure 24. His company offers mainly LWS's, and that is what he prefers, but: "It really depends on what the client wants" (Q05S12R07, p.15).

While this specialized gardener mainly focusses on the LWS's, his competitor has a different view on how to offer vertical gardens: "We believe in a combination [of systems]. Preferably with elevated ground level systems that are rooted in soil and creepers" (Q02S12R10, p.24). He is very sceptic on the LWS's: "A plant does not belong there at all. It does not want to live in a jar or in a basket. That's not the way the Lord designed it. And it's not the way it will last for 40 to 50 years. As green roofer and realist, I consider that stuff to be pure nonsense" (p.24).

The landscape architect seemed to fully agree with this perspective: "In my experience, all these boxes and baskets do not actually work. (…) But there are of course also various forms of

combining systems. Elevated ground level you can mix well with a climbing plant" (Q04S11R09, p.20).

Besides the individual differences all of the respondents shared the opinion that combining systems was key for effectiveness, minimizing risk and reducing costs. But as most of the respondents had little experience with vertical systems specifically, their preferences seemed to be more explicitly shared on what prerequisites were relevant for participation, as described in the next paragraph.

4.2.4. ON COSTS

"Starting from 500,- including installation? That's the most expensive piece of green I can imagine!", (Q02S12R10, p.24).

The issue of costs was a vivid topic with nearly all stakeholders. "It is just very expensive…", one of the project developers sighed (Q01S03R11, p.26). The quote above relates to the price of an LWS, and was shared by a specialized gardener. Also respondents from the different municipalities argued that high costs are a crucial threshold for implementing vertical garden systems. That is why only if there is no cheaper alternative, one of the municipality officials contemplated, a LWS may be an option.

For most stakeholders, this perception of pricing seemed closely related with the topic of return on investment. The interviewed investor: "The reason why we are not involved in vertical gardens, is that there is no model of revenue". That's a general problem with climate adaptation, he added. "Climate mitigation on the other hand is starting to have a proper model of revenue, but adaption doesn't yet" (Q00S09R04, p.8). When some do see valuable effects: "it is hard to put these returns in numbers", one of the specialized gardeners admitted (Q05S12R07, p.15). Effects that were hard to measure formed an issue to project developers. One states about implementing vertical green for a housing project: "I'm looking for the 'why': Why should I *green* my facade? Knowledge institutions should communicate the 'why' to me and the users. So that when it offers protection against precipitation, than as a consequence, a renter pays less housing expenses. And when it offers an isolating effect, it means the renter needs to pay less for heating. We need to translate everything into the benefits for the user" (Q03S03R08, p.17). Another specialized gardener recognized this paradigm of return on investment: "This is because it is considered as a construction product. How much does it cost, and how much does it deliver me? And how is that situation after 10 years?" (Q02S12R10, p.23).

But this is a perspective that is strongly challenged by some: "Why are we calculating the financial returns for things that contribute to the quality of life? For most things we don't do this: take your watch, for example, or your car. It is accepted that we spend on these matters, without any return on investment. So, we should ask ourselves, how we could give the value of vertical gardens a place" (Q20S01R02, p.6). One of the project developers seems to agree: "You should not see it as a burden for a user. There must be a change of mindset. I see three aspects that have value: 1) the physical well-being 2) the psychic wellbeing and 3) social weel-being. (…) People must be aware that these are values that they will receive" (Q03S03R08, p.19). The landscape architect added: "I think this is changing. It becomes more hip, and the younger generation of urban residents seems more aware. That will increase the value of green buildings" (Q04S11R09, p.21).

It can be concluded that a strong relation exist between the attitude towards implementation and the perception of costs. However, there exists a significant disagreement on how to perceive the costs of vertical gardens. One line of reasoning focuses on the return on investment of a project. These stakeholders prefer to make a financial calculation, comparing the costs of a system with the measurable benefits of a system. As a result, participation should only follow when the benefits balance out or exceed the costs. That is problematic when effects are hard to measure. The other line of reasoning disagrees at least partially with this perspective. These stakeholders consider (vertical) green of intrinsic value in the urban environment and do not need measurable outcomes. For them, participation is not a question of 'if', but a matter of 'how'. They focus on feasibility and rely on a shift in paradigms that aligns with their perspective.

As a second conclusion on costs, it appears that both of these groups of stakeholders have their doubts on the price of vertical gardens. Many consider these systems as pricy, and aim to reduce costs by combining different systems.

4.2.5. ON RISKS

"The ones who go for it, are the ones that are at risk when things go wrong", (Q04S11R09, p.20).

Often, the attitude on vertical gardens seemed connected to the perception of risks. "For me, the most important thing is to realize my project with as little problems as possible", a project developer said (Q01S03R11, p.26). "The ones who go for it, are the ones that are at risk when things go wrong", the landscape architect added (Q04S11R09, p.20). The landscape architect stressed the relevance of this issue, and argued that it is crucial to be able to use proven technology. He mentioned earlier projects, in which they considered adding a LWS to the project. But as there was no proven technology available, they decided to drop the idea (Q04S11R09, p.20). One of the project developers seemed to agree, and stated that if a system is not proven technology, "than it forms a risk (…) and that is something any investor wants to avoid" (Q03S03R08, p.17). In two projects, he is currently working with vertical gardens, and is excited about it. However, he admits it is no proven technology, and that that makes it risky and difficult. Also, it is not sure yet whether it is adding financial value to the building: "taxation is a slow process", he sighed (Q03S03R08, p.18)

During a visit at a vertical garden, it became apparent how relevant proven technology is. While giving a short tour around the vertical garden, the facility manager told about the troubles the installation had brought, after the installation in 2012: "Since then, the functionality of the system has been just an utter disappointment. The plants never really covered the wall. (…) Especially the North-side never really got in shape. The South-side looks good during summer, but in wintertime it's also pretty bad" (Q00S07R05, p.11), as can been seen in Figure 25. The building itself suffered from the irrigation system too. The respondent

Figure 25 | Failing vertical garden Amsterdam (photo by author, summer 2018)

explained: "Drainage problems are visible on the walls. (…) Many window frames show remains of chalk, caused by dripping water" (p.11).

As a conclusion, it can be said that the relation between the perception of risks and the attitude towards implementation should not be underestimated. The hopelessness that was expressed by the facility manager had clearly taken away all enthusiasm for vertical gardens. Not only his attitude, but also the costs of restoring something that is not working seem to be dramatic. The emphasis on proven technology, as expressed by some, adds only to the relevance of this topic. The attitude towards implementation seems fairly negative when risks are considered high.

