Forward-looking characteristics in long-term infrastructure investments

A criteria based assessment of the expansion and renovation project of the Eefde navigation lock

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Abstract

A considerable part of the current Dutch waterway infrastructure is beginning to deteriorate after many decades of use. Therefore, strategic thinking is necessary to ensure that these large-scale infrastructure assets remain functional in the long-term. This single-case study uses multiple criteria to investigate if the decisions in the case of the expansion and renovation of the Eefde navigation lock are forward-looking by examining the performance of the decision-making process. This research recognized three potential solutions that could introduce a forward-looking decision-making process in future infrastructure project in the Dutch waterway system. A more active adaptive management, an iterative infrastructure planning process, and a changed attitude in the tendering process could contribute towards a forward-looking decision-making process surrounding large-scale infrastructure projects. This is in line with the overall ambition of this research to make the ageing Dutch waterway infrastructure system able to deal with long-term challenges.

Keywords: Forward-looking decisions – Performance – Infrastructure asset management – Decision-making – Aging infrastructure

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Corneel van der Wielen

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1. Introduction

A considerable amount of infrastructure assets is deteriorating after decades of use (Pot et al., 2018). A large amount of 20th-century Dutch waterway infrastructure assets require renovation to maintain their operational capacity and quality (Willems al., 2018). Since these large-scale structures have a long lifespan and need significant financial investments, it becomes clear that strategic thinking is necessary for all stakeholders involved. This situation can be characterized as a 'tipping point,' in which the function no longer meets the objectives and further actions are necessary (Pahl-Wostl et al., 2011; Kwadijk et al., 2010). As such, a window of opportunity arises to think about future developments and scenarios, and consequently making forward-looking decisions. Factors such as disrupted power relations, dominant short-term political and policy discourses, and differences in agendas of the stakeholders' involved can influence the decision-making process (Rijke et al., 2014; Masood et al., 2016). Therefore, it is necessary to take a closer look at the challenges that long-term investments in infrastructure evoke and discover whether current infrastructure projects are forward-looking.

It is essential to find new ways to improve the decision-making processes of the Dutch waterway infrastructure renewal to create infrastructure assets that can cope with a broad variety of potential challenges. The infrastructure has to be adaptive to ensure the long-term functionality of infrastructure under continuous economic, social and environmental changes (Pahl-Wostl, 2007; Haasnoot et al., 2013). These uncertain developments impose challenges for decision-makers in coping with long-term infrastructure projects (Ranger et al., 2013). Therefore, it is crucial to think strategically about future problems to maximize the returns of (public) financial investments (Rijke et al., 2014). A much-used way of dealing with long-term infrastructure investments is asset management, which continually considers the performance, risk, and costs with the investments made by the stakeholders involved in developing and maintaining infrastructure assets (Schraven et al., 2011). This way of asset management is meant to improve the outcomes of projects. The necessity to reinvest in infrastructure creates the opportunity to not only benefit the project itself but also the region surrounding it (Hijdra et al., 2014). However, research shows that a significant amount of investments in the Dutch waterway infrastructure projects are constructed with a limited long-term approach (Pot et al., 2018).

1.1 Problem definition

As discussed in the previous paragraphs, several developments potentially limit the long-term functionality of the Dutch waterway infrastructure. The introduction of a forward-looking decision-making strategy could make decision-makers able to induce a long-term strategy into investment decisions. The forward-looking decision framework is a tool for recognizing underlying motives, arguments, and discourses that prevent contemporary infrastructure projects becoming forward-looking (Pot et al., 2018). Forward-looking decisions are necessary to ensure that a long-term approach is present in contemporary infrastructure projects. There are currently several challenges that prevent infrastructural decisions from becoming forward-looking.

First, as Tapinos & Pyper (2018) argued, there is currently a lack of insight in the way decision-makers view and deal with future challenges. This is surprising because the long-term functionality of these large-scale infrastructure assets depends on contemporary investment decisions. Second, several techniques are already established as mechanisms that help decision-makers to brainstorm about potential long-term challenges, such as foresight, scenario planning, and adaptation pathway maps (e.g., Brand, 2008; Haasnoot et al., 2013; Williams & Samset, 2010). These tools were developed and introduced in the decision-making processes several years ago. However, research of Pot et al. (2018) and Pot (2019) showed that many infrastructural projects often implement solutions that lack flexibility, universal robustness tests, and a strategic visions or scenario making process. Taken together, this indicates that there are more profound practices that prevent new infrastructure projects from actively addressing uncertain developments.

1.2 Research objectives

Based on the problems recognized above, this research aims to identify underlying practices that prevent infrastructural investment decisions from becoming forward-looking and finding solutions that could create the necessary conditions to deal with future challenges. Since the

Dutch waterway infrastructure system is ageing and is facing difficulties in terms of long-term functionality, it is necessary to increase the understanding surrounding the investment decisions of large-scale infrastructure assets in the Dutch waterway system.

Considering that the realization of a final infrastructural investment decision can drag on for several decades, it is essential that the whole decision-making process is analyzed. The forward-looking decision framework is, as Pot (2019) argued, suitable for 'ex-ante' analysis and 'ex-post' evaluation of the decision-making process. Therefore this framework is used as a tool to recognize underlying arguments in the decision-making process.

In addition to previous scientific research, this study adds the performance perspective when analyzing investment decisions. By taking a performance perspective instead of a conformance approach, the process through time is emphasized rather than solely analyzing the outcome. The presence of forward-looking characteristics in large-scale infrastructure projects is researched using the knowledge, legitimacy, and feasibility that the stakeholders involved have and will be further elaborated on in Chapter 2 (e.g., van Dijk & Beunen, 2009; Restemeyer et al., 2017; Wise et al., 2014).

This research contributes to the understanding of the decision-making process of large-scale infrastructure renewal projects to find solutions that can make future infrastructure projects forward-looking. The case that is used to illustrate and explain how decisions become forward-looking is the renovation and expansion project of the Eefde navigation lock, situated in the eastern part of the Netherlands. This case is selected since it is a recent renovation project that is part of a large-scale renovation program of navigation locks (Dutch: Programma Sluizen). Building on this, the case examined in the research of Pot et al. (2018), which evaluates and explains forward-looking decisions, is also part of the Programma Sluizen. This connection accommodates the opportunity to expand on the existing knowledge by researching other mechanisms or contextual factors that could facilitate forward-looking decisions.

1.2.1 Scientific and societal relevance

Although it makes sense to construct large-scale infrastructure that can deal with future challenges, long-term functionality is often not the main factor in infrastructure projects. As the research of Pot et al. (2019) on Dutch municipalities showed, the future is not necessarily considered in investment decisions, there are hardly any tests for the robustness of solutions, solutions are often not explicitly designed to be flexible, and the use of strategic visions or scenarios is scarce. Several scientific researchers have tried to expand the existing knowledge on making long-term investments more forward-looking (e.g., Masood et al., 2016; Pot et al., 2019; Rijke et al., 2014). The research framework of Pot et al. (2018) imposes a promising avenue for further research since it includes essential characteristics to analyze how long-term challenges are involved in the investment decisions and whether investment decisions can be considered as forward-looking. According to this framework, decisions are forward-looking when the following three criteria are satisfied. It has to include a problem definition with a long-term horizon, be adaptive or robust to cope with uncertainty, and consist of a justification based on long-term goals or developments.

The enormous task of renewing infrastructure in the coming decades requires an approach that considers long-term developments. Anticipating on conceivable challenges could prevent lock-ins, increased risks and misuse of public funds (Ranger et al., 2013). On a more strategic note, by finding ways to include for instance life-cycle costs in infrastructure projects they could become more future resistant (Lenferink et al., 2013).

Besides the scientific relevance, the societal importance of this research is the potential saving of public funds and decreasing potential future risks (Ranger et al., 2011). The development of infrastructure assets hinges on many factors and conditions that determine the long-term functionality of the Dutch waterway system. By critically analyzing the decision-making process practitioners are encouraged to reflect on and learn from preceding practices. The results of this research could contribute to a forward-looking decision-making process of developing large-scale infrastructural renewal projects.

1.3 Research question

Based on the problem definition and the research objectives, the main research question is formulated that guides this study. This question is expressed in the following way: *How can infrastructural investment decisions become forward-looking in the renewal of the Dutch waterway infrastructure network?*

To continue, three sub-questions are developed in an effort to address each component of this research systematically:

1. What are forward-looking decisions in the context of the renewal of the Dutch waterway infrastructure network?

2. How do decision-makers include the long-term in the planning process of the Dutch waterway infrastructure network?

3. How can future Dutch waterway infrastructure projects be improved to become forward-looking?

1.4 Reading guide

This thesis is set up in the following way. Chapter 2 provides an elaboration of the theoretical concepts that are used in this research. An overview is given on current practices during investment decisions of large-scale infrastructure assets. This explanation is followed by a detailed description of the forward-looking decision criteria and the conditions of the performance perspective. Subsequently, Chapter 3 provides information about the case of the Eefde navigation lock, which is situated in the Netherlands. Further, the research methods and method of data collection are discussed. Chapter 4 shows the gathered results of the selected case. Five phases are recognized and analyzed for the presence of forward-looking criteria and performance conditions. This interpretation of the data leads to three overarching limitations that restrict a forward-looking decision-making process. Chapter 5 elaborates on the three recognized limitations and addresses these with finding a suitable solution. Also, the limitations of this research are discussed in conjunction with avenues for future research. Chapter 6 answers the sub-questions and the main research question to conclude this research.

2. Theoretic framework

The renovation of infrastructure objects has been a returning point for discussion since new insights and changing conditions force scientist and practitioners to improve existing practices. This chapter discusses several concepts that are at the base of contemporary infrastructure renovation and expansion projects. These are ageing infrastructure, performance, infrastructure asset management, and forward-looking decisions.

2.1 Ageing (waterway) infrastructure networks

Infrastructure systems are an indispensable part of current society as they form a network that provides the distribution of for example goods, electricity, and communication. They are all subject to ageing through loss in performance, new developments, and changing situations. Therefore, these structures require a long-term strategy given their projected lifespan. Specifically, waterway infrastructures, such as navigation locks, weirs, and pumps, are characterized by long-lasting functionality. Since these assets provide for among others water safety, transportation of people and goods, agriculture, and the availability of drinking water, a long-term strategy is essential. Since this thesis is mainly concerned with the waterway system, broad terms such as infrastructure and asset refer to the word navigation lock.

The Netherlands has a rather extensive and one of the oldest waterway networks that is tasked with multiple responsibilities. There is approximately 1.700 km of strategic waterways with around 650 large-scale hydraulic navigation locks. The bulk of these structures were constructed between 1920 and 1960, which means that many have to be replaced and expanded in the coming decades (Pot et al., 2018). An infrastructure asset can last up to one hundred years and will deteriorate from the moment that a waterway infrastructure asset is constructed. In this light, an ageing infrastructure asset is considered as non-functional when it is not economically efficient to maintain it or when it does not fit contemporary needs.

Determining the moments of maintenance and renovation is part of effective life-cycle management of infrastructure assets. According to Pathirana et al. (2018), asset management originated from the growing realization that the existing practices of infrastructure maintenance were unviable. After that Rijkswaterstaat has significantly improved their management of maturing infrastructure assets since the introduction in 2009 (Van der Velde et al., 2013).

This was realized through the use of *"predefined risk management criteria and risk based methodologies"* to prioritize renovation budgets (Volker et al., 2013: 9). Daneshkhah et al. (2017) divide maintenance practices into two strands. First, corrective maintenance mainly comprises of repairing damaged or failed components that negatively influence the functioning of an infrastructure system. Further, preventative maintenance purports intensive and systematic inspection that could prevent unexpected failure. Preferably these two strands are combined in an effort to optimize the operational lifetime of infrastructure. Moreover, even if the whole operational lifetime of an infrastructure asset is considered, what about the moment that an infrastructure asset reached its technical and functional end of life?

From the moment it becomes clear that an infrastructure asset requires replacement, decision-makers have to formulate their goals and budgets. Multiple factors are considered in order to come up with a strategic plan that can deal with challenges in a timespan of a century. Hijdra et al. (2016) discuss three main challenges for stakeholders responsible for maintaining and developing the waterway system. These are, the necessity to renovate and replace the ageing Dutch waterway infrastructure, a changing climate that influences the conditions in which waterway infrastructure operates, and a changing role of these structures in society since the early years of their development. These developments are related to the introduction of new ways to maintain and reinvest in infrastructure assets. The following part addresses the principle of asset management in the decision-making process.

2.2 Asset management

Contemporary infrastructure asset management tries to gain the most value out of every euro invested (Herder & Wijnia, 2012). Originating from the financial sector, there are three core ideas of this business approach in managing infrastructure (Alegra & Coelho, 2012; Brown & Humphrey, 2005). The first aim is to secure long-term the performance of an asset. Secondly, appropriate management of potential risks. Lastly, the costs of the infrastructure project need to be as low as possible. As a result, it is often the goal to reduce spending with the least consequences for the risk and performance of an infrastructure asset. It enables the decision makers to address pressing challenges, such as the ageing waterway infrastructure. In a world where there are immense expectations, decreasing budgets and an increased influence of climate change, asset management is a commonly used approach (Volker et al., 2011).

The objective of decision-makers to choose the best strategy while balancing the risks, costs, and performance of an infrastructure project is under constant pressure. As visualized in Figure 1, the infrastructure system is subject to many competing forces (Shah et al., 2017; Van der Velde et al., 2013). In previous years the development and maintenance of infrastructure assets started shifting from the public domain towards a more privatized style of managing as a consequence of a limited (public) budget. Also, the increased use of for example roads and waterways has made large-scale infrastructure objects indispensable. Since there is hardly room for failure, there are increased performance requirements for infrastructure systems. Furthermore, there is less public acceptance because a reliable service is demanded. Lastly, higher legal requirements require adequate maintenance and managing structure. The following objective of Rijkswaterstaat exemplifies their view: *"to deliver the best service to the public at lowest life-cycle cost, given acceptable public risk"* (Van der Velde et al., 2013: p.340).