4.2.6. ON MAINTENANCE

Closely related to these risks, is the topic of maintenance. It is the specialized gardeners that are the first to admit that with many vertical garden systems, maintenance is crucial for the survival of a wall. One explains how it works with a LWS: "There are two levels of maintenance. The first is the physical, which happens twice a year: during spring to rejuvenate wall and during autumn to prune. The second level is a system that controls and monitors everything remotely. You still need to check those sensors and we do these inspections four to six times a year. Then we also fill the nutrition reservoir, look at sickness and pests. That just takes 30 minutes or so" (Q05S12R07, p.14).

The user confirmed this description: "The company comes by twice a year for extensive maintenance. In autumn to remove dead leaves, and in spring to replant. During the year they keep things up to date. But now, after 12 years, the vertical garden will need to be replaced" (Q00S07R05, p.11).

The weight of this maintenance, and its accompanying risks does indeed create a threshold for some: "I do not consider a vertical garden as a sustainable solution, yet. Currently, too much maintenance is needed. Preferably, after installation maintenance should be needed only on a minimum bases", a municipality official stated (Q11S01R01, p.2). "It should be reliable and affordable to have it maintained" (Q03S03R08, p.19 (quote) & Q02S12R10, p.25).

4.2.7. ON STAKEHOLDER SALIENCE

How do the stakeholders perceive the relevance of the involvement of other stakeholders? Each respondent was asked to rate the other stakeholders in relevance for the implementation of vertical gardens (see Figure 26). This paragraph discusses the the different attitudes as shared

1.	Municipality	1 – 2 – 3 – 4 – 5
2.	The State government	1 – 2 – 3 – 4 – 5
3.	Project Developer	1 – 2 – 3 – 4 – 5
4.	The neighborhood	1 – 2 – 3 – 4 – 5
5.	Architects	1 – 2 – 3 – 4 – 5
6.	Waterboards	1 – 2 – 3 – 4 – 5
7.	Housing Corporations/Real estate owner	1 – 2 – 3 – 4 – 5
8.	Residents/Users	1 – 2 – 3 – 4 – 5
9.	Insurance company	1 – 2 – 3 – 4 – 5
10.	Investors	1 – 2 – 3 – 4 – 5
11.	Knowledge institutions (NGOs)	1 – 2 – 3 – 4 – 5
12.	Landscape architects	1 – 2 – 3 – 4 – 5
13.	Specialized horticultural companies	1 – 2 – 3 – 4 – 5

Figure 26 | List of stakeholders as presented to the interviewees

by the respondents and provides quantitative data in addition to their motivations and disagreements.

The salience of the municipality as a stakeholder was greatly challenged during the interviews. Some respondents shared much skepticism on their role: "They [the municipality and national government] can provide a playing field, but they do not have an active role. Their influence is much more limited than a project developer for example", one of the specialized gardeners stated (Q05S12R07, p.15). His colleague shared this skepticism: "There are some municipalities who want to set an example and do a little project, but after that it stops. Or they simply skip vertical gardens, because they consider it too expensive" (Q02S12R10, p.24). One of the project developers had perceived a same lack of interest, but considered their role far more crucial. "What the municipality or government demands, is decisive. (…) Municipalities should set the first step" (Q01S03R11, p.24).
The interviewed municipality officials seemed to be well aware of the importance of their role: "For companies the costs of such investments are the main thing they look at. We should set an example, otherwise the rest won't follow" (Q22S11R06, p.13). In the three interviews with the different municipality officials, all of them emphasized the importance their role as a frontrunner. A municipality is there to foster the quality of urban life, one added: "We need to stay healthy, both mentally and physically. (…) Every building should play a part in this challenge, therefore a city needs integral design" (Q22S11R06, p.12).
But the ambition and self-awareness of these municipality officials is not by all respondents recognized: "Currently, the government does nothing but facilitate. Instead, they should be saying: we want state of the art, and those processes should be starting immediately" (Q04S11R09, p.20). And they should continue doing so, a specialized gardener stresses: "It is a drama when one government reverses all decisions and policies of the previous government" (Q02S12R10, p.25).

On housing corporations, the interviewees seemed unanimous. Their potential role is significant, but currently they do too little. A project developer believed that it is up to users and residents to motivate them (Q01S03R11, p.27). A part of their current lack of involvement could be explained by their long-term involvement in projects. For them, maintenance troubles are much more important than for a project developer, who is only involved in the construction stage of a project (Q04S11R09, p.21).

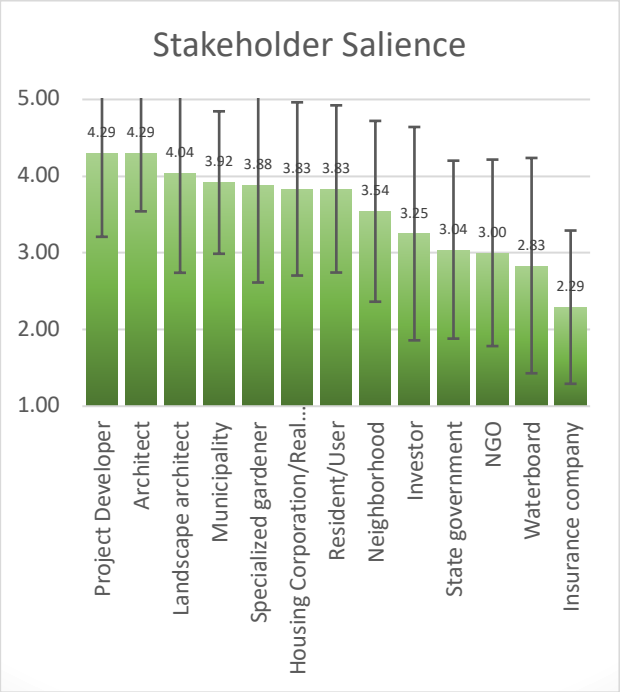

Figure 27 | Results from questionnaire on attitude other stakeholders. Showing the mean and standard deviation. A Likert-scale in which 5 is rated as 'very relevant', 4 'relevant', 3 'neutral', 2 'irrelevant to 1 'very irrelevant'. Number of respondents: 24.

Insurance companies were in most interviews dismissed as irrelevant. Most respondents acknowledged the necessity to comply with their given standards, but did not share any further thoughts on them. One project developer however, gave some insights in how a vertical garden can alter the standard situations for which insurances apply: "A vertical garden must be in line with their requirements. If the system suddenly makes the first floor accessible, it has an internal effect on safety. After all, an alarm must be installed" (Q01S03R11, p.27).

About knowledge institutions (NGO's) most of the stakeholders had conflicting ideas. A municipality official stated that by law, these institutions were often involved. "When putting out a tender, we check with them [NGO's] whether our requirements suffice" (Q11S01R01, p.2). A project developer on the other hand, considered their role important as a frontrunner: "they should communicate the 'why' with users", in order to give an insight in the values of vertical gardens. "Go into neighborhoods with busses. Tell the children! Explain how it is not-done to live in a F-rated house" (Q03S03R08, p.18).

4.2.8. ON STAKEHOLDER PARTNERSHIPS

How do these stakeholders perceive the relevance of partnerships with other stakeholders? In the interviews, a diverse perspective was given on the possible partnerships. Most respondents seemed to agree on the idea that there is a friction in the division of costs and benefits. One of the municipality officials described the problem as: "It is not in the interest of the building owner, but rather of the community" (Q11S01R01, p.3).

The interviewed investor suggested the partnerships that are based on the effects that come from vertical gardens: "What you could do is saying: Here we have a vertical garden with these six positive effects. For each of these effects, you identify a stakeholder. Than you decide how much value each effect represents and ask the stakeholder to invest this percentage. Let's say insulation is 20%, then the house owner pays 20%. And air quality also 15%, then the municipality invests 15%, etc." (Q00S09R04, p.9). It would require some organization, but as investor it would make sense.

Other stakeholders thought differently about the benefits of such set-up: "A utopia", one of the specialized gardeners stated (Q02S12R10, p.25). A project developer was more nuanced: "It makes things far more complicated. It would mean that if we sell real estate, we need to take multiple stakeholders into account" (Q03S03R08, p.18). And that did not seem to be appealing.

When discussing partnerships, the eyes of many turned to the municipality and government: "It is the role of the municipality to stimulate project developers and challenge them to deliver a proof of concept. Architects should be challenged to work together with project developers on these topics" (Q20S01R02, p.5), was the view of one of the municipality officials. But also knowledge institutions were regarded as a stakeholder with a high partnership potential. "If you want to lobby for vertical gardens, you need to work together with them" (Q02S12R10, p.25). Also, these knowledge institutions could be very useful for feedback, the landscape architect added: "They should share their information in advance, during decision-making" (Q04S11R09, p.21). One of the municipality officials would prefer to see knowledge institutions, landscape architect and specialized gardeners sit together before the start of a project (Q22S11R06, p.13)

4.2.9. ON CRITICAL SUCCESS FACTORS

Many CSFs were discussed in earlier paragraphs, in relation to stakeholders, costs, risks and more. The quantitative data that was derived from the questionnaire supports many of these statements, see Figure 28. The figure shows the average ratings as given by the stakeholders per CSF. Much of this data seems to correspond with the expressions in the earlier paragraphs. Here, briefly the confirming and conflicting outcomes are discussed.

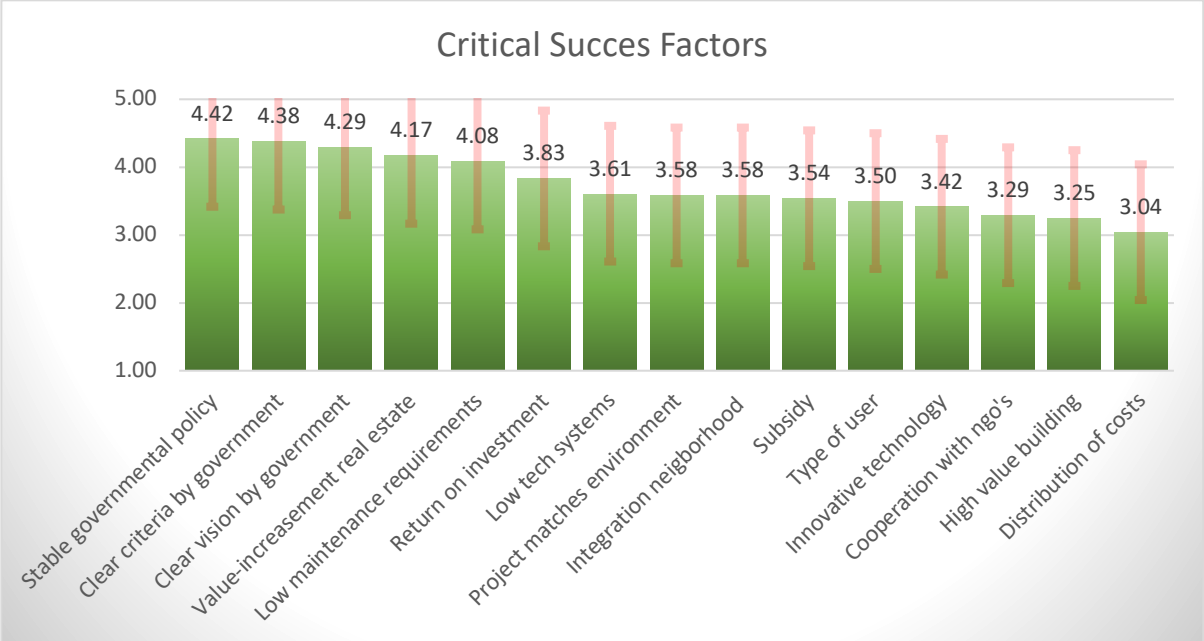

Figure 28 | Results from questionnaire on the critical success factors. Showing the mean and standard deviation. A Likert-scale in which 5 is rated as 'very relevant', 4 'relevant', 3 'neutral', 2 'irrelevant to 1 'very irrelevant'. Number of respondents: 24.

The top 3 CSFs reflect the strong call for a stable and supportive context provided by the government, as expressed in paragraph 4.2.7 and 4.2.8. Although many stakeholders focused on the role of local municipalities, this graph shows that the national government should be incorporated in this view. The chart also shows how low maintenance and low-tech aspects of a system are considered very important, as expressed in the paragraph 4.2.4, 4.2.5 and 4.2.6. Also the relevance of a solid return on investment was emphasized discussed, rated a 3,83 on average in the questionnaire.