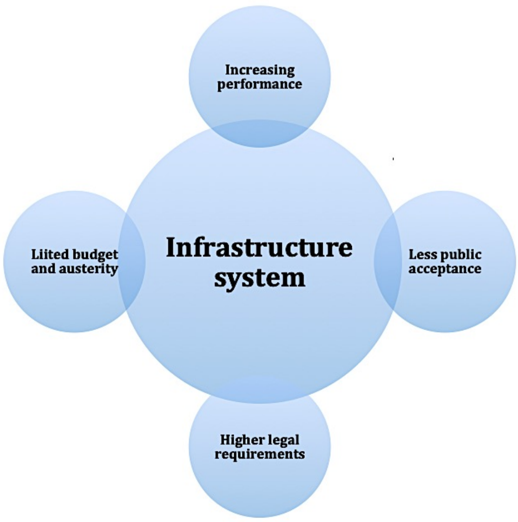

Figure 1. Pressures on infrastructure systems (Source: adapted from Van der Velde et al., 2013)

Although asset management has a great potential to overcome pressing issues, some authors describe it as top-down, predictive and controlled (Hijdra et al., 2014; Pahl-Wostl et al., 2011). Asset management often gravitates towards more short-term service coverage, quality, and affordability in a constant consideration of performance, risk, and costs by the decision-makers (Alegre et al., 2012). Dealing with these factors has proven to be a long and challenging process (Shah et al., 2017). This resulted in a growing body of literature aimed at making infrastructure development more integrated and adaptive to ensure the performance of infrastructure (e.g., Hamarat et al., 2013; Haasnoot et al., 2013; Restemeyer et al., 2017).

However, a thorough approach for dealing with long-term future changes and challenges is missing in infrastructure asset management. As Hijdra et al. (2014) discussed, there is an urgency to rethink the way ageing waterway infrastructure is dealt with. This has led to (some) broadening of the environmental and institutional context in the decision-making process. However, it is clear that there is still room for improvement due to the high pressure and dependency on these ageing assets. Therefore, it is necessary to integrate long-term strategies in contemporary asset management (Masood et al., 2016). Further, Masood et al., (2016) argue that especially in the early development part of a waterway infrastructure project the future goals and visions need to be linked to the existing consideration of cost, risk, and performance by decision-makers. Nonetheless, the actual meaning behind implementing a long-term strategy appears to be vague. Hence, the subsequent section will go into further detail on long-term and forward-looking decisions.

2.3 From long-term to forward-looking decisions

From the moment that it becomes clear that replacement of a waterway infrastructure asset is necessary, decision-makers are forced to take into account a long-term horizon. However, long-term investments are often troubled by a high degree of uncertainty, which can make the decision-making process difficult (Pot et al., 2018). Further, waterway infrastructures operate in a complex mixture of functions and stakeholders (van Vuren et al., 2015). Due to internal and external factors, the context of an infrastructure project can take an unexpected turn, which could eventually influence the long-term performance or efficiency of an infrastructure asset. This makes designing infrastructural assets that can cope with future challenges a problematic task. Since there are factors with a high degree of uncertainty in both the technical and social side of infrastructure development, a high degree of awareness is necessary in order to carefully investment in large-scale projects (Herder & Wijnia, 2012). Large-scale infrastructure projects are to a certain extent irreversible. Therefore, a well-considered assessment of future risks and costs to a high degree of uncertainty is essential.

Through time there has been a growing acknowledgment for long-term uncertainty in waterway renewal plans. This realization resulted in the introduction of a variety of measures that could make waterway renewal plans better suited for future change. A much-used practice to anticipate future developments has been the introduction of scenario planning. According to Restemeyer et al. (2017), the opportunity to offer a wide range of possible scenarios broadens the insight on potential future developments. These insights can be used to think about what can be done to reach a certain future. However, Pot et al. (2018: p.174) are not entirely convinced of this approach. *"This dominant perspective of decision making as an orderly process is more prescriptive than descriptive, being more concerned with how alternative solutions and futures should be explored than with how specific solutions are chosen."* It is often assumed that strategic planning involves subsequent steps in which an actor aspires to find the best solution. This approach is thus focused on rationality and linear models that are mostly prescriptive, which often comes to a 'best-guess' approach (Maier et al., 2016). However, this does not mean that scenario planning is useless. In contrary, it can be one of many useful tools to make infrastructure assets more forward-looking when used in combination with other elements. These valuable insights are precisely the reason why this more comprehensive approach of forward-looking decisions imposes a promising avenue since it combines multiple facets of long-term decision-making (Pot et al., 2018).

2.4 Forward-looking decisions

To combat the 'best-guess' style of planning in waterway renewal, a more holistic approach is necessary that includes multiple facets of making plans in an uncertain future. A relatively new perspective on the decision process of these infrastructure renewal projects has been forward-looking decisions. In order to understand if waterway infrastructure renewal projects are prepared for the future a definition of forward-looking decisions is necessary. In the past, multiple authors have touched upon aspects of forward-looking decisions (Iden et al., 2016). Especially foresight has been a much-analyzed aspect, although somewhat narrowly defined

(Pot et al., 2018). According to Iden et al. (2016), foresight refers to an activity that searches for factors that could influence future developments and deal with these factors by formulating appropriate responses. Nevertheless, forward-looking decisions integrate a broader range of criteria to assess long-term circumstances and outcomes. Further, it could also be seen as the opposite of myopic decisions, which have a bias toward short-term results (Bonfiglioli & Gancia, 2013). According to Restemeyer et al. (2017), this is often the case in contemporary policy-making. Subsequently, following the argumentation of Pot et al. (2018), three features can define if decisions are forward-looking (Table 1). These features are the inclusion of future orientation and long-term horizon in the problem definition, robust and flexible solution and long-term goals/visions and future scenarios. Each of these criteria will be discussed in relation to forward-looking decisions. This research only considers decision forward-looking when all criteria of the framework (Table 1) are satisfied. There is no mutual hierarchy between the nature of the problem, the solution, and the justification of long-term infrastructure investments.

Criteria	**Elements**	**Description**
1) Forward-looking problem	Future orientation and long-term horizon	▪ Problem definition includes future challenges and/or needs. ▪ Time horizon of at least 10 years.
2) Forward-looking solution	Robust and/or flexible	Robustness: ▪ The solution remains functionally effective during its technical lifetime when tested against an extreme case scenario. ▪ Pilots or experiments of one or more solutions were executed to test robustness. Flexibility: ▪ The solution can be adapted to changed circumstances and insights during its lifetime, or supplemented by other measures to secure long-term effectiveness. ▪ There is an agreement to establish a monitoring process to secure the effectiveness of the chosen solution. ▪ There is an agreement to establish an iterative decision process for the adaptation of the solution.
3) Forward-looking justification	Long-term goals/visions and/or future scenarios	Long-term goals/visions: ▪ The decision is connected to future goals or a future vision. Future scenarios: ▪ The decision relies on multiple scenarios for one future development. ▪ The decision relies on scenarios to understand multiple future developments.

Table 1. Criteria that make decisions forward-looking (Source: Pot et al., 2018)

2.4.1 Future orientation and long-term horizon

First, the problem statement of forward-looking decisions should comprise a long-term horizon. Although this might seem obvious, research of Segrave et al. (2014) showed that the temporal dimension could explain how problems are perceived, the questions that are asked and the kind of solutions favored. For instance, the subjective idea of what amount of years ‘long-term’ means can differentiate between the actors involved. Although waterway infrastructure can last up to a hundred years, that does not have to suggest that decision makers are aiming for a solution in that time frame. Each stakeholder has potentially a different agenda and time horizon. For example, the political will in a municipal council to be re-elected tends to lead to myopic or short-term visions rather than long-term strategy (Philips, 2017). Therefore, this research regards a problem statement of a waterway infrastructure project to be forward-looking when there is a minimum time horizon of ten years. This minimum amount of years is used to look beyond the (often) short-term policies by political decision-makers and to understand issues that necessitate a long-term vision.

Another important factor is the long-term nature of the problem definition in itself. A forward-looking problem statement should include future challenges and needs. According to Williams & Samset (2010), if the future challenges were (partially) overlooked in the problem statement it would be highly unlikely that a solution will solve them. This could, in turn, create more future problems than a solution was intended to solve. Therefore, it is important that a project is aware of potential future challenges and needs, and aims to solve problems that are in the distant future.

2.4.2 Robust and flexible solution

A forward-looking decision has to be comprised of a robust and flexible solution (Pot et al., 2018). In an ideal world, this would result in a plan that would be flexible enough to adjust to an altered context and robust enough to be able to cope with a multiplicity of future scenarios (Nair & Howlett, 2014). Hereby robustness indicates the immunity to uncertainty during the technical lifetime of an infrastructure object (Ben-Haim et al., 2015; Haasnoot et al., 2013). This is characterized in forward-looking decisions by a solution that is able to withstand extreme scenarios in the course of its technical lifespan and is subject to pilots or experiments in order to test the robustness. In contrast, this is not necessarily an optimal solution that produces the best performance in terms of efficiency or cost, as it is not certain that it will endure all future scenarios (Walker et al., 2013).

On the other hand, flexibility ensures that a project is able to adapt to future changes and still be functional (Wise et al., 2014). Flexible forward-looking decisions can be identified by the ability of a waterway project to adapt to changing circumstances and ideas that surface during its technical lifespan. This long-term adaptive tendency of a project is in place to endure changes over time in factors such as climate change, technological innovations and economic conditions (Walker et al., 2013). Also, there should be a continuous monitoring process of the asset in order to assess the technical and functional condition. This constant gathering of information offers the ability to respond earlier in situations when the performance of an infrastructure asset is not optimal. Further, a constant and iterative decision-making process can prevent that a project is set when the final decision is made to implement it. This offers the ability to constantly improve the project by the opportunity to introduce new technologies, insights, and gathered data during the monitoring process.

All in all, a forward-looking solution should be able to stay robust in order to cope with uncertainty but flexible enough to deal with changing conditions. However, this is no easy task for decision-makers since the time horizon of waterway infrastructure could be up to a hundred years. Therefore, the justification of long-term goals and future scenarios is another important factor in forward-looking decisions. This will be elaborated in the following part.

2.4.3 Long-term justification

A project has to advocate for the desired long-term objectives by discovering potential future scenarios under different conditions (Pot et al., 2018). To begin with, discovering and including long-term goals or visions could steer the decision-making process to find the justification necessary to make it more forward-looking. However, in order to understand what the goals of a project are a clear idea of the needs is necessary. Not surprisingly, this is not an easy task in a process where multiple stakeholders are involved, since not every stakeholder has the same agenda.

Williams & Samset (2010) classify the difficulties of the challenges surrounding a project as “dynamic complexity” and the struggles between stakeholders in a decision-making process as “behavioural complexity”. Dynamic complexity refers to uncertainty in future developments, making planning difficult. Further, behavioural complexity is concerned with for example differences in perception on developments, understandings of the problems at hand, and divergence in goals that are at play in a decision-making process. These two potential complexities in developing a strategy for waterway infrastructure renewal require a clear strategy that is supported by the stakeholders involved. By introducing and connecting a decision to future goals or a future vision early in the decision-making process the justification for an infrastructure asset could become more forward-looking. Another element of a forward-looking justification is the inclusion of future scenarios. Two commonly used approaches will be discussed, namely, scenario development and adaptation pathways.

Corresponding with the previously mentioned inclusion of long-term goals or visions, the inclusion of future scenarios is also an important part of a forward-looking justification. Trying to come up with multiple scenarios can broaden the search for plausible futures (Soetanto et al., 2011). This could spark further discussion between the decision-makers involved. The inclusion of scenarios gives a broad range of potential futures and offers the opportunity to understand multiple future developments. By systematically analyzing possible developments insight is given in alternative futures. According to Pot et al. (2018), a decision-making process can be considered as forward-looking when it is based on multiple scenarios that discuss a conceivable or envisaged prospective. Figure 2 provides a visual representation of scenario building that is based on evoking creativity and the exchange of thoughts between stakeholders. The current situation is regarded as a starting point from which storylines can develop in every direction through the coming years. The development of these storylines is connected to two drivers, which, to a certain degree, calibrate a long-term future compass. Each axis represents a driver that is highly influential and has two extremes (e.g. little climate change vs. strong climate change). This creates four quadrants, which represent a broad understanding of a potential future development. By repeating this process with a range of future developments is used that shapes the conditions for social learning (Hulme & Dessai, 2008). Also, as Brand (2008) argued, thinking in potential scenarios stimulates the idea that the future is, to a certain degree, shapeable.

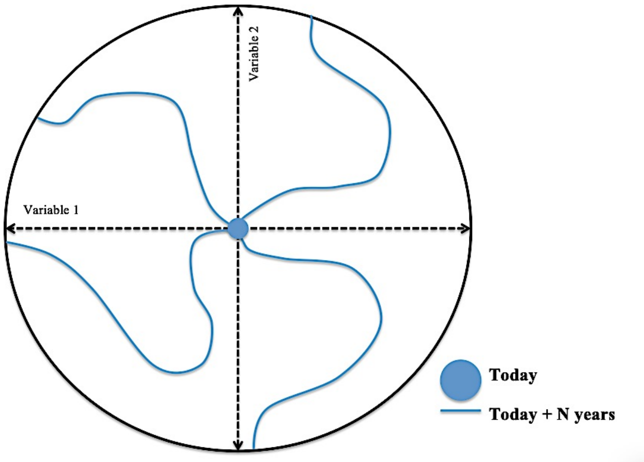

Figure 2: Creating scenario narratives (Based on: Meinert, 2014)

Another promising approach to develop future developments is the inclusion of adaptation pathways in the decision-making process. This approach, also referred to as a “route-map” or “decision pathway”, requires decision-makers to consider possible implementations and results in long-term strategic planning (Walker et al., 2013). By chaining subsequent potential actions through time an overview is created that creates a pathway towards a desired future situation.

Figure 3 provides an example of what an adaptation pathway encompasses. The current situation, distinguished by the grey line, is reaching its end of life within a few amount of years. This moment is also an indication as a tipping point that requires action. According to Haasnoot et al. (2013), this moment triggers decision-makers to search for other actions because the current actions are not adequate for reaching the long-term objectives. This result in a diverse range of potential actions, with various effects on a timescale, of at least one hundred years, indicated by the red, yellow, green, and blue line. This map offers the opportunity to display and compare no-regret actions, lock-ins, and the preferred moment of action for decision-makers to arrange a short- and long-term strategy to anticipate for and react to changes in future conditions (Walker et al., 2013).