4.3. Analyzing the network

In the next three paragraphs, the results discussed in previous paragraphs are analyzed and discussed in the relation to the main research question. This requires analyzing the qualitative and quantitative data of previous chapter by presenting two-mode network charts and the centrality scores. The most remarkable or substantial links and scores are then discussed.

4.3.1. ATTITUDES ON EFFECTS

In Figure 29 a selection of effects of vertical gardens is connected to a selection of stakeholders. Excluding some of the stakeholders and some of the effects, helped to increase the readability of the diagram. The diagram combines the data from both the quantitative and qualitative responses. As for the quantitative data: effects rated by stakeholders on average a 4 'relevant' or 5 'very relevant' were included. Those rated below these score received were considered 'neutral' or even irrelevant, and are therefore excluded. The selection of stakeholders shows those five stakeholders with highest total ranking on preferences in the questionnaire and most explicit preferences during the interviews.

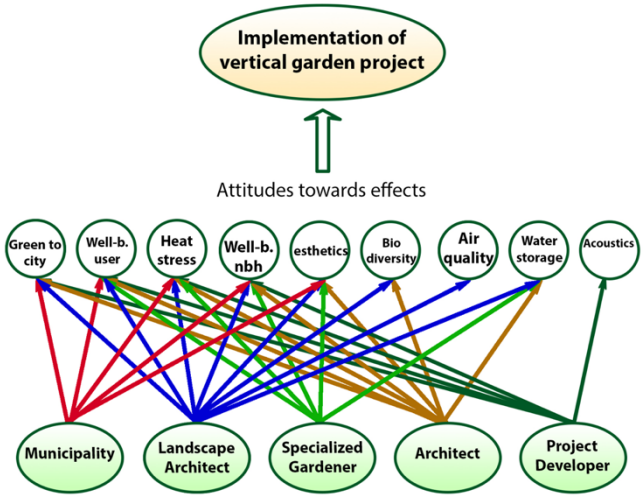

Figure 29 | Two-mode network linking stakeholders to attitudes on effects of vertical gardens

Before diving into the implication of this diagram, the centrality scores of the effects are addressed. To determine the betweenness centrality score, the number of links per effect to stakeholders is counted. The results of this score are presented in Table 3:

Abbreviation effect as used in Figure 29	Description of effect	Betweenness centrality score
Green to city	Greening of the city in a general sense	5
Well-b. user	Contributing to the wellbeing of users	5
Heat stress	Isolating building and mitigating UHI-effect	5
Well-b. nbh	Contributing to the wellbeing of local residents	5
Esthetics	Adds to the esthetical value to urban landscape	4
Water storage	Provides water retention capacity	3
Biodiversity	Increasing biodiversity	2
Air quality	Improving air quality	1
Acoustics	Provides a sound absorbing effect	1

Table 3 | In betweenness centrality score of effects

What does this analysis indicate? The ranking lists not those effects that are ranked highest, but the effects that received a high ranking by most stakeholders. What this creates is a list of shared attitudes towards the effects of vertical gardens. Table 3 shows that most stakeholders valued the more general effects that improve the quality of urban life. It became clear from the interviews that this attitude towards the effects of vertical gardens is indeed positive, but not per se positively contributes to their attitude towards implementation. Project developers seem to be hesitant in valuing specific effects, as can be seen in the figure. They expressed their doubts on the effectiveness of these effects and stressed the importance of a return on investment, which could not be guaranteed with these effects. Figure 29 shows how municipalities, architects and landscape architects show a widest appreciation of effects, linking most of the listed nodes. For them, these matters are positively linked to their attitude towards implementation. However, the links between the specific attitude and the general attitude becomes more evident in the following analyses.

4.3.2. ATTITUDES ON OTHER STAKEHOLDERS

In Figure 30, a similar figure of a two-mode network shows a selection of stakeholders is connected to another selection of stakeholders. The lower nodes of stakeholders represent the stakeholders that were interviewed. The selection of both stakeholder groups is similar to the selection in the previous paragraph. In this figure, it is illustrated who of the upper row of nodes they consider salient.

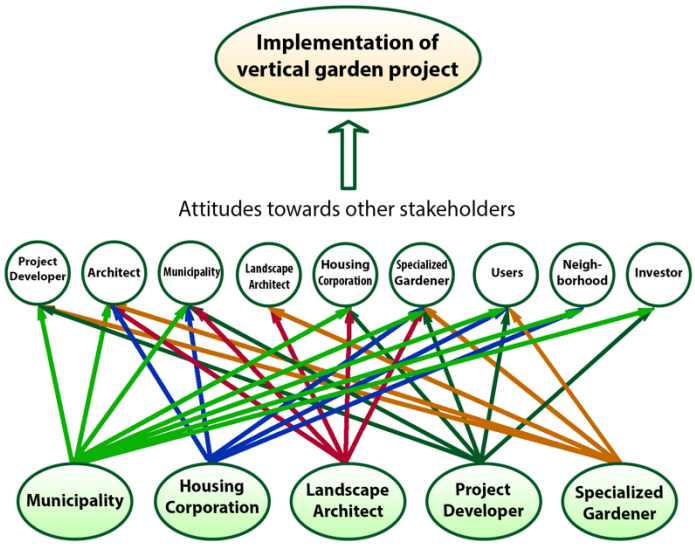

Figure 30 | Two-mode network on attitudes towards other stakeholders

The figure shows who received a high salience score by which stakeholder. The analysis of this figure follows below, after presenting the betweenness centrality score. Derived from this figure, the table below show the centrality score of the stakeholders salience.

Stakeholder	Betweenness centrality score
Specialized Gardener	5
Municipality	4
Architect	4
Users	4
Housing Corporation / Real-estate owner	3
Project Developer	3
Landscape Architect	2

Investor	2
Neighborhood	2

Table 4 | In betweenness centrality score of other stakeholders

Analyzing this figure and table, some outputs need closer attention. The betweenness centrality scores in the table, show a single outlier: the specialized gardener specialist with a score of 5 out of 5. This score matches the statements of many of the stakeholders that there is a need for expertise in the field, proving and improving the technology of the vertical gardens. In addition, it could also be explained as a call for including specialized gardeners in project development in an early stage, as was suggested by the project developers. The same reasoning helps to interpret the high position of the architects, as these were too described as powerful in the early stage of a project. However, relying on this score alone may be unjustified as not much attention was given to the role of the architects by most of the respondents.

The municipalities however, receiving a betweenness score of 4 as well, were often discussed. Their role is considered crucial by most respondents as they pleaded for clear and stable policies, in which the municipalities take a front runners position. What is interesting here, is that the national government received such a low rating that it was excluded from both the figure and the table. In the interviews, respondents explained that they considered the national government as a stakeholder that should not be involved in the implementation of vertical gardens at all. There is too much distance to have effective influence; hence their low salience score. However, it they should provide a stable and progressive context, by creating and maintaining encouraging policies. This is reflected in the CSF-analysis in the next paragraph.

Concluding, it can be said that the municipalities are considered most relevant by most stakeholders. The role of a municipality in the implementation of vertical gardens can strongly influence the attitudes of stakeholders towards the implementation of vertical gardens. But this position is strongly related to the position of the specialized gardeners. They are expected to provide knowledge, improve their systems and effectiveness.

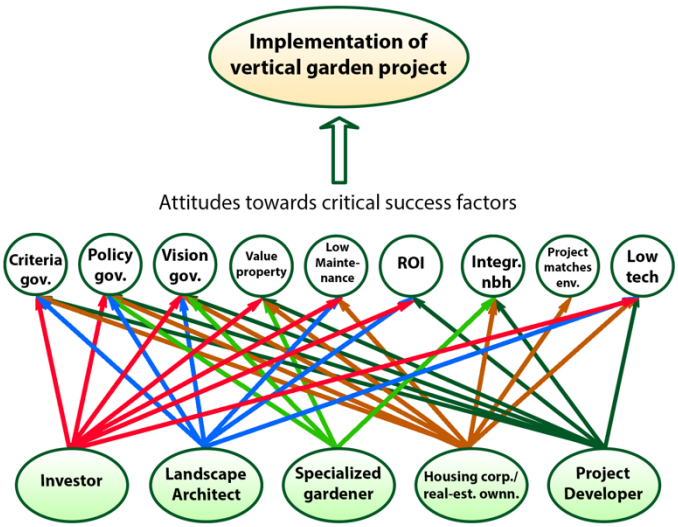

Figure 31 | Two-mode network on attitudes towards other stakeholders

4.3.3. ATTITUDES ON CRITICAL SUCCES FACTORS

Figure 31 shows the two-mode network connecting a selection of the stakeholders to a selection of the CSFs. The pre-selection of both stakeholders and CSFs is similar to the selection in the previous paragraphs. The figure shows which stakeholder considers which CSF relevant.
Figure 31 shows the links representing the attitudes of stakeholders towards critical success factors. From this figure the centrality score of the critical success factors can be calculated. See the table below.

Abbreviation CSF	Description of CSF	Betweenness centrality score
Vision gov.	Clear vision provided by national government	5
Policy gov.	Stable policy assurance by national government	5
Criteria gov.	Clear criteria provided by national government	4
Value property	Value increasement real-estate by vert. garden	4
Low tech	Systems used are low-tech	4
ROI	There is a return on investment	3
Low Maintenance	System requires low-maintenance	3
Integr. nbh	Neighbors are involved in project development	3
Project matches env.	Project matches environment	1

Table 5 | In betweenness centrality score of critical success factors (CSFs)

It is clear from both the figure as the table that the role of the government is crucial success factor. The betweenness score shows these factors receive the highest by the most stakeholders. This is reflected in the previous paragraph, where the role of the municipalities was ranked highly, also stressing the importance of stable policies and a supportive role. It seems that these results show that stakeholders closely relate the role of governmental institutions to the implementation of vertical gardens.

Figure 31 shows a strong alignment in ranking between the investor, housing corporations and project developers. This figure helps to understand the ranking of centrality in Table 5. Their overlap represents most of the lower ranked factors, such as ROI and the low tech requirement. From their position this can be understood, as they represent a very practical position within the stakeholder network. For them, implementation is closely related to feasibility, risk aversion and viability.

As a last, value increasement of property stands out as a highly weighted factor for project success. This shared perspective is remarkable, because during the interviews, many stakeholders shared the difficulties that come with value increasement. It is considered a slow process, that is highly reliant on ROI, trends and proof of concept. This indicates that this requirement shows a hesitant approach towards the implementation of vertical gardens.

5. Conclusion

5.1. Discussion & Conclusions

In a time of urbanization and climate change, new innovations aim to address the pressing challenges that affect the quality of urban life. This study explored the attitudes of stakeholders towards one of such innovations: the vertical garden, an innovation with intriguing qualities, but so far only limited implementation. The result is a diverse testimony constituting the potentially involved stakeholders' attitudes towards the implementation of vertical gardens. More specifically, this study examined how the stakeholders' attitudes towards the effects of vertical gardens, towards other stakeholders and towards critical success factors constituted their attitude towards the implementation of vertical gardens. In other words: how do these isolated opinions influence their overall view on the implementation of vertical gardens? Their narratives reveal the interconnectedness of stakeholders and the dynamics that restrain them from participating.

When discussing other stakeholders, the role of the government and its municipalities proved to be a crucial player: its vision and criteria must be clear, its policies stable. But there is also an edge of skepticism in this perspective shared by some, doubting the ability of municipalities to take that role. These stakeholders experienced the impact of fluctuating policies and inconsistent subsidies in the past. It seems that the municipalities therefore have not only a crucial role, but also a delicate one.

But what role should a municipality play? The stakeholders' attitudes on effects and critical success factors hint to a possibility. Almost unanimously, the effect of enriching the urban landscape and improving the well-being of its citizens were highly valued. However, when it comes to the more specific effects, such as mitigating air- and noise pollution, a large part of the respondents stressed the relevance of detailed quantifications of these benefits. For them a return on investment is decisive for implementing vertical gardens; a general well-being is not sufficient. Critical to some is a return on investment or at least calculatable effects for implementation. Also lack of proven technologies and high costs are restraining factors. Currently, knowledge institutions and NGO's that could research these matters are only rarely consulted, results show.

Municipalities could therefore instead invest in research on the effects and knowledge institutions that provide the tools for implementation. The demanded frontrunners role of a municipality could be to invest, support and facilitate extensive research and proof of concept. This study shows that stakeholders have a need for tangible tools to incorporate an innovation such as vertical gardens into their projects and meanwhile share a cautious but substantial attention to the municipalities' vision. The outcomes of this stakeholder analysis, suggest that the stakeholders' attitude towards implementation could therefore be positively influenced by addressing these aspects of the implementation of vertical gardens. The trend of urbanization is far from reaching its peak. Municipalities seem not yet to have found their position on how to consistently encourage stakeholders to invest in innovations improving the quality of urban life. This could be their wake-up call.