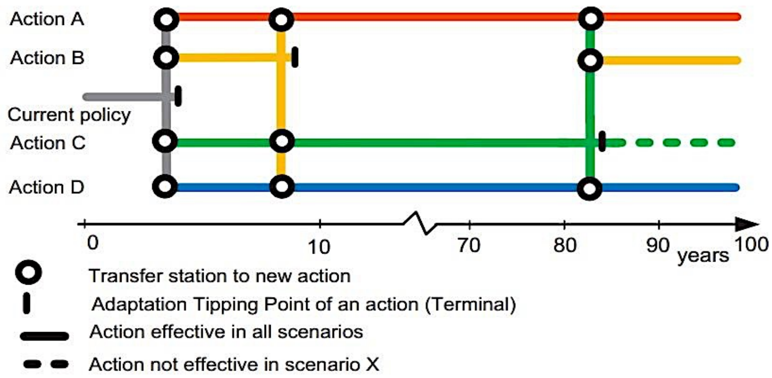

Figure 3: Adaptation pathway map and scorecard (Source: Haasnoot et al., 2013)

To conclude, this section has discussed the underlying logic of the three forward-looking criteria. Each of the three criteria covers an aspect of dealing with uncertainty and change, namely, the inclusion of future orientation and long-term horizon in the problem definition, robust and flexible solution, and long-term goals/visions and future scenarios. The combination of these criteria offers the ability to consider and answer what the perceived problems and goals are, potential solutions and what the explanation behind the argumentation is.

However, an investment has to be comprised of the right elements to consider it as forward-looking. Firstly, the problem definition is only considered as forward-looking when it involves both a long-term horizon of at least ten years and future challenges. Secondly, solutions are perceived as forward-looking when the two components of a robust solution are present, when the three components of flexible solutions are met, or when a solution is both robust and flexible. Lastly, the justification of a decision is forward-looking if it relies on long-term goals or visions, when the two components of scenarios are present, or when there is both a long-term vision and scenario planning. These guidelines will be used throughout the rest of this thesis when analyzing the forward-looking nature of the investment decisions.

2.5 Evaluation of performance

The forward-looking criteria discussed in the previous part are researched using policy documents and qualitative interviews and combine multiple facets of long-term decision-making. However, these forward-looking criteria are difficult to measure because of their descriptive nature and the influence of developments through time that may change the objective or outcome of a project.

The addition of a performance perspective when analyzing forward-looking decisions supports the analysis of the overall decision-making process in infrastructure investments. The forward-looking criteria focus mainly on the inclusion of adaptivity and long-term challenges in the decision-making process. However, the performance perspective provides a broader view that gives context to the decision-making process. Previous research on long-term infrastructure investments gravitated more towards the conformance of goals and future scenarios (e.g., Restemeyer et al., 2017; Wise et al., 2014), which predominantly aimed at how future scenarios should be chosen (Korthals Altes, 2006). Concerning the previous discussion surrounding the improvement of this 'best-guess' style of decision-making, more attention is required on the performance of the process itself (Pot et al., 2018). The performance perspective implies that the execution of a project can be productive while the results are not in line with the goals set in an early stage (Faludi, 2000). By evaluating the performance of the decision-making process from the perspective of forward-looking decisions insight is provided in developments that shaped the outcome of the process (van Dijk & Beunen, 2009).

Policy performance theory is currently a widely acknowledged field in spatial planning and scientific researchers (e.g., Faludi, 2000; Korthals Altes, 2006; van Dijk & Beunen, 2009). Nonetheless, there is a limited amount of scientific articles that operationalized this reasoning. Based on the research of Faludi (2000) three conditions are recognized. The following paragraphs discuss the knowledge, legitimacy, and feasibility conditions that indicate the performance of the decision-making process.

Firstly, knowledge is a necessary condition in the performance of an infrastructure process that decision-makers have to possess in order to provide a successful strategic plan (Faludi, 2000; van Dijk & Beunen, 2009). This condition is related to the extent to which the stakeholders involved know the plan or policy in the provided context. This condition can be recognized when the decision-makers involved acknowledging the plan. Further, the knowledge condition is present when research shows the consistency of knowledge between the interviews and policy documents.

Legitimacy is the second condition when analyzing the performance of a policy or project. The legitimacy condition relates to the acknowledgment of the project by the stakeholders involved (Faludi, 2000). Also, as Van Dijk and Beuningen (2009) argued, stakeholders have to be 'willing' to approve the project concerning their specific interests. Differences between the ideas, perceptions, and goals of the actors involved could change through time and lead to tensions during the decision-making process (Wu et al., 2017). A project is regarded as legitimate when stakeholders acknowledge the necessity, appropriateness, and justification of the project involved (Faludi, 2000). These actors are characterized by willingness, trust, and reliability to overcome barriers during the decision-making process. In contrast to the knowledge condition, the legitimacy of a project is regarded as a 'sufficient' factor since a policy or project can hypothetically still perform when support is scarce.

The third condition that is used to analyze the performance of a project is feasibility, which correlates with the competency of stakeholders to contribute to the project (van Dijk and Beunen, 2009). Feasibility not only relates to the financial aspect of large infrastructure projects, but also resources such as the availability and knowledge of the staff, and the correspondence between the different stakeholders involved (Petridou, 2014). Therefore, the sufficiency of the resources and coherency within and between stakeholders is used to evaluate whether the feasibility aspect is present in each of the three forward-looking criteria. To conclude, feasibility is regarded as a 'sufficient' component of analyzing the performance of a project since the willingness to overcome barriers in terms of financial resources and coherency could still be considered a form of performance (May and Jochim, 2012).

2.6 The performance of forward-looking decisions

The second chapter has discussed the current difficulties of asset management, the need for long-term thinking, the forward-looking decision framework, and the performance perspective. This more elaborate, broad, and thorough analysis of long-term decision-making has the potential to improve the management of the Dutch waterway infrastructure system by introducing the forward-looking framework of Pot et al. (2018). Further, the integration of scenario narratives and adaptation pathway maps in the early stages of decision-making processes could contribute to a better understanding and justification surrounding forward-looking decisions. This theoretical elaboration on forward-looking decisions is continued by an exploration of the renovation and expansion project of the Eefde navigation lock in the Netherlands.

3. Methodology

The subsequent chapter discusses the methodology of this thesis. Firstly, the research approach is discussed. Hereafter, the relevant case is introduced, and the methods of collecting and analyzing the data are discussed.

3.1 Research approach

This research is concerned with the long-term perspective of large-scale infrastructure projects in the renewal process of the Dutch waterway system. In previous years scientists and practitioners have elaborated on long-term decision-making under uncertainty. These researches focused on foresight, the introduction of scenarios, and the implementation of adaptive approaches. However, these methods are mainly prescriptive through their ideas on how different long-term solutions should be examined instead of how a strategy is chosen. The previous chapter provided and elaborated on the framework that is used to explain for and gain insight into the arguments of decision-makers in renewal projects of long-term waterway infrastructure assets (Table 1).

As discussed previously, this research is concerned with forward-looking decisions in the Dutch waterway infrastructure system. Building on the existing scientific literature, a case is selected to gain more insight into the decision-making process surrounding long-term infrastructural renovation projects. Further, this case study has a ‘critical’ design since this research is testing the results of previous research in order to obtain a better understanding of forward-looking decisions in infrastructure investments (Yin, 2014). Also, it is chosen to investigate and analyze the expansion and renovation of the Dutch Eefde navigation lock for multiple reasons. These will be discussed later on in this chapter.

3.2 Unit of analysis

This part discusses the case that is being researched in this single case study. First, it is discussed what kind of case study is used to analyze forward-looking decisions in the management of the Dutch water infrastructure. Further, the considerations for choosing the Eefde navigation lock are elaborated. This part is concluded with a short introduction to this case.

3.2.1 Case selection

The used case is situated in the northeastern area of the province of Gelderland in the Netherlands. More specifically, it is located near the city of Zutphen, as is shown in Figure 4. The selection procedure of the case includes several considerations that led to the determination of the case. First, from a temporal perspective, it is regarded as beneficial for the reliability of this research to choose a project that has started recently. This facilitates the collection of policy documents, and interviews with the decision-makers that were involved with approving the project. Also, the use of a contemporary infrastructure project is assumed to be representative for future decision-making processes. Considering that the case of the renovation of the Eefde navigation lock was relative recently decided (2016) the project fitted one of the initial criteria.

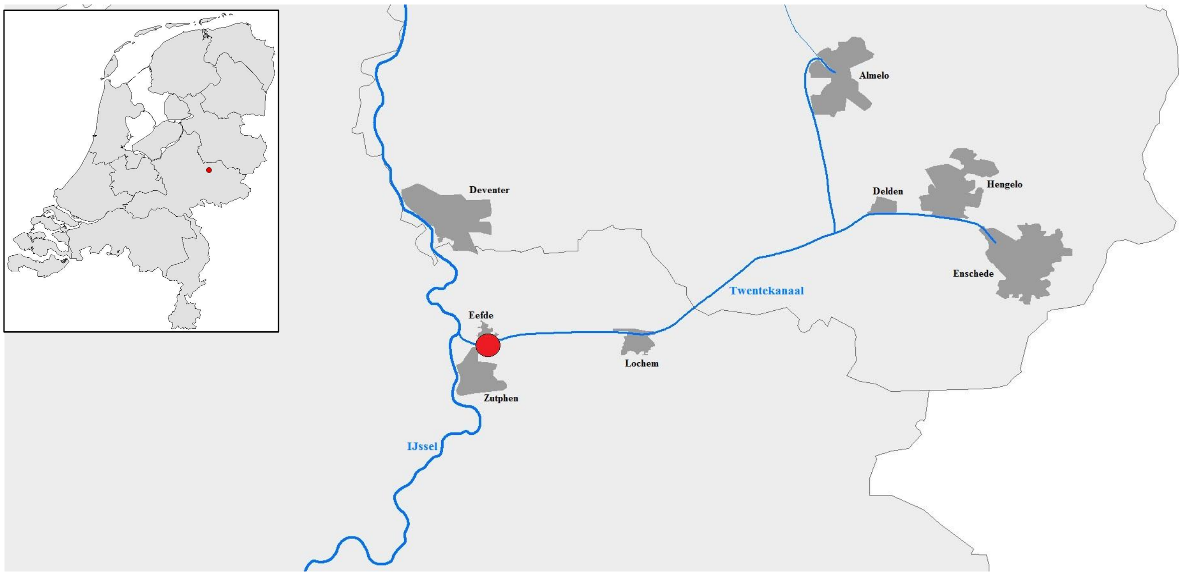

Figure 4. Location of the navigation lock Eefde (Source: Author)

Further, a case is selected which is part of the same program as the case that was researched in the article of Pot et al. (2018). This renovation program of large-scale waterway infrastructure in the Netherlands (Dutch: Programma Sluizen) derived from the necessity to invest in the aging assets. The introduction of a new case and context within the same institutional framework offers the opportunity to validate, dispute, or expand on the existing knowledge of previous research on forward-looking decisions in infrastructure investments.

For instance, contextual and institutional mechanisms could influence the results gained and thus the extent to which a decision-making process was presumed to be forward-looking.

Thirdly, the renovation and expansion project of the Eefde navigation lock is part of a more extensive sequence of measures to increase the waterway accessibility and water safety in the region. For example, the Twentekanalen is widened to allow for more shipping, and higher primary water defense measures are taken to decrease the risk of flooding. Although many related contextual developments are surrounding the Eefde navigation lock, this research will focus on the development of the renovation and expansion of the navigation lock itself. Concerning the nearing renovation peak of the Dutch waterway infrastructure in the next decades, more in-depth research could potentially improve the performance of future navigation lock investments.

In sum, this research focuses on assessing the external validity of the framework rather than relate the two case studies. Analyzing the Eefde case offers the opportunity to gain insight into what role the introduction of forward-looking decisions plays in the renewal of the Dutch waterway infrastructure network. The following part provides a more detailed description of the selected case.

3.2.2 Case description

As discussed earlier, there has been a growing need for renovating and expanding the Eefde navigation lock. The aging of the Dutch waterway network is related to the nearing technical end and a lack of functional capacity for waterway transportation. Due to the low functional speed of the navigation lock, there are regularly queues of cargo ships that have to pass this point, which results in higher transportation costs. The navigation lock in Eefde is a gateway between the river IJssel and the hinterland. Disruptions in the accessibility negatively influence the accessibility of businesses in the area. Also, in a period of increased demand for container transport via this waterway, the reliability of the navigation lock is crucial. When incidents occur, as in January 2012 (Parool, 2012), there is the possibility that the navigation lock is out of order for an extended period. The addition of a second navigation lock guarantees functionality when one of them is not operative (Figure 5).

Figure 5. Operational Eefde navigation lock during construction of the second lock (left) (Source: Author)

For reference, the village Eefde is situated north of the navigation lock while the city Zutphen is located in a southwest direction, as is displayed in Figure 6. On the western side of the existing navigation lock, the channel connects with the river IJssel. The Twentekanalen are the only connection by water to the eastern part of the Netherland. The channel was partially dug with shovels and wheelbarrows and completed in 1938. Further, the navigation lock intersects the Kapperallee. This road provides a local north-south access for cars, bicycles, and other traffic. Also, this road acts as a secondary route for emergency services to cross the Twentekanalen.

Figure 6. The area surrounding the Eefde navigation lock (Source: Google Maps, 2018)

Continuing, Figure 7 shows the navigation lock Eefde area before the expansion and renovation project has started. The existing navigation lock (red area) is renovated and is near the new lock (yellow area). However, this area has more functions than only serving as a gateway to the region. For instance, the 'old' and 'new' water pumping station regulate the water level in the surrounding area (blue area). Also, there are some residential areas near the navigation lock. Lastly, the embankments parallel to the Twentekanalen are part of the main water defense structure for the surrounding area.