5.2. Limitations & further research

This study did encounter some limitations that need further research. The following three aspects deserve closer attention:

As the field of vertical gardens is relatively new and unexplored, it proved difficult to find stakeholders with in-field experience on the topic. This required the selection of respondents to be less strict and therefore include respondents that are related to the field, but had no prior experience with vertical gardens. In further research, this difficulty could be addressed by comparing stakeholders who have and who have not participated in vertical garden projects.

It was not an aim of this study to gain representative data for the entire social network around vertical gardens, as too little is known on the dynamics around these new innovation. Instead, the study explored the different narratives of experts directly or indirectly related to vertical gardens. As a follow-up to this initial exploration of qualitative narratives, further research could build upon these gained insights by setting up an extensive quantitative questionnaire. The outcomes of this study can then be checked on their representation within the social network.

Listing the effects of vertical gardens revealed several challenges. Currently, available data is derived from laboratory setups and lacked consistency in categorizing systems, effects and scales of influence. That made discussing and comparing the data problematic. Both the scientific domain as the stakeholders would be served with a universal system that standardizes these aspects and provides tools to measure and present the data.

5.3. Recommendations to stakeholders

- Municipalities should take a frontrunners role in the implementation of vertical gardens. This role should focus on research to explore the effectiveness of vertical gardens, provide tools for comparison of effects and systems, and focus on the potential of a return on investment.
- Specialized gardeners should play a proactive role in sharing their knowledge on different available systems, risks and costs to investors, project developers, (landscape) architects and housing corporations. The specialized gardeners are highly thought of by these stakeholders, which legitimizes their position as advisor.
- Together with municipalities and specialized gardeners, knowledge institutions should offer their knowledge or skills to become involved in the implementation of vertical gardens.
- Specialized gardeners should invest in reducing the costs and risks of vertical garden systems. Stakeholders are risk aversive and prefer the combination of different systems, instead of one specific version.
- Project developers and housing corporations can take a proactive role in the integration of vertical gardens in their projects, by sharing their priorities with municipalities and specialized gardeners. These can than adjust their products and services to these needs.

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Appendix A | Item list interviews

General Interview structure - [stakeholder] – [date] – [location]
First checklist interview:

- Explain semi-structured aspect of interview
- Check for agreement on recording
- Check for agreement on privacy, referring in final thesis
- Introduce topic and ask to introduce themselves (function, organization)

URBAN CHALLENGES
(measuring attitude stakeholder towards urban challenges)

What is the mission of your organization?
(stakeholder position)
Which values are important to you, concerning urban development?
(stakeholder position)
Which urban challenges are most urgent to you?
(stakeholder legitimacy)
How important is greening urban areas to you?
(stakeholder legitimacy)

VERTICAL GARDENS
(measuring attitude stakeholder towards vertical gardens)

To what extent are you involved in urban greening?

Why do you think this is or is not important?

What is your experience with vertical gardens so far?
(baseline assessment knowledge vertical gardens)

What is your impression on the quality and sustainability of current available systems?
→ together with respondent defining 'vertical gardens':

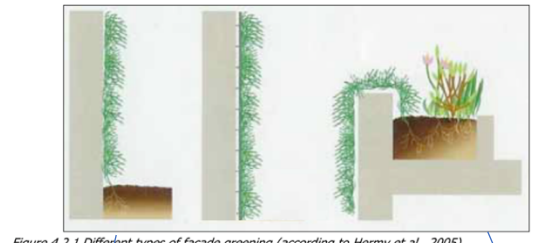
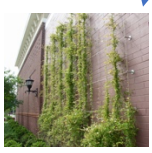


Figure 4.2.1 Different types of façade greening (according to Hermy et al., 2005).



A

B

C

How important are the following potential values of vertical green, and why?:

1.	Improvement of air quality	1 – 2 – 3 – 4 – 5
2.	Increasing biodiversity	1 – 2 – 3 – 4 – 5
3.	Protection building against precipitation and solar radiation	1 – 2 – 3 – 4 – 5
4.	Temperature regulation and insulation & urban heat stress	1 – 2 – 3 – 4 – 5
5.	Value-increasement of real estate	1 – 2 – 3 – 4 – 5
6.	Greening of the city in a general sense	1 – 2 – 3 – 4 – 5
7.	Sound absorbing effect	1 – 2 – 3 – 4 – 5
8.	Contributes to well-being residents/users	1 – 2 – 3 – 4 – 5
9.	Contributes to the wellbeing of local residents	1 – 2 – 3 – 4 – 5
10.	Esthetical value to urban landscape	1 – 2 – 3 – 4 – 5

STAKEHOLDERS
(Assessing position Stakeholder)
Which of the above effects is most close to your/your values?
(Stakeholder legitimacy)
What effects are part of your current activities?
(Stakeholder urgency/power)
What effects would you like to add to your goals in the future?
(Stakeholder position)
What other stakeholders do you think are important in the construction of green in urban areas?
(Stakeholder Power)

How Relevant Do you Consider The influence of the Following Parties in the realization of a vertical garden? And Why?

1.	Municipality	1 – 2 – 3 – 4 – 5
2.	The State government	1 – 2 – 3 – 4 – 5
3.	Project Developer	1 – 2 – 3 – 4 – 5
4.	The neighborhood	1 – 2 – 3 – 4 – 5
5.	Architects	1 – 2 – 3 – 4 – 5
6.	Waterboards	1 – 2 – 3 – 4 – 5
7.	Housing Corporations/Real estate owner	1 – 2 – 3 – 4 – 5
8.	Residents/Users	1 – 2 – 3 – 4 – 5
9.	Insurance company	1 – 2 – 3 – 4 – 5
10.	Investors	1 – 2 – 3 – 4 – 5
11.	Knowledge institutions (NGOs)	1 – 2 – 3 – 4 – 5
12.	Landscape architects	1 – 2 – 3 – 4 – 5
13.	Specialized horticultural companies	1 – 2 – 3 – 4 – 5

Which of these parties have you ever worked with and how?
(Proven participation)
With which of these parties do you see potential collaboration opportunities, and how?
(Potential participation)
What role would you have in the cooperation and what role do these others have?
→ Information, leading,

How important are the following conditions for you for the success of a green facade project in urban area?

Financial

- Subsidy is provided 1 – 2 – 3 – 4 – 5
- There is a return on investment 1 – 2 – 3 – 4 – 5
- The project contributes to value-increasement of real estate 1 – 2 – 3 – 4 – 5
- Distribution costs over multiple stakeholders 1 – 2 – 3 – 4 – 5
- … 1 – 2 – 3 – 4 – 5

Existing building Status

- The project joins existing environment 1 – 2 – 3 – 4 – 5
- The building is under construction 1 – 2 – 3 – 4 – 5
- Value of Building 1 – 2 – 3 – 4 – 5
- … 1 – 2 – 3 – 4 – 5

Technical

- Innovative Technology (pioneering) 1 – 2 – 3 – 4 – 5
- Complexity of Green 1 – 2 – 3 – 4 – 5
- Low maintenance requirements 1 – 2 – 3 – 4 – 5
- … 1 – 2 – 3 – 4 – 5

Social

- Type of end-user 1 – 2 – 3 – 4 – 5
- Integration of neighborhood in project development 1 – 2 – 3 – 4 – 5
- Cooperation NGOs 1 – 2 – 3 – 4 – 5
- … 1 – 2 – 3 – 4 – 5

Government

- Clear criteria 1 – 2 – 3 – 4 – 5
- Clear Vision 1 – 2 – 3 – 4 – 5
- Stable Policy 1 – 2 – 3 – 4 – 5
- … 1 – 2 – 3 – 4 – 5

Appendix B | Color codes

- To what extent do the stakeholders' attitudes towards effects, towards other stakeholders and towards critical success factors constitute their overall attitude towards the implementation of vertical gardens?
- What are the effects of vertical gardens in the urban environment?
- How can stakeholders be identified?
- How to measure attitudes and perceptions of stakeholders?
- What stakeholders are affected by or concerned with the implementation of vertical gardens in the urban environment?
- What are the attitudes and perceptions of these stakeholders concerning vertical gardens in the urban environment?
- How do these stakeholders perceive the relevance of involvement of or partnership with other stakeholders?
- What do these stakeholders consider to be the most relevant critical success factors (CSFs) for the implementation of vertical gardens in the urban environment?

Codes:

VALUES: values in work, valuing specific aspects of vertical gardens, or urban green in general – related to attitude

> With this code, all specific statements of interviewees related to their own values in their professional activities and their organization are selected. These values help to position the stakeholder, and give a further insight in their motivations. Coded text could describe the vision of the stakeholder, but also aims to identify (un)consciously stated preferences or priorities.

ATTITUDE: towards vertical gardens (positive, negative, doubt, suspicion). Regards the opinion/perspective of interviewee, or perceived attitude with another stakeholder

> Closely related to 'values', is the code 'attitude'. This code aims to capture the paradigm in which the stakeholder appears to place the topic of vertical gardens. All statements around valuing vertical gardens, its potential, its success or failure are coded with this label. Together, these codes describe the attitude of the stakeholder towards vertical garden. Also, it could give an indication of how a stakeholder expects other stakeholders to value vertical gardens.

IMPLEMENTATION: of vertical gardens (positive, negative, doubt, suspicion)

With understanding the values of a stakeholder and its attitude towards vertical gardens, no explicit statement on its willingness to participate is shown. That it is why the green label highlights the explicitly stated attitudes towards implementation.

PARTICIPATION: role, activity, (potential) participation as a stakeholder

Any statement on how such participation could be expressed are highlighted in grey. This concerns not only participation by the interviewed stakeholder, but also any statements on the participation of other stakeholders.

PARTNERSHIPS: interrelations between stakeholders, valuing confidence in partnerships

The 'partnership' label specifically aims to identify expressions on working in partnerships with other stakeholders. This could concern an opinion on collaboration or any description of a partnership set-up.

CSF: consideration of critical requirements for project success

Concerning vertical garden projects, the stakeholders will be asked to rate the relevance of a list of given crucial success factors. Any statements on CSFs outside of this questionnaire, will be highlighted with this pink label.

UNSORTED: but potentially relevant

Any statements that are considered potentially relevant, but do not fit in any of the given codes, will be highlighted yellow. These statements will be scanned for any similarities. If any similarities are found, this could result in a new code, linking those statements together in a new theme.

Appendix C | Quantitative Responses

How relevant are the following effects of vertical gardens to you?:
Answers on a scale from 1 to 5, ranging from 'Not important' to 'Very important'.

Respondent code	Verbetering luchtkwaliteit	Vergroting biodiversiteit	Bescherming gebouw tegen neerslag en zonnestraling	Temperatuur regulatie en isolatie & stedelijke hittestress	Waardevergroting gebouw	Vergroening van de stad in algemene zin	Geluid absorberende werking	Draagt bij aan welzijn bewoners/gebruikers	Draagt bij aan welzijn van buurtbewoners	Esthetische bijdrage aan stadslandschap
Q01S03R11	3	4	4	4	3	4	4	5	5	3
Q02S12R10	3	4	5	5	1	5	4	4	3	5
Q03S03R08	4	2	4	4	5	4	4	5	4	3
Q04S11R09	5	3	3	5	4	5	4	5	3	4
Q05S12R07	2	4	3	4	4	5	4	5	5	5
Q06S05R00	2	4	4	4	2	5	3	4	4	5
Q07S05R00	4	5	4	5	4	5	4	5	5	5
Q08S05R00	5	5	2	3	4	5	3	5	4	4
Q09S00R03	5	5	5	5	4	5	4	5	4	5
Q10S12R00	3	3	3	3	4	4	3	4	4	3
Q11S01R01	1	3	3	3	2	5	2	4	5	5
Q12S06R00	4	2	2	3	5	4	2	4	3	4
Q13S00R00	4	3	3	5	4	4	3	3	5	5
Q14S00R00	4	5	5	5	4	5	5	5	5	5
Q15S00R00	4	2	4	4	1	5	4	5	5	5
Q15S06R00	4	3	4	5	3	5	5	4	5	4
Q16S12R00	4	4	3	5	3	5	4	5	5	4
Q17S01R00	5	5	4	5	4	5	4	4	4	4
Q18S01R00	3	4	4	4	4	5	3	4	4	4
Q19S01R00	3	3	5	5	3	3	2	2	3	3
Q20S01R02	4	4	2	4	2	4	2	5	5	4
Q21S00R00	5	5	3	5	3	4	5	5	3	4
Q22S11R06	3	4	2	4	4	5	3	4	5	3
Average	3,7	3,7	3,5	4,3	3,3	4,6	3,5	4,4	4,3	4,2

Code refers to the identity and characteristics of the respondent, in which:

- Q## stands for the unique number of each respondent who filled in the questionnaire
- S## provides information over the stakeholder category the respondent belongs. This number corresponds with the codes provided in chapter 2. S00 means that this respondent does not fit the stakeholder categories, but did fill in the questionnaire.
- R## refers to the number each interviewee was given. R00 means this respondent only filled in the questionnaire, and did not partake in the interviews.