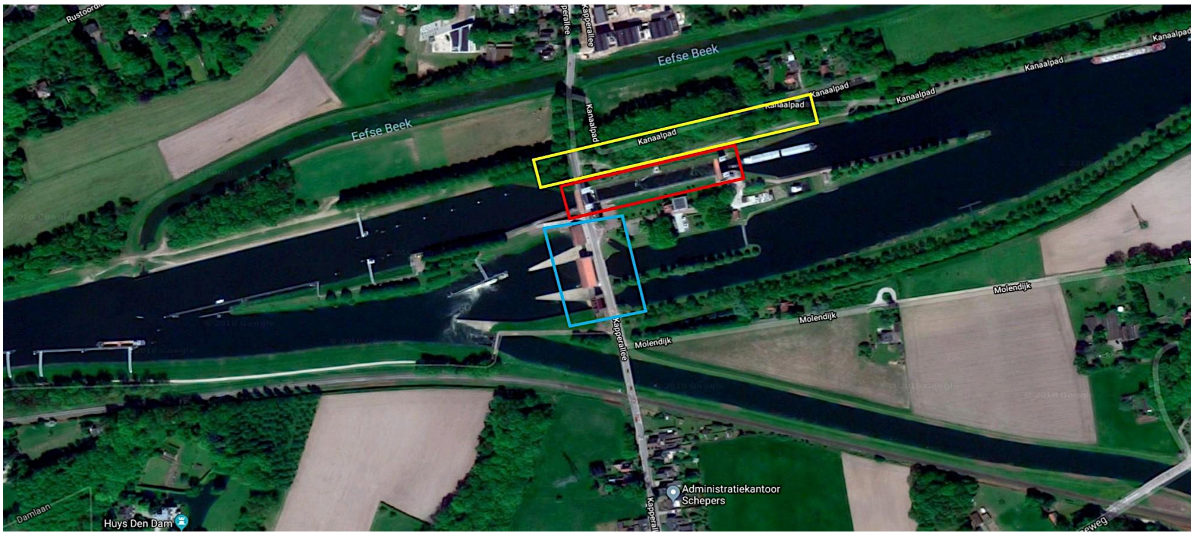

Figure 7. The project area of the Eefde navigation lock (Source: Google Maps, 2018)

3.3 Data collection

This research bases its conclusions on multiple sources of information. These are scientific literature, qualitative interviews, and policy analysis. Houghton et al. (2013) argue that qualitative case study research is contributing to the development of knowledge by the detailed and information 'rich' data it provides. Therefore, applying and conducting a qualitative method by gathering and analyzing a single case study results in a more in-depth analysis of the decision-making process. Also, they discuss the importance of 'triangulation' in studying a phenomenon. This action implies that multiple sources of information are compared to provide comprehensive and credible research. Subsequently, the information that has been used to carry out this research originates from multiple sources. The triangulation is part of the effort to increase the construct validity of this research.

Figure 8 illustrates the variety of sources of information and the basic structure of this research. To begin with, Chapter 2 provided a discussion in the broader scientific debate (1). This broad starting point elucidates the basic concepts that provide a framework of reference for the following parts of this research. After this, the gathered information is directed by the introduction of qualitative interviews and policy documents (2). This bridges the literature study with more case-specific characteristics provided by the qualitative interviews and the policy documents. The combination of qualitative data and policy documents is used to analyze whether the arguments made in the reports of the projects match the arguments of decision-makers that participated in the decision-making process (3). Overlapping the multiple sources of information is thus executed to provide a comprehensive and credible research.

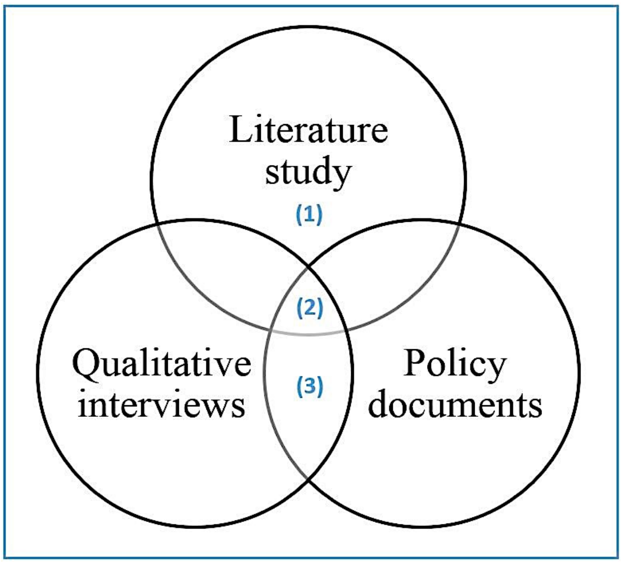

Figure 8. Triangulation of multiple sources of information

The following paragraphs will further elaborate on the methods of gathering information used in this research. Also, it discusses the considerations regarding the literature study, qualitative interviews, and analysis of policy documents.

<u>3.3.1 Literature study</u>

The study of literature in Chapter 2 aimed at creating a framework that supports the rest of this research. This articulation is intended to extend the existing knowledge on forward-looking criteria in the context of the renovation and expansion of the Eefde navigation lock to provide a progressive coherence of the existing theory and research (Golden-Biddle & Locke, 2007). In other words, it combines and relates a variety of acknowledged scientific information to which additions are made over time. In addition to this assemblage of information, a general problem is identified that could benefit from a new approach. In the case of this research, this relates to the presumed lack of forward-looking decisions in the renewal of the Dutch waterway infrastructure network. These two basic exercises are in place to guide the rest of this research.

3.3.2 Policy analysis

The policy documents that are written by the stakeholders involved are the second source of information. These documents provide an administrative framework that includes the primary and official considerations on which the decisions surrounding the renovation and expansion project of the Eefde navigation lock are based. These policy documents help to study the planning process of the renewal of the Dutch waterway infrastructure network. For example, it uncovers the formal administrative structures that guide spatial planning (Reimer & Blotevogel, 2012). Further, it provides an additional source of information that is used to verify the data gathered from the interviews. These documents are collected through the official websites of the municipalities, provinces, Rijkswaterstaat and the water boards involved in the renovation and expansion project of the navigation lock in Eefde.

3.3.3 Qualitative interviews

The qualitative information is gathered by conducting interviews with the key stakeholders involved in the selected case of this research. Representatives of Rijkswaterstaat, municipal council Eefde, municipality Lochem, province Gelderland, and waterboard Rijn & IJssel were approached for their role in the renovation and expansion project of the Eefde navigation lock. The interviewees were selected through an analysis of the primary decision-makers in policy documents and through ‘snowballing,’ the act of using the network of one person to contact other potential interviewees (Bryman, 2012). By taking a qualitative approach, the goal is to gain more insight into the presence of forward-looking criteria in the decision-making process. Following the argumentation of Yin (2014), this comprehensive examination of the “real” world has two main benefits. First, it allows for a complete apprehension of the complex dynamics present in this case study. Second, external contextual variables that potentially influenced the outcome are taken into account when analyzing a decision-making process. Since the decision-making process of large infrastructural projects, such as navigation locks, includes many stakeholders, interests, and risks, a qualitative research strategy is regarded as a more suitable method to uncover these complex dynamics and structures in such projects.

Since there are multiple techniques in the qualitative research strategy, it is essential to elaborate on the method of preference in this thesis. Although there are several qualitative methods to abstract information from the real world, the practice of one-on-one interviews with decision-makers is chosen. Following the argumentation of Hammersley (2008), interviewing decision-makers separately provides the ability to validate different views on a development to get a sense of the developments during a decision-making process. Continuing, discovering the nuances between stakeholders provides the opportunity to complement the results found in the policy documents and scientific literature. The two strategies that fit the goal of finding in-depth information from participants in a selected case would be to undertake a one-on-one interview or by assembling a focus group. Interviewing a group of people focuses mainly, according to Bryman (2012), on the interaction between the participants in a discussion on an area of interest while a one-on-one interview offers the ability to dig deeper into the arguments and beliefs of a single person or a stakeholder.

In this research the use of a focus group seems to be less applicable and fitting than performing interviews with individuals. Some of the limitations of these focus groups are the possible influence of group effects during a discussion, and the issue of only expressing culturally expected views (Bryman, 2012). It is expected that these effects are less present in one-on-one interviews. This research will carry out interviews with individuals since the outcomes of this method resemble the objective of this research. It is expected that this increases the construct validity, meaning that the research measures resonate with the concept that is studied (Yin, 2014).

3.3.4 Data collection framework

The data collection framework that was used in this study is shown below (Table 2). It provides an overview of the methods that were used to answer the sub-questions.

Question	Which information	Moment of retrieval	Source	Method of retrieval	Documentation method	Method of analysis
What are forward-looking decisions in the context of the renewal of the Dutch waterway infrastructure network?	Perceptions of existing scientific literature through articles and books	September 2018	Scientific literature on key subjects	Literature study, Snowball method of gathering information Critical reading	Theoretical framework	Study of literature
How do decision-makers perceive the current long-term planning process in the Dutch waterway infrastructure network?	Current barriers, and opportunities	December 2018	Interviews, policy & decision documents	Semi-structured interviews, policy analysis	Transcription	Atlas.ti coding software
How can future infrastructure projects be improved to become forward-looking?	Contextual information from interviewees	January 2019	Interviews, policy & decision documents	Semi-structured interviews, policy analysis	Transcription	Atlas.ti coding software

Table 2. Techniques of data collection

3.4 Data analysis

The previous part discussed what and why sources of information were gathered and how they help to answer the research question of this thesis. The analysis of the gathered data, the policy documents and the transcripts of the interviews will be discussed in this part of the methodology. First, the policy documents were analyzed first to gain a better understanding of the developments in the Eefde renovation project. In this process, formal decision documents of national organizations, provinces, municipalities, study reports, cost-benefit analysis, and multiparty agreements were gathered and coded. This gathering of documents created a general understanding of the arguments, considerations and the context in which the decision-making process took place. Appendix 8.1 provides an overview of these decision-documents.

Simultaneously a semi-structured list of interview questions was created. The interviews had a semi-structured nature because this offered the opportunity to be more flexible in the wording and questioning depending on the knowledge framework, role, or argumentation of the interviewee (Bryman, 2012). The topics and questions in the interview guide are based on the discussed literature in Chapter 2 and the policy documents. They seek to answer the sub-questions depicted in Table 2, and ultimately the main research question. Table 3 provides an overview of the interviews performed to gather qualitative information. Further, the interview guide served as a guideline in these interviews and is provided in Appendix 8.2.

#	Interviewee	Time of involvement	Method	Date
1	Advisor strong administration, Province of Gelderland	2011-2015	Face-to-face, recorded and transcribed	14-01-2019 (13:05-13:55)
2	Project manager navigation lock Eefde, Rijkswaterstaat	2015-present	Telephone, recorded and transcribed	21-01-2019 (14:25-15:02)
3	Project leader Spatial planning department, Municipality Lochem	2013-present	Face-to-face, recorded and transcribed	25-01-2019 (10:38-11:26)
4	Program leader dikes, Waterboard Rijn and IJssel	2015-present	Face-to-face, recorded and transcribed	25-01-2019 (15:05-15:45)
5	Member of village council Eefde	2011-2013	Face-to-face, recorded and transcribed	25-01-2019 (17:05-18:11)
6	Senior advisor innovation and market, Rijkswaterstaat GPO	2011-2015	Face-to-face, recorded and transcribed	12-02-2019 (11:05-11:50)

Table 3. List of the interviewees

When all interviews with stakeholders were completed, the policy documents and the transcriptions of the interviews were collected and bundled into the qualitative data analysis program Atlas.ti (version 8.3.1). Indicating when the moment of theoretical saturation occurred is difficult. However, it is regarded as the point at which no new concepts or insights are discovered (Bryman, 2012). The process of analyzing qualitative data is carried out with the Computer-Assisted Qualitative Data Analysis program, also referred to as CAQDAS (Bryman, 2012). The aim of introducing this analysis process is to increase the transparency of the coding process and to structure the gathered information for the analysis.

Since coding a large amount of different subject could increase the chance of missing valuable information, the analysis of the gathered data on forward-looking decisions in infrastructure investments was performed in two successive rounds. Firstly, the transcribed data was searched for the presence of criteria that indicate forward-looking decisions during the investment process of the renovation and expansion project of the Eefde navigation lock (see Table 1). After this step, the performance of the process surrounding the renovation and expansion was analyzed. This included an examination of the presence of knowledge, legitimacy, and feasibility. Also, the different roles of the stakeholders were examined. The specific roles and interests of each stakeholder involved were selected in the data.

The coding list provided an overview of the concepts that indicated a discussion of certain information in the gathered empirical data (Table 4). The codes are based on the earlier discussed forward-looking criteria and the concepts of knowledge, legitimacy, and ability. This theoretical foundation provides the opportunity to recognize, analyze, and structure the data. After labeling the different parts, the information is combined with the theoretical concepts discussed in Chapter 2. This theory-building process provides the opportunity to expand on the existing knowledge of previous research on forward-looking decisions in infrastructure investments by introducing 'rich' qualitative data to bridge the gap between the scientific debate and decision-making practice (Eisenhardt & Graebner, 2007). Further, Appendix 8.3 provides an overview of what information was collected, how it was analyzed, and used in this research.

Category	**Code**
Forward-looking decision	Forward-looking problem
	Forward-looking solution
	Forward-looking justification
Performance of the process	Knowledge
	Legitimacy
	Feasibility
Stakeholders	Role village county Eefde
	Role municipality Lochem
	Role province of Gelderland
	Role waterboard Rijn & IJssel
	Role Rijkswaterstaat

Table 4. The coding scheme used in the data analysis

In sum, this chapter discussed the methodology surrounding this research, including which, how, and why specific sources of information were used. Further, it presented the selection procedure of this single-case study with an elaboration of the context of the case. Finally, the method of analysis was discussed to clarify how the gathered data was evaluated to answer the research question. The subsequent chapter examines the data gathered for this research.

4. Navigation lock Eefde

The decision to renovate and expand the Eefde navigation lock did not happen overnight. On the contrary, it has been a process that is spread out over almost two decades of planning and discussion. During this period five phases can be distinguished that each has his specific interests, decisions, and conditions, and influenced the eventual outcome of the infrastructural project in Eefde. These periods are based on a historical analysis of the decisions concerning the renovation and expansion of the Eefde navigation lock. Each phase had a considerable impact on the course of the project and can be marked as a conclusion that transitioned the project into the next phase of planning.

This chapter continues with an analysis of the gathered information and will go into greater detail on the decision-making process surrounding the expansion and renovation of the Eefde navigation lock. Each period provides oversight of the main developments with their crucial investment decisions that shaped the decision-making process surrounding the Eefde navigation lock. The evaluation of the different investment decisions of the expansion and renovation project navigation lock Eefde is based on the forward-looking criteria as discussed in Chapter 2.4.

Also, all periods are analyzed for the presence of forward-looking decisions in combination with the performance approach. Each of these periods is marked by a decision that influenced the course of the decision-making process. The classification of different periods is in line with the performance perspective, as discussed in Chapter 2.5. Namely, rather than only looking at the result, this research highlights the different stages with their crucial investment decisions. These crucial decisions are made by the most important stakeholders, which are the Ministry of Infrastructure and Water Management, Rijkswaterstaat, and the municipality of Lochem.

The goal of this analysis is to portray the context in which the decisions for the navigation lock were made, whether the decisions are forward-looking, and what the performance of the decision-making process was. This chronological elaboration starts around the beginning of the twenty-first century with an increased awareness that the capacity of the Eefde navigation lock was limited.

4.1 2001-2002: Limited capacity

Main waterways, such as the IJssel and the Twentekanalen, are regarded as essential shipping connections between the Randstad, the north of the Netherlands and the economic regions in the eastern part of the country (Appendix A: Documentt #4). However, during this period there was a growing realization that the Twentekanalen and its navigation locks appeared to be a barrier for the shipping sector (Appendix A: document #1). For example, the waiting times for ships at the navigation locks became longer. Also, in concurrence with a long-term trend, ships became longer and layed deeper in the water, which limited the accessibility of the ports in the hinterland of the Twente region. These developments contributed to capacity problems at among others the Eefde navigation lock.

The need to optimize the use of the waterways, by for example adding a second navigation lock, was acknowledged by the former Minister of Infrastructure and Water Management Tineke Netelenbos in 2001 (Appendix A: Document #1). However, due to limited budgets, it was decided in 2002 that mitigating solutions were preferred and further exploration was essential. Potential cost-effective solutions with limited implications were researched. For example, it was studied whether an optimization of the capacity on the boats and a better temporal distribution of the passing boats during the day could limit the capacity problems. By 2002 it became clear that the capacity of the existing Eefde navigation lock still was insufficient to facilitate a growing use of the Twentekanalen. Nonetheless, due to a reprioritization of the project in Eefde, the realization was postponed until after 2010 (Appendix A: MIRT 2008).

Investment decision 1 (2002):

Minister Tineke Netelenbos decided that the expansion of the Eefde navigation lock could facilitate further economic growth. Therefore, multiple possible solutions should be investigated and analyzed. However, due to a lack of funds, the project was postponed, and alternative measures were taken.

Based on: Appendix A: Document #3

4.1.1 Forward-looking decision

Building on the developments between 2001 and 2002, investment decision 1 is not regarded as a forward-looking decision. By responding to future needs, the minister connected the growing market and economy to the navigation lock Eefde, which is in line with the first component of a forward-looking problem (Appendix A: Document #2). However, it is argued that the problem at hand was only regarded as one with an economic foundation since there is no indication that for example climate change and technological functionality were regarded as a problem at the time (interviewee #2). Also, no explicit articulation in the documents or interviews can be found that the time horizon of the problem is longer than ten years. Taking these arguments into consideration, the problem during this period is not regarded as a forward-looking problem definition.

Further, the solution during this period is also not considered as forward-looking since it only meets one of the three elements of a flexible solution. Although the monitoring process for the effectiveness of a solution is present through the search for better use of the capacity (Appendix A: Document #3), no sign of flexibility in the adaptability of the solution or the existence of an iterative decision process were found. Also, since the solutions are not tested for their resistance against extreme scenarios they are not regarded as robust. Additionally, during this period no pilots of experimental solutions were executed to test the robustness.

Lastly, the justification of the decision is regarded as forward-looking since the decisions are related to the long-term goals. This interconnectedness translates through the attempt of the national government to encourage regional economic growth through the connection of a long-term vision or goal (Appendix A: Document #4). Additionally, the justification of the decision relies on multiple scenarios for one future development. This reasoning supports the impression that the existing navigation lock in Eefde does not meet the required capacity and other options have to be sought after. By exploring several different solutions, the justification of the decision became more explorative.

4.1.2 Performance perspective

The performance of the decision-making process during this period indicates the interplay between the stakeholders involved and the decision. Although in several documents the willingness is expressed to improve the conditions for economic growth through the expansion of the Eefde navigation lock, for example, there is a lack of knowledge and feasibility (e.g., Appendix A: Document #1; #4). The lack of knowledge is articulated through the expressed need for more research to understand the regional importance and possible solutions. The limited capacity of the Eefde navigation lock was, according to the gathered documents (e.g., Appendix A: Document #2), broadly regarded as necessary for the further economic development of the region. Therefore, the legitimacy is considered as a decisive factor during this first period.

Despite the broad support in the parliament and the region there was a lack of financial resources to start the project. Therefore, the feasibility during this period is limited. The absence of feasibility is backed by the decision to postpone the development of the navigation lock Eefde until after 2010 (Appendix A: MIRT 2008).

4.2 2003-2007: Exploratory phase

By 2003, the necessity for an exploration of a second navigation lock in Eefde was recognized. However, the exact form of the desired project was still unclear. In the years that followed several plan studies were executed that explored the necessity of the project. The navigation lock Eefde started as an integral part of a waterway project that was aimed at improving the accessibility of the whole region by widening and deepening the channel itself and increase the capacity of the navigation locks which were considered as ‘bottlenecks.’ By combining multiple projects, it was aimed to create a “synergy” within the corridor of the Twentekanalen (Appendix A: MIRT 2008). This idea of widening the scope fits in a more regional vision that tries to combine multiple projects.

In 2007, Rijkswaterstaat finished its research in which three alternative solutions for expanding the capacity of the Eefde navigation lock were identified, as discussed in the environmental impact report of 2013 (Appendix A: Document #17). The explored alternatives ranged from better utilization of the existing navigation lock, the construction of a second navigation lock with the minimum required dimensions, and the construction of a second extra wide navigation lock. Based on this cost-benefit analysis it was decided that a second navigation lock in Eefde was necessary and the project progressed into a more in-depth study of the plans with a cost-benefit analysis.

> Investment decision 2 (2007):
>
> The ministry of Infrastructure and Environment decided to combine the Eefde navigation lock and the Twentekanalen project for synergy reasons and to investigate the expansion of the navigation lock further.
>
> Based on: Appendix A: Document #17

4.2.1 Forward-looking decision

Firstly, the problem-definition is analyzed for forward-looking characteristics. The effort to create "synergy" within the corridor of the Twentekanalen demonstrates that the Minister of Transport, Public Works and Water Management Karla Peijs and Rijkswaterstaat were aware that the minimum requirements had to be the same across all projects (Appendix A: MIRT 2008). In doing so, future challenges of a project were incorporated throughout the rest of the corridor to ensure they were capable of dealing with future needs. However, there is no indication from the decision documents that the problem definition concerns difficulties with a time horizon of minimum ten years during this period. Therefore, the problem definition during this second period is not considered as forward-looking.

Secondly, the solution of the investment decision during this period is regarded as forward-looking. Although the primary directives were clear, no specific solution was chosen yet. This 'open' period with a broad range of potential solutions indicates that the navigation lock was adaptive to future challenges, and that there was an iterative decision process to adapt the solution to future developments. In other words, although it was likely that there will be a second navigation lock, the ambiguity of the correct interpretation of solution offered flexibility to address a wide range of potential future challenges, which is regarded as forward-looking.

Lastly, the justification of the decision during this period is forward-looking since there is a connection with long-term goals or a future vision. This vision included the desired regional economic growth by improving the accessibility for larger ships (Appendix A: Document #6). While the presence of a long-term vision is sufficient to characterize this period as forward-looking, there is room for improvement during this period to address the scenario element. Namely, the necessity of the second lock in Eefde derived from the assumption of one scenario, one that prescribes that the amounts of ships will only grow in the years that follow (Appendix A: Document #17). Overall, the investment decision between 2005 and 2007 is not regarded as forward-looking since the problem definition does not have the required elements.

4.2.2 Performance perspective

The performance is, similar to the previous period, dependent on a few stakeholders. These are the Ministry of Transport, Public Works and Water Management, Rijkswaterstaat and the region of Twente. The exploratory result from Rijkswaterstaat improved the knowledge surrounding the necessity of the project, which led to an increased acknowledgment of the Eeefde navigation lock project and further research in the following years (e.g., Appendix A: MIRT 2008; interviewee #2).

Further, the legitimacy of this project is high, which is shown by for example the network analysis of the region Twente (Appendix A: Document #6), the exploration of alternative solutions in a cost-benefit analysis (Appendix A: Document #17), and the budgeting for the infrastructure funds by the parliament (Appendix A: Document #7). Also, the resources were present to conduct further research on possible solutions. To conclude, the improved performance of the project is mainly achieved due to the results of the first exploratory research. This initial investigation provided the decision-makers the arguments for taking the project of the second navigation lock in Eefde to the next phase.

4.3 2008-2010: Regional interests are backed up for further research

Following the exploratory cost-benefit analysis in the previous period, the project continued into the next phase with a more in-depth cost-benefit analysis that demonstrates the preferred specifications of the second navigation lock. The Ministry of Transport, Public Works, and Water Management selected three scenarios as potential desired solutions. These are a better utilization of the existing navigation lock, an extension in length of the existing navigation lock from 133 meters to 230 meters, and the construction of a second lock with the minimum requirements suitable for class Va ships. Class Va ships have a loading depth of 3,50 meters and require a deeper gutter than some part of the Twentekanalen can deal with (class IV). The cost-benefit analysis concluded that only the addition of a second navigation lock would have the requested problem-solving ability (Appendix A: Document #17). As a result, 120 million Euros were reserved for the renovation and expansion of the Eefde navigation lock (Appendix A: MIRT 2008).

Due to a lack of budget and capacity at Rijkswaterstaat no real action was initiated up until 2010. Other infrastructure projects in the country were prioritized despite that the decided maximum waiting times at the navigation lock Eefde were greatly exceeded (Appendix A: Document #12). Furthermore, the limited funds also led to austerity and phasing in the planning of the Twentekanalen project (Appendix A: MIRT 2011).

The new Minister of Infrastructure and Environment Melanie Schultz Van Haegen in 2010 reaffirmed the necessity of the expansion and renovation of the Eefde navigation lock. As interviewee #2 mentioned, an agreement was made between the minister and the region of Twente to decrease the number of trucks by increasing the shipping capacity from 12.000 cargo ships in 2012 to 20.000 in 2020 for economic growth in the hinterland. However, the overall scope of Rijkswaterstaat also became apparent. It concentrated on the basic functionality of the navigation lock. This narrow scope was translated to targets that provided for factors such as the efficiency, reliability, the design of the navigation lock, and compensation measures for its immediate surroundings (interviewee #6).

Investment decision 3 (2010):

Based on the cost-benefit analysis and the negotiations with the region of Twente Minister Melanie Schultz Van Haegen decided to add a second navigation lock in Eefde. This decision marked the start of a detailed investigation of the exact specifications of the new navigation lock and the reservation of monetary funds for a future tendering process.

Based on: Appendix A: MIRT 2011

4.3.1 Forward-looking decision

The third investment decision is also not regarded as a forward-looking decision. Similar to the previous period, the problem definition is not regarded as forward-looking. Despite that future challenges and ambitions, such as sustainability, were included in the problem definition, there was no precise articulation of a long-term time horizon that would address these problems (Appendix A: Document #9). This absence is exemplified by the motto of Rijkswaterstaat during this period, infrastructure had to be 'sober and efficient' (interviewee #6). The task of adding a second lock was, according to MIRT 2011 (Appendix A), to solve the existing inaccessibility of the Twente region by widening and deepening the channels and navigation locks for Va-class ships. Other potential long-term challenges that did not fit the scope of Rijkswaterstaat were not added to the problem definition of the Eefde infrastructure renewal project (interviewee #6).

Also, the solution during this period is not forward-looking. Although there was a continuous monitoring process to ensure the functionality of the existing and new navigation lock in Eefde to ensure functionality, the other two necessary elements of a flexible solution were not present during this period. There was no iterative decision process in place for the adaption of the chosen solution. Also, Rijkswaterstaat did not constitute requirements to make the solution of in Eefde flexible to deal with changing circumstances or insights to ensure long-term functionality. This is supported by interviewee #2, "*I do not know if you should call it (the Eefde navigation lock project) flexible. It is mainly focused on optimizing management and maintenance to ensure availability and a high availability percentage.*"

Finally, the justification of the investment decision during the third period is forward-looking because of the connection between the decision and a long-term vision for the new navigation lock and the region. This interplay is for example expressed through the goal of Rijkswaterstaat to implement the cradle-to-cradle concept at the Eefde navigation lock project (Appendix A: Document #10). The cradle-to-cradle concept is orientated towards a circular economy in which products and materials are repaired, reused, and refurbished in order to prevent wastage (Korhonen et al., 2018). Additionally, the three scenarios as mentioned at the beginning of Chapter 4.3 were researched extensively. However, the cost-benefit analysis is still based on one development, namely, the growth of the number of ships and thus increased waiting time at the Eefde navigation lock.

4.3.2 Performance perspective

Considering the developments, which occurred in the third period, the performance during this period is mainly limited by a continued lack of resources, which led to the postponement of the necessary additional capacity of the Eefde navigation lock (e.g., Appendix A: MIRT

2008; Appendix A: MIRT 2011). However, this provided the opportunity to perform further research to extend the knowledge on the project. This resulted in a more informed decision, which ultimately cannot be regarded as a negative performance of the decision-making process. Also, the legitimacy of the project is emphasized by the willingness during this period to invest 120 million euros on phase two of the widening of the Twentekanalen and the extension of the capacity of the Eefde navigation lock (Appendix A: MIRT 2008).

4.4 2011-2014: Highport Eefde, integral area development

During this fourth period, the Eefde navigation lock project gained momentum and several developments took place. To begin with, after the desired solution was chosen, which was based on the cost-benefit analysis in the previous period, the exact location of the second navigation lock had to be selected. Out of six potential locations Minister Schultz van Haegen selected the north variant. Also, the expansion of the Eefde navigation lock was disconnected from the integral Twentekanalen program, mainly because it required different fields of knowledge (interviewee #2).

Further, one of the doors of the existing navigation lock failed and collapsed on the 3rd of January in 2012, blocking off the channel for almost three months. According to interviewee #3, this incident marked a moment at which the development of the second navigation lock gained momentum by the decision-makers involved. During this period the necessity of renovating the existing navigation lock was emphasized, and thus the idea grew to combine it with the construction of the new navigation lock.

Parallel to the infrastructure project in Eefde, interviewee #6, an innovator at Rijkswaterstaat, came up with the idea to start Highport Eefde as an equivalent to other mainport projects such as Schiphol Airport and the harbour of Rotterdam in order to bring economic benefits to the Twente region. This idea grew since several local inhabitants of Eefde approached the technical project leader of the Eefde navigation lock with innovative ideas that did not fit the scope of the project itself. After multiple sessions with all stakeholders, ranging from local farmers and artists to the municipality of Lochem, ten fundamental elements were recognized, which were signed by all stakeholders in a covenant. These ten elements were all outside the scope of the responsible owner of the infrastructure asset, namely Rijkswaterstaat, and concentrated on subjects such as sustainability, culture, art, and recreation.

The decision of the exact location of the new navigation lock, the failure of the door, and the innovative project of Highport Eefde are crucial moments in the overall process of the project. Following these developments, the minister decided what the preferred location of the second navigation lock was, although this was a contested by the residents and the municipality Lochem (interviewee #3; interviewee #5).

> Investment decision 4 (2014):
>
> All stakeholders involved, Rijkswaterstaat, province of Gelderland, Municipality Lochem, village county Eefde, and the Waterboard Rijn en IJssel, showed willingness to invest in the region and make the expansion and renovation of the Eefde navigation lock an integral part of it. Also, the minister decided on the exact location of the new navigation lock.
>
> Based on: Appendix A: Document #19

4.4.1 Forward-looking decision

Based on the criteria discussed in Chapter 2.4, the decision in the fourth period is considered as forward-looking. Firstly, the problem definition during the fourth period is regarded as forward-looking since it includes future challenges and a long-term horizon. The connection between the construction of the new navigation lock and the renovation of the existing navigation lock, as discussed in the tender contract, shows the awareness for future developments (Appendix A: Document #22). Major maintenance on the existing navigation lock would result in a three months obstruction for the shipping sector. Further, the Highport Eefde initiative by Rijkswaterstaat to broaden the problem definition showed the willingness to broaden their scope, also regarding their problem definition (interviewee #1).

Further, given the developments during this period, the solution is regarded as forward-looking. To begin with, the relative late decision to lower the threshold of the existing navigation lock shows the presence of a continuous effort to secure long-term functionality based on changing circumstances (Appendix A: Document #21; Appendix A: MIRT 2014). With the expected lower future water levels on the IJssel, this is an essential solution to secure the long-term functionality of the existing navigation lock (Interviewee #2). Thus, a constant monitoring process is in place during this period and throughout the length of the maintenance contract, to make sure that the navigation lock remains functional.

To conclude the analysis for forward-looking decisions during this fourth period, also the justification is regarded as forward-looking. This is expressed through the connection between the decision and long-term goals for the region. By signing a covenant at the Highport Eefde initiative, Rijkswaterstaat and the other stakeholders showed their willingness to combine the construction of a second navigation lock with local and regional goals (Appendix A: Document #19). Building on this, the selection process of the exact location of the new navigation lock considered six potential locations and included the influence of the infrastructure project on its local surroundings.

4.4.2 Performance perspective

Aside from the forward-looking criteria, the performance of the process is analyzed. First, the knowledge condition is present through the effort of Rijkswaterstaat to provide a podium for the development of local ideas, initiatives, and visions through the Highport Eefde initiative. In doing so, residents were able to maximize the local benefits of infrastructure investment. As interviewee #4 argued, the inclusion of local inhabitants provided valuable additions to the overall project since some families have lived in the vicinity for generations. However, since Rijkswaterstaat was the only stakeholder that had the necessary technical knowledge available to decide what would be possible in the design of the new navigation lock was it difficult for the inhabitants of Eefde and the municipality Lochem to negotiate (interviewee #5).

The inclusion of local stakeholders did not only provide a more comprehensive perspective surrounding the expansion of the navigation lock in Eefde, but it also strengthened the legitimacy of the project. The overall conception was according to interviewee #3 that *"the effects of the navigation lock are serious and interventions have to be made, but it also provides a lot of positive things."* Thus, not only at the national level, but also the local inhabitants and municipal politicians saw it as an opportunity to bring economic, environmental, and recreational benefits to the area.

Lastly, although the legitimacy and knowledge were high during this fourth period, there was not a convincing amount of feasibility surrounding the project during this period. Not only did austerity measures limit the viability of initiatives outside the scope of Rijkswaterstaat, but also the differences in resources and influence between Rijkswaterstaat at one hand and the inhabitants of Eefde and the municipality Lochem at the other hand became clear (interviewee #5). The difference in resources between Rijkswaterstaat and the municipality in a technically complex infrastructure project can, according to interviewee #3, be exemplified through the battle between David and Goliath. *"When the arguments are on the table (..), and there is not a millimeter to negotiate, then it makes more sense to focus our attention within the choice of Rijkswaterstaat to optimize their solution rather than initiating a debate and challenge the decision with the risk of losing influence or ending it with a Pyrrhus victory."*

In conclusion, this fourth period with its investment decision can be regarded as forward-looking given that all criteria are present. The actual performance of the process shows that the conditions for an innovative, integral, and long-term decision shaped the eventual outcome. The configuration of the three performance conditions during this fourth period also demonstrates this. However, despite the intentions of all stakeholders, the project is still dependent on the willingness and means of the most influential stakeholder, namely Rijkswaterstaat. The translation of the ideas gathered during the Highport Eefde initiative and the specified conditions in the tender contract seem to be limited, which is discussed further in the next period.

4.5 2015-2017: The tender process

After the results of Highport Eefde convenant were taken into consideration by Rijkswaterstaat the tender for the construction of the new navigation lock, the renovation of the existing lock and the maintenance of both navigation lock for twenty-seven years was published in 2015. This DBFM-contract (Design, Build, Finance, and Maintain) was eventually won and signed by Lock to Twente, which is a collaboration between the three companies Mobilis (civil engineering), Croonwolter & Dros (technical installations), and TBI PPP (Financing).

The required zoning plan became definitive in 2017 and was the last step before the construction of the second Eefde navigation lock started. The final estimation of the cost of the project in Eefde was at 153 million Euros (Appendix A: MIRT 2017). This total includes the higher costs for the organization, integration measures, the excavation of soil, and higher construction costs (Appendix A: MIRT 2018).

The construction of the new navigation lock ultimately started in 2018 after new delays. The postponement of the construction of the project was the result of disagreements in the administrative decision-making process between Rijkswaterstaat and the municipality Lochem on the zoning plan procedures and the supervision of the execution of the constructor. As interviewee #3 argued, Rijkswaterstaat feared that the municipality would veto everything as a result of dissatisfaction. Based on mutual trust that the municipality would not do this they were admitted to the Q-team, which rarely occurs. This team makes sure that the quality of the materials used for the construction is in line with the desired ambitions.

> Investment decision 5:
>
> By 2016 a constructor was chosen, and the final financial agreement was signed. The construction of the new navigation lock started in 2018 and is expected to be operational in 2020.
>
> Based on: Appendix A: MIRT 2017

4.5.1 Forward-looking decision

The problem definition of this period is considered as forward-looking. This is supported by the constant search for future challenges that could potentially negatively influence the functionality of the existing and new navigation lock. The realization that the existing navigation lock in Eefde was reaching its technical end-of-lifetime and needed thorough renovation demonstrated the recognition of long-term challenges by Rijkswaterstaat (Appendix A: Document #22). Therefore, the renovation of the existing navigation lock was added to the requirements for constructors in the DBFM contract.

In contrast to the problem definition, the solution does not fulfill the required criteria to be forward-looking. Although flexibility is added to the solution through the continuous monitoring of the functionality of the navigation lock as described in the DBFM contract, the constructor is compensated during the length of the signed contract based on the beforehand-specified performance of their construction. However, the other two elements of a flexible solution are not present. First, Rijkswaterstaat did not make the solution adaptable for future circumstances or suited for future additions that would secure long-term functionality after the planning phase of the project finished (interviewee #6). From that moment employees of Rijkswaterstaat, that made the construction of a project possible, transferred the responsibilities of the infrastructure asset to the local maintenance administrators of Rijkswaterstaat-Oost (interviewee #2). Secondly, there is no iterative decision process for the adaptation of the solution. As interviewee #6 argued, the decision-making process can be defined as a linear process in which the discourse "new project, new chances" is evident. In other words, when the construction is finished maintenance is the most important occupation of Rijkswaterstaat. Rijkswaterstaat only considers new solutions when a navigation lock is reaching its technical end-of-life.

Finally, the justification is characterized as forward-looking. The connection of the investment decision to long-term goals is represented through the decision to strengthen the economic importance of the Twentekanalen region (Interviewee #2), and the effort to resolve future traffic jams by transferring the transport of freight from the road to the waterways (Appendix A: MIRT 2019). However, it is essential to note that the results of for example the Highport Eefde initiative and the sustainability goals, which showed the inclusion of long-term goals, were hardly reached (interviewee #3; interviewee #5; interviewee #6). The justification of the project relied on multiple scenarios for one future development. For example, Rijkswaterstaat considered the results of the social cost-benefit analysis in 2009 (Appendix A: Document #9) and the environmental impact report in 2013 (Appendix A: Document #17) as relevant.

In conclusion, the investment decision in the fifth period is not regarded as forward-looking since the solution does not meet all required elements of either a flexible or robust solution. Further, it is striking that some of the innovative and inclusive ideas are lost between the planning phase in the fourth period and the tender procedure. Possible reasons and solutions for these circumstances are, along with other instances, discussed in Chapter 5.

4.5.2 Performance perspective

The knowledge condition during this fifth and most recent period is present through the consistency between the plans as described in the decision documents and the administrative action by primarily Rijkswaterstaat. The requirements of the new navigation lock, as specified in the tender guide of 2015 (Appendix A: Document #22), are up to this point in correspondence with the execution of the contract, which is the result of a successful decision-making process in the fifth period (interviewee #3).

Despite that the infrastructure project of the Eefde navigation lock has been developed since 2001, the legitimacy of the project has been omnipresent throughout all periods. Especially the necessity of the project expansion of the navigation lock in Eefde has been widely supported (e.g., Appendix A: MIRT 2018; Appendix A: Document #22). Especially Rijkswaterstaat and the Waterboard seem to be satisfied with the administrative actions and the plans (interviewee #2; interviewee #4). However, not all stakeholders completely share this point of view, as interviewee #3, interviewee #5, and interviewee #6, all argue that the process could have been more appropriate and just. For example, many of the intentions signed at the Highport Eefde covenant by all stakeholders are not, or in attenuated form, implemented in the final decision (interviewee #5). Although Rijkswaterstaat intended to generate electricity in the adjacent pumping station, this was not implemented (Appendix A: Document #19).

Further, the feasibility differed between the stakeholders involved and therefore partially influenced the realization of the intentions signed during the Highport Eefde initiative (interviewee #1). For example, the decision relied primarily on the budget available and the distribution of the money itself. *"It was something that we as inhabitants of the village of Eefde were 'miles away' from, while it (the Eefde infrastructure project) did affect us"* (interviewee #5). Further, interviewee #6 argued that the intentions, as were made at the Highport Eefde covenant, are dependent on both the willingness of Rijkswaterstaat and the availability of money for these innovative developments. When either of these factors is missing, Rijkswaterstaat does not consider them as an essential goal in the tender contract. In other words, Rijkswaterstaat had the resources to reach an infrastructure decision that was sober and practical. However, plans that were outside of the primary scope of Rijkswaterstaat were affected and therefore hardly included in the construction contract.

4.6 Performance of forward-looking decision-making

Previous parts in this chapter have gone into detail of the performance of the process and the presence of forward-looking characteristics of each period. Table 5 summarizes the results (Y means that the element is present, N means that the element is not present). This table provides an overview of the developments over time and shows general developments during the decision-making process.

Criteria	Element	Decision 1 (2001-2002)	Decision 2 (2003-2007)	Decision 3 (2008-2010)	Decision 4 (2011-2014)	Decision 5 (2015-2017)
FWL Problem		**N**	**N**	**N**	**Y**	**Y**
	Includes future challenges and needs	Y	Y	Y	Y	Y
	Time horizon of at least ten years	N	N	N	Y	Y
FWL solution		**N**	**Y**	**N**	**Y**	**N**
	ROBUST: tested for extreme scenarios	N	N	N	N	N
	ROBUST: pilots were executed	N	N	N	N	N
	FLEXIBLE: adaptable to changed circumstances	N	Y	N	Y	N
	FLEXIBLE: established monitoring process	Y	Y	Y	Y	Y
	FLEXIBLE: iterative decision process for adaption	N	Y	N	Y	Y
FWL justification		**Y**	**Y**	**Y**	**Y**	**Y**
	VISION: connected to long-term goals future visions	Y	Y	Y	Y	Y
	SCENARIO: multiple scenarios for one future development	N	N	Y	Y	Y
	SCENARIO: scenarios for potential future developments	N	N	N	N	N
FWL decision		**N**	**N**	**N**	**Y**	**N**

Table 5. Overview of forward-looking characteristics during each period

First, the problem definition is forward-looking in decision 4 and 5. Before these periods the project was primarily focused on tackling the immediate lack of capacity by finding affordable solutions that would solve this for the years to come. However, during the fourth decision it was realized that the existing navigation lock was nearing its technical end-of-life. Therefore, the renovation of the existing navigation lock in Eefde was included in the contract. Also, potential long-term changes that could compromise the effectiveness of the navigation lock, such as lowered water levels by drought, were included in the problem definition (Appendix A: Document #23).

Secondly, the solution is considered forward-looking in decisions 2 and 4. These periods differentiate from the others through their flexible approach and iterative decision-making process. Further, it is noteworthy that none of the decisions included was a robust solution that was tested against extreme case scenarios. Also, there is no sign that pilot experiments were carried out to test the robustness of the solutions. According to interviewee #5 and #6, this can be explained by the reliance on proven technology by Rijkswaterstaat.

Lastly, the justification of the project has been forward-looking during all decisions. This is predominantly because all decisions included a long-term vision, which aimed at regional economic growth by improving the accessibility for freight ships, lowering traffic on the roads by replacing trucks for ships, and initiative Highport Eefde as a means to start a more integrated style of project planning (e.g., interviewee #2; Appendix A: Document #12).

The analysis of the performance of the decision-making process throughout the five periods shows that a low process performance does not preclude that the project is bound to fail. On the contrary, the analysis of knowledge, legitimacy, and feasibility provides a broader perspective that clarifies the presence or absence of forward-looking decisions. It is not surprising that during periods where there is considerable process performance, as during fourth decision, the Eefde navigation lock project has become more forward-looking. High performance seems to be a necessary condition for a large-scale infrastructure project to become forward-looking. The presence of knowledge, legitimacy, and feasibility seems to be important conditions that make the introduction of forward-looking decisions possible in such large-scale infrastructure projects.

4.6.1 Constraints in the decision-making process

The combination of the performance of the process and the forward-looking criteria during the five periods uncovers the main hurdles in making the Eefde navigation lock project able to cope with future challenges (Table 6). For example, a lack of feasibility is easily considered as an influential constraint in developing a forward-looking infrastructure project. When funding is abundant, it would be more likely that Rijkswaterstaat implements more integral measures and widen its scope. However, there seem to be more deep-seated organizational assumptions and practices that limit the efficiency of the decision-making process and thus hinder a more long-term focus in the infrastructure project.

		Performance perspective		
		Knowledge	Legitimacy	Feasibility
Forward-looking decision	Problem	The problem definition is mainly based on economic reasoning and originates from accessibility studies and prognoses.	High legitimacy to include a broad range of challenges and future developments in the problem definition. However, they have to fit within the scope of Rijkswaterstaat.	Austerity measures limit the feasibility and thus the integral and inclusive scope of the problem definition.
	Solution	Passive adaptive management through an examination of the specifications of the existing navigation lock and minimal technical requirements.	High degree of legitimacy to implement a forward-looking solution. However, it has a narrow bandwidth given the focus on reliability and functionality.	The fixation on a reliable, cost-efficient, and quick solution limits the opportunity to generate a flexible long-term solution.
	Justification	The project fits in the ambition to create infrastructure, which remains “safe, quick, and reliable” (Appendix A: MIRT, 2019).	The project is considered as an important link in the waterway system. This results in a high legitimacy of the project.	The project is recognized as an integral part of the region. However, the high necessity and need construct the navigation lock cost-efficient limits the feasibility.

Table 6. The performance of forward-looking criteria in the Eefde navigation lock project

Further, Table 6 shows that the overall discourse of Rijkswaterstaat regarding infrastructure projects is to construct new infrastructure as quickly as possible to capitalize on regional economic developments, to create a technical solution that remains functional, and to construct it with limited budgets. These assumptions resulted in a narrow scope, which reduces the flexibility of an infrastructure asset and thus the degree to which infrastructure is forward-looking. An example of the narrow scope is the limited ties between the projects of Rijkswaterstaat and developments in the region. Also, since Rijkswaterstaat is an entity that has to make sure that its infrastructure is functional at all times, there is little room for inventive solutions that tackle other problems. Three specific constraints are recognized and will be discussed in the next paragraphs.

First, Table 5 showed that the outcome of the Eefde navigation lock project is not forward-looking. The absence of a long-term focus is partially due to the passive adaptive management of Rijkswaterstaat. Hanna et al. (2016) recognized this ‘passive’ style through the use of historical information to develop a solution that is assumed to be suitable to deal with long-term challenges. However, following this logic Rijkswaterstaat should introduce a more ‘active’ adaptive management, which is in line with forward-looking decision-making (Pot et al., 2018).

A second flaw in the decision-making process is that Rijkswaterstaat perceives current infrastructure renewal projects as a linear process. As interviewee #2 argued, once an infrastructure project is finished, monitoring the technical functionality and maintenance are the main tasks of Rijkswaterstaat. From this moment all development is stopped and only revisited when the maximum capacity or the technical end-of-life is reached (Figure 9). For example, the intention to make the navigation lock in Eefde the most sustainable in the world did not fit the primary scope of Rijkswaterstaat and was therefore not implemented (interviewee #5). Due to this linear project planning, no radical changes are made to the infrastructure asset for at least the length of the existing DBFM-contract, which lasts twenty-seven years in the case of the Eefde navigation lock project.

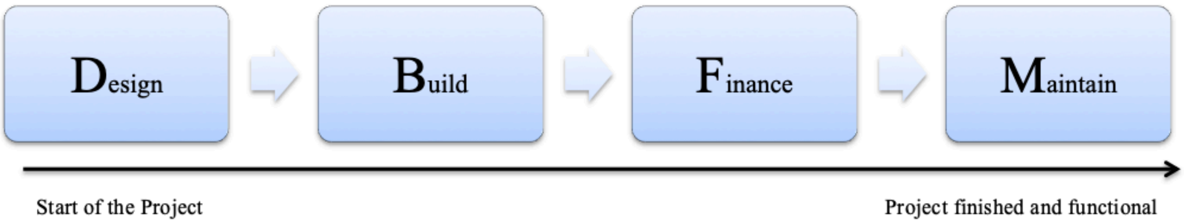

Figure 9. Visual representation of linear DBFM-contracts

Lastly, the case of the Eefde navigation lock project showed that innovative ideas developed during the preliminary planning stages were lost during the tendering process. According to interviewee #5, Rijkswaterstaat determined the minimum specifications of the new navigation lock through multiple cost-benefit analyses. The Highport Eefde initiative was started to make the project more inclusive. This collaboration resulted in many new ideas for the project itself and its direct surroundings. However, specifications such as sustainability and recreation were not included in the fundamental requirements of the infrastructure project. Instead, Rijkswaterstaat considered the conditions that are outside the primary scope as a bonus. In practice, constructors try to meet the minimum requirements through a cost-efficient solution with predominantly proven-technology (interviewee #6). In other words, the current tendering process of large infrastructural projects does not challenge constructors enough to find innovative solutions, which leads to missed chances (interviewee #3).

4.6.2 Final remarks

The analysis of the case of the Eefde navigation lock has resulted in three main constraints in the decision-making process that restrict the forward-looking nature of such large infrastructural projects. However, it does not suggest that the outcome of the decision-making process surrounding the navigation lock Eefde is unfavorable, nor it does presume that the decision-makers involved acted solely to meet short-term goals. Instead, the forward-looking framework and the performance perspective have highlighted the aspects that do not meet the requirements for the project to be regarded as forward-looking. The next chapter will, among others, discuss possible solutions to curb these constraints.

5. Discussion

This study has focused on improving the decision-making process surrounding the challenge of making the ageing Dutch waterway infrastructure forward-looking. The results are based on a qualitative single case study of the Eefde navigation lock project to explore the decision-making process surrounding a multi-million Euro costing infrastructure project. The analysis of the policy documents and interviews with critical decision-makers gave insight into the performance of the decision-making process and how long-term developments are included in such projects.

5.1 The role of a forward-looking framework

When considering the gathered information, it can be concluded that the case of the renovation and expansion project of the Eefde navigation lock became increasingly innovative, long-term, integral, and inclusive through time. For example, the introduction of the inclusive and integral initiative of Highport Eefde widened the scope of the Rijkswaterstaat project and sparked other developments in the surrounding area. However, the outcome of the decision-making process did not meet the required elements to be a forward-looking project. Further, the renewal and expansion project in Eefde is innovative and unique through the introduction of the Highport Eefde initiative. Also, Rijkswaterstaat had difficulties with integrating an adaptive and inclusive approach in other large-scale infrastructure projects. Three underlying practices are recognized that influenced the decision-making process and dwindled the forward-looking perspective of the Eefde navigation lock project. These are the passive adaptive management of Rijkswaterstaat, the linear perception of infrastructure renewal projects, and the loss of innovations during the tendering process. Finding solutions for these limitations could make future infrastructure projects forward-looking.

In sum, the framework of the forward-looking decisions can contribute to further integration of a long-term horizon in the renewal process of the Dutch waterway infrastructure network. Further, changes in the current decision-making process are necessary to optimize the effectiveness of infrastructure assets to deal with future challenges. The case of the Eefde navigation lock project showed that Rijkswaterstaat and the corresponding Ministry of

Infrastructure and Water Management renewed the Dutch waterway infrastructure mostly as self-contained projects with a narrow scope. The results of an integral approach depend on the context of each project. However, multiple opportunities that could potentially ensure long-term effectiveness during its functional lifetime are missed through this narrow scope. The introduction of a forward-looking framework, in combination with the performance perspective, could offer the ability for planners, politicians, and scientists to systematically analyze which elements of the decision-making process are lacking integration of forward-looking reasoning in a combined effort to combat future challenges. The forward-looking decision framework does not only influence the effectiveness of the infrastructure asset through a systematic analysis of a infrastructural investment decision, it could also function as a method to change the discourse of the current planning practice on long-term regional resilience.

5.2 Solutions

With many more infrastructure assets that require renovation and expansion in the coming decades, it is essential to find new ways to stimulate decision-makers to make future infrastructure projects more forward-looking. Prior research has already shown that large-scale infrastructure projects do not necessarily include long-term solutions (e.g., Maier et al., 2016; Pot et al., 2018), that a more inclusive and integral decision-making process can make infrastructure assets more 'future proof' (e.g., Alegre et al., 2012; Masood et al., 2016), and the necessity of introducing adaptive decision-making under deep uncertainty (e.g., Restemeyer et al., 2017; Wise et al., 2014).

The difficulties of Rijkswaterstaat to implement more flexible and adaptive solutions are also reflected in their request to the Netherlands Bureau for Economic Policy Analysis (Dutch: Centraal Planbureau, CPB) to analyze how to deal with flexibility in infrastructure policies and cost-benefit analyses (Appendix A: CPB, 2017). Some of the problems recognized in this policy analysis are also present in this research. For example, only a single scenario was included in the cost-benefit analysis in the third phase (2008-2010). Although it is only a fraction of the decision-making process, this cost-benefit analysis was the foundation of later investment decisions. Since the future is uncertain, it is essential to account for at least two scenarios to test the flexibility and robustness of the solution. Six other recommendations were provided, to search for flexibility, to introduce more decision-moments, to include extreme scenarios, to actively search for no-regret measures, to make a decision tree analysis, and to consider customized analysis methods. However, the analysis of the Eefde navigation lock case has uncovered other complementary changes to make the decision-making process of future waterway infrastructure projects forward-looking.

First, the forward-looking decision framework uncovered the lack of flexibility and robustness in the solutions for large-scale infrastructure projects. This research has pointed out that the case of the Eefde navigation lock is no exception. The forward-looking decision framework showed the absence of active adaptive management. It is remarkable that the infrastructure project has a narrow focus and scope when it will be functional for almost a century. This could limit the long-term performance of an infrastructure asset. Therefore, as Hanna et al. (2016) argued, the introduction of multiple potential future scenarios in an early moment of an infrastructure project is essential, and it should be included more deliberately in future infrastructure projects to deal with future challenges. More extensive use of adaptation pathways, as discussed in Chapter 2.4.3, could streamline the decision-making process and emphasize the long-term consequences of current infrastructure solutions.

From a performance perspective, the introduction of active adaptive management would enable decision-makers to make infrastructural investment decisions more strategically. A systematic analysis of the costs and benefits of potential solutions could decrease the necessary financial funds by preventing future lock-ins (Haasnoot et al., 2013). Furthermore, the increased knowledge from an early stage in the decision-making process would result in better-informed decisions.

Secondly, the planning of infrastructure renewal projects should be seen as an iterative and on-going process by all stakeholders, as is demonstrated in Figure 10. Every phase in the decision-making process offers different opportunities and constraints that influence the ability to include adaptivity. For example, the planning phase is more open and susceptible to radical forward-looking ideas than the construction phase, since the stakeholders involved already settled the main decisions. Therefore, each phase requires a different set of long-term solutions, which has to be recognized by the decision-makers. The forward-looking framework can evaluate the inclusion of a long-term logic, regardless of the phase of the infrastructure project

The analysis of the Eefde navigation lock showed that the current linear tendering process does not provide the opportunity to learn from previous implementations because all processes stop when the construction phase is finished. Therefore, a changed discourse is necessary to provide for a more open learning attitude that contributes to the development and selection of options throughout the lifetime of an infrastructure asset (Salet et al., 2013). The continuity of such infrastructure development processes could also improve the knowledge condition in future infrastructure projects from a performance perspective.

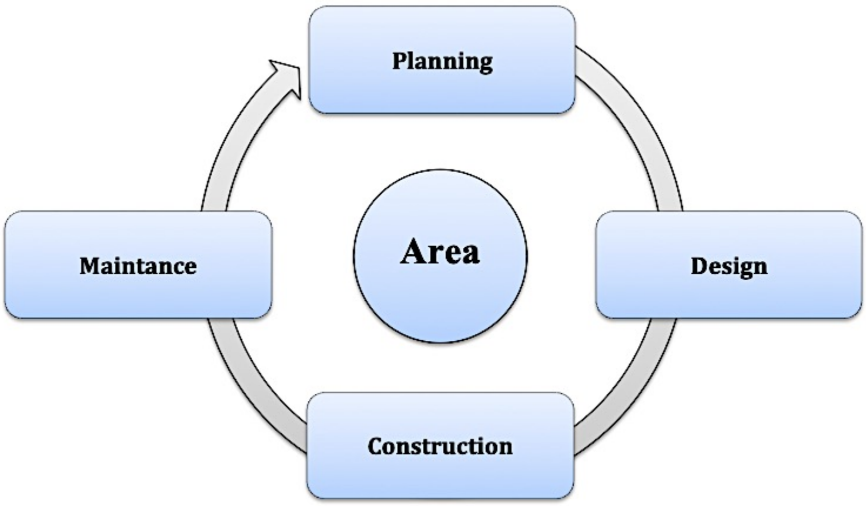

Figure 10. The iterative decision-making process in large-scale infrastructure projects

A third recommendation is to widen the scope of an infrastructure project and encourage innovation through a changed attitude in the tendering process. Currently, the constructor often copies the list of requirements compiled by Rijkswaterstaat, which in turn is copied from the specifications of the existing navigation lock (interviewee #6). This approach results in a solution that is already mostly definitive at an early moment in the development of the solution. Therefore, Rijkswaterstaat should introduce the logic that a new navigation lock has to be more innovative and better than the most recently built navigation lock. In addition, the specification list should be transformed into a parametric model rather than a simple list of requirements. The increased innovation could lead to the discovery of new cost-efficient solutions that might increase the feasibility of future infrastructure project from a performance perspective.

Based on information gathered from the decision-documents and experts involved it seems to be difficult for an agency such as Rijkswaterstaat to include challenges outside their scope. Factors such as a limited financial budget, willingness of other stakeholders to take action, and primary objectives restrain the development of integral and adaptive measures in large-scale infrastructure projects (interviewee #6). Especially the feasibility is difficult to solve for Rijkswaterstaat since the financial budgets are mostly an organizational choice commissioned by the Ministry Infrastructure and Water Management. The introduction of asset management has already improved the feasibility, however, as Chapter 2.3 discussed, it could be optimised further through the introduction of a forward-looking perspective. The proposed forward-looking solutions could indirectly influence the performance of the decision-making process.

Rijkswaterstaat is not the only ministerial entity in the Netherlands and could potentially learn how other agencies deal with similar challenges of integral and adaptive decision-making. For example, the main objective of the Central Government Real Estate Agency (Dutch: Rijksvastgoedbedrijf) is to maximize the value of their assets. However, challenges such as climate change, soil subsidence, and soil degradation are imposing long-term difficulties that could significantly influence future land-use and forces the Rijksvastgoedbedrijf to find long-term solutions that guarantee the value of their portfolio (Petrus, 2019). Together with the province of Flevoland, Waterboard Zuiderzeeland, and the Dutch Federation of Agriculture and Horticulture a ‘steering group’ was introduced called Stuurgroep Grondgebruik Flevoland to collaborate and find mutually beneficial solutions for the long-term challenges that are present in the province of Flevoland. Rijkswaterstaat could learn from this approach by implementing a similar collaboration with other stakeholders to find forward-looking solutions that address future challenges (Vogelzang et al., 2019). Not only on a local scale such as the Highport Eefde initiative but also on a regional level. Ultimately, for such initiatives to succeed it is essential for both Rijkswaterstaat and the Central Government Real Estate Agency as executive agencies that the coordinating ministries commission a forward-looking and integral policy.

5.3 Limitations & future research

Although this research aimed to identify underlying practices that prevent infrastructural investment decisions from becoming forward-looking and finding solutions that could create the necessary conditions to deal with future challenges, several limitations have to be taken into consideration. First, this research bases its results on an intensive qualitative analysis of a single case that includes unique characteristics (interviewee #3 & #6). For example, the participation of the local residents in the Highport Eefde initiative and the eagerness of the stakeholders to realize an integral project are attributes that distinguishes this project from others. Therefore, it is difficult to generalize the specific outcomes of this research. However, through the analysis of the Eefde navigation lock project several fundamental assumptions and practices have uncovered that influence the extent to which long-term challenges are included in the decision-making processes.

Furthermore, several interviewees are still in some way involved in the Eefde navigation lock project. Therefore, subjectivity and cognitive dissonance could be present in the answers on the performance of the process. These limitations are countered by a close comparison of different views and policy documents.

Also, it is essential to note that the forward-looking decision framework does not determine the quality of a decision. Additionally, it does not aim to review to what degree the decision-making process includes a forward-looking reasoning. However, it serves as a means to reflect the investment decisions of the stakeholders involved. Furthermore, the performance perspective complements this through the addition of contextual factors help to describe the developments during the decision-making process. Thus, the forward-looking decision framework offers the opportunity to reflect on whether the decisions made during an infrastructure project include a long-term horizon.

Despite the limitations of this research, the gathered results can still be regarded as a valuable contribution to the scientific debate on long-term and large-scale infrastructure investments and planning practice. As previously discussed, several characteristics of contemporary infrastructure planning are uncovered, and the necessity to implement forward-looking decisions has been emphasized. However, several topics deserve more attention. For instance, long-term decisions are not exclusive to the Dutch waterway infrastructure. Applying the forward-looking framework to other sectors, such as the energy grid and the preservation of cultural heritage, and different countries could introduce a new perspective to the long-term decision-making process of large-scale infrastructure assets.

Further, it has become clear that institutions, such as Rijkswaterstaat, have difficulties with including flexible, robust, and innovative solutions in the tender contracts of large-scale infrastructure projects. Therefore, future research should also focus on how to integrate adaptive strategies into the current DBFM-contracts, potentially by comparing and learning from other Dutch ministerial agencies. Also, it became clear that such integral initiatives hinge on the support of local and regional stakeholders. Although every project needs tailoring to its context, it would be beneficial to investigate how to merge multiple interests to find spatial solutions on a regional level. Lastly, more cases have to be researched in order to increase the reliability of the forward-looking framework. A more extensive analysis using Qualitative Comparative Analysis (QCA) could provide a broader understanding of long-term decision-making by systematically analyzing a large number of cases.

6. Conclusion

This thesis aimed to identify underlying practices that prevent infrastructural investment decisions from becoming forward-looking and finding solutions that could create the necessary conditions to deal with future challenges. Three sub-questions were consecutively analyzed to answer the main research question.

First, the theoretical framework in Chapter 2 discussed what forward-looking decisions are in the context of the renewal of the Dutch waterway infrastructure network. The analysis of scientific literature showed that contemporary management of Dutch waterway infrastructure assets lacks the incentive to address long-term challenges (Hijdra et al., 2014). The current practice of dealing with long-term developments can be described as a best-guess approach (Maier et al., 2016). Therefore, further research is necessary since the concept of forward-looking decisions is a relatively new practice. As in the article of Pot et al. (2018), this research considers decisions as forward-looking when the problem definition, the proposed solution, and the justification of the resolution include a long-term horizon (Pot et al., 2018). However, the development of an infrastructure asset comprises of many decisions with different configurations of the forward-looking criteria. The performance perspective was added to evaluate contextual events that shaped the project through time (van Dijk & Beunen, 2009). Thus, the inclusion of forward-looking decision in combination with the performance perspective could introduce a new way to analyze whether the process of infrastructure renewal has a long-term horizon and is adaptive to future challenges.

Secondly, the empirical study of the Eefde navigation lock case in Chapter 4 discussed whether decision-makers include long-term challenges in the planning process of the Dutch waterway infrastructure network. The case of the expansion and renovation of the Eefde navigation lock showed that this large-scale infrastructure project is, except for the fourth investment decision (between 2011 and 2014), not considered as forward-looking. It is surprising that such large-scale infrastructure assets are not forward-looking while they require large sums of money and will function for a century. Long-term adaptivity and resistance to long-term challenges did not appear to be a vital part throughout the planning process of the Eefde navigation lock. Part of this was due to the lack of knowledge, legitimacy, or feasibility during the different phases of the project. Also, the narrow scope of Rijkswaterstaat restricted the extent to which the project was forward-looking. Three overarching factors were recognized that limited the inclusion of a long-term vision in the decision-making process. More specifically, the passive-adaptive management, the linear decision-making process, and the loss of innovation during the tendering process where constraining factors during the expansion and renovation project of the Eefde navigation lock. The challenge for decision-makers is to reflect on these developments and to improve future waterway infrastructure projects.

Lastly, the discussion of the results in Chapter 5 examined the challenge of how future Dutch waterway infrastructure projects can be improved to become forward-looking. The three constraints recognized in Chapter 4 served as a starting point in the search for new ideas that could introduce a forward-looking logic in future Dutch waterway infrastructure projects. The renovation and expansion project of the Eefde navigation lock showed that a more active adaptive management has to be introduced at an early stage. Further, the planning of infrastructure renewal projects should be an iterative and ongoing process. Finally, a changed attitude in the tendering process of future infrastructure projects should bring more innovation.

Based on these outcomes the following main research question is answered: *How can infrastructural investment decisions become forward-looking in the renewal of the Dutch waterway infrastructure network?* As the case of the Eefde navigation lock showed, there is room for improvement in the way that long-term challenges in the renewal of waterway infrastructure are addressed. The forward-looking decision framework is, in combination with the performance perspective, capable of uncovering the underlying rationale in the decision-making process. To continue, it would benefit scientists and decision-makers to find out systematically whether their decisions are forward-looking. Therefore, the forward-looking decision framework should be introduced into the current discourse in conjunction with the other proposed solutions.

In addition, the performance perspective turned out as an effective logic to increase the understanding of underlying argumentations in infrastructural investment decisions.

Therefore, it is advised to further investigate the interplay between the forward-looking decision framework and the performance perspective in further research.

To conclude, this research showed that many direct and indirect factors influence how the decision-making process of infrastructure assets takes place. It is essential to bear in mind that the forward-looking decision framework does not aim to analyze the general quality of the decision-making process surrounding such large-scale infrastructure projects. However, the forward-looking decision framework provides the rhetoric to systematically examine whether infrastructure projects are designed to be adaptive for future challenges. Future challenges, such as the aging Dutch waterway infrastructure, climate change, and limited financial budgets, are all examples that put pressure on the current and future functionality infrastructure assets. Therefore, further research should focus on resolving the constraining factors for long-term decision recognized in this research and build on potential solutions.

7. Literature

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Appendix

A. Decision documents overview

Year	Multi-party agreement	Parliament	Report	Cost benefit analysis
2001		1) National Parliament (2001-2002) 28000-A no. 23. 2) National Parliament (2001-2002) 28000-XII no. 48.		
2002		3) National Parliament (2002-2003) 28600-A no. 43.		
2003				
2004		4) National Parliament (2004-2005) 29644 no. 6.		
2005		5) National Parliament (2005-2006) 30300-A no. 2.		
2006			6) Regio Twente (2006) Netwerkanalyse regio Twente Eindrapport	
2007		7) National Parliament (2007-2008) 31200-A no. 2		
2008		8) National Parliament (2008-2009) 31700-A no. 19		
2009		9) Rijkswaterstaat (2009) Uitwerking Waterbeheer 21e eeuw, Kaderrichtlijn Water en Natura 2000 Beheer- en Ontwikkelplan voor de Rijkswateren 2010-2015	10) Deltares (2009) Jaarverslag 2008. 11) Wetenschapswinkel Wageningen WU (2009) Plan van Aanpak onderzoek Eefde	12) RIGO (2009) MKBA verruiming Twentekanalen, 19 november
2010		13) Parliament (2010) Bijlage 3: Publiek Private Samenwerking (PPS)		
2011				
2012		14) Parliament (2012) Aanhangsel van de Handelingen, kamervragen sluisdeur Eefde 15) Parliament (2012) Vaststelling van de begrotingsstaat van het Infrastructuurfonds voor het jaar 2012 16) Parliament (2012) Voortgangsrapportage DBFM(O) 2012		
2013			17) Grontmij (2013) MER Capaciteitsuitbreidi-ng sluis Eefde 18) Netherlands Commission for Environmental Assessment (2013) Voorlopig toetsingsadvies over het milieueffectrapport	
2014	19) Highport Eefde (2014) Eindrapportage.		20) Actiegroep 'Voor Midden Noord'(2014) Uitbreiding Sluis Eefde, Noord of Midden-Noord 21) Panteia (2014) Implementatietoets TEN-T	
2015		22) Rijkswaterstaat (2015) Aanbestedingsleidraad Zaaknummer 31080779		
2016				
2017		23) Rijkswaterstaat (2017)	24) Waterschap Rijn en	

		Deelrapportage Vaarwegen voor de Nationale Markt- en Capaciteitsanalyse (NMCA)	Ijssel (2017) Projectplan Waterwet voor dijkversterking Twentekanaal te Zutphen	

Table 7. Overview of decision documents Navigation lock Eefde

Additional documents:

- 10 MIRT (Multi-annual infrastructural plans) 2008, 2011-2019 https://www.rijksoverheid.nl/onderwerpen/ruimtelijke-ordening-en-gebiedsontwikkeling/meerjarenprogramma-infrastructuur-ruimte-en-transport-mirt
- CPB (Netherlands Bureau for Economic Policy Analysis)
    - CPB (2017) Hoe omgaan met flexibiliteit in infrastructuurbeleid en MKBA's infrastructuur.
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B. Interview guide

- *When involved and in what function?*

Introduction

- *Could you briefly pitch the project?*
- *What were the main incentives for starting this project?*
- *How would you describe the decision-making process?*

Process

- *How was the project viewed from the perspective of .(organization/stakeholder)?*
- *Did this vision differ from other organizations or stakeholders?*
- *Was the process of this project different from other large-scale infrastructure investments?*

Forward-looking problem

- *What would you consider as the problem definition of the project?*

- *Did this definition change through time?*
- *Were future challenges or needs included in the problem definition?*
- *What was regarded as an appropriate time horizon for the project?*

Forward-looking solution

- *Did political views play a role in the solution of the project?*
- *Would the project remain functional during its technical lifetime when tested against extreme case scenarios?*
- *Were pilots or experiments executed?*
- *Would you consider the project to be flexible enough to be adapted during its lifetime to handle changed circumstances and insights?*
- *Is there a monitoring