How relevant do you consider the following

Respondent code	Gemeente	De Rijksoverheid	Projectontwikkelaar	De buurt	Architecten bureaus	Waterschappen	Woningbouwcorporaties	Bewoners/gebruikers	Verzekeraars	Investeerders	Kennisinstellingen (ngo's)	Landschapsarchitect	Gespecialiseerd hoveniersbedrijf
Q01S03R11	5	3	5	4	3	1	5	3	1	1	3	1	1
Q02S12R10	1	1	1	1	5	1	1	5	1	1	4	5	5
Q03S03R08	4	5	3	4	3	3	3	5	2	3	4	4	4
Q04S11R09	5	1	5	3	4	2	5	3	2	3	2	4	4
Q05S12R07	2	2	5	4	5	3	4	4	3	5	3	5	4
Q06S05R00	4	2	4	3	5	2	3	4	1	2	1	5	5
Q07S05R00	4	5	5	2	3	1	4	2	1	4	2	1	1
Q08S05R00	4	3	3	5	4	4	3	5	3	2	3	4	4
Q09S00R03	4	4	5	4	5	5	5	5	3	4	5	5	5
Q10S12R00	4	2	5	2	4	1	3	2	1	3	1	4	3
Q11S01R01	5	2	5	2	3	1	5	3	3	5	1	2	3
Q12S06R00	4	3	2	4	4	5	2	3	4	2	3	5	5
Q13S00R00	3	3	4	5	5	5	3	4	3	5	4	5	5
Q14S00R00	4	4	4	4	5	4	5	5	3	4	4	4	5
Q15S00R00	4	4	4	4	4	4	4	4	1	1	4	4	4
Q15S06R00	4	3	5	5	4	2	5	5	2	2	4	5	4
Q16S12R00	4	4	5	2	4	3	3	2	3	4	2	3	2
Q17S01R00	4	4	5	5	5	4	5	5	4	5	4	2	5
Q18S01R00	4	2	4	5	4	4	5	5	3	4	4	5	5
Q19S01R00	3	2	5	3	5	1	3	4	1	5	3	5	3
Q20S01R02	4	3	5	5	5	3	5	5	2	2	1	5	5
Q21S00R00	5	5	5	3	5	3	4	3	2	5	4	5	3
Q22S11R06	5	3	5	3	5	2	3	3	3	3	4	5	5
Average	3,9	3,0	4,3	3,6	4,3	2,8	3,8	3,9	2,3	3,3	3,0	4,0	3,9

Hoe belangrijk zijn de volgende voorwaarden voor jou voor het slagen van een groene gevel project in stedelijk gebied?

Respondent code	Er wordt subsidie verstrekt	Er is een rendement op de investering	Het project draagt bij aan waarde-vergroting	Kosten worden verdeeld over meerdere partijen	Het project sluit aan bij bestaande (omliggende)	Het gaat om nieuwbouw	Het gebouw is van relatief hoge waarde (door bijv.	Innovatieve techniek (pionieren)	Lage complexiteit groen	Lage onderhoudsvereisten	Soort eindgebruiker	Participatie van buurt bij tijdens project	Samenwerking kennisinstellingen (ngo's)	Heldere criteria	Duidelijke visie	Stabiliteit beleid
Q01S03R11	5	4	4	3	4	4	2	2	2	2	5	5	3	5	5	5
Q02S12R10	1	4	4	1	5	4	5	1	1	3	5	5	5	5	5	5
Q03S03R08	3	5	5	2	3	4	5	2	4	4	3	4	4	4	5	5
Q04S11R09	2	4	5	3	4	4	3	5	3	5	5	3	2	5	5	5
Q05S12R07	2	5	5	2	2	2	4	5	4	5	4	5	3	4	4	4
Q06S05R00	3	3	3	4	4	3	4	4	4	4	3	2	2	2	2	2
Q07S05R00	5	5	5	3	2	3	4	4	4	5	2	3	3	5	4	5
Q08S05R00	4	4	5	3	5	1	2	5	5	5	4	4	5	5	5	5
Q09S00R03	4	5	5	4	5	5	5	4	4	4	5	4	4	5	5	5
Q10S12R00	5	4	4	2	4	3	4	3		3	3	3	3	3	3	3
Q11S01R01	4	4	4	2	3	4	5	4	4	5	2	1	1	4	2	4
Q12S06R00	5	4	5	4	4	4	5	3	4	4	3	3	4	5	5	5
Q13S00R00	4	3	4	4	3	2	2	3	5	4	3	5	4	5	4	5
Q14S00R00	4	4	4	4	2	3	3	4	4	4	5	5	4	4	5	4
Q15S00R00	4	2	2	4	4	1	1	4	5	5	1	4	4	4	4	4
Q15S06R00	3	3	3	3	4	5	3	4	3	4	5	5	4	5	5	5
Q16S12R00	5	2	4	3	2	2	2	4	3	3	1	3	4	4	5	4
Q17S01R00	5	5	4	1	5	1	1	4	5	5	4	5	3	5	5	5
Q18S01R00	4	5	5	3	4	5	4	3	3	4	4	4	3	4	4	4
Q19S01R00	1	4	4	1	2	1	1	1	5	4	4	2	2	5	3	3
Q20S01R02	1	2	5	5	5	1	1	2	2	3	2	4	2	5	5	5
Q21S00R00	4	3	2	4	4	4	4	4	1	5	4	2	4	5	4	5
Q22S11R06	4	4	5	4	3	3	5	4	4	4	4	3	4	4	5	4
Average	3,6	3,8	4,2	3,0	3,6	3,0	3,3	3,4	3,6	4,1	3,5	3,7	3,3	4,4	4,3	4,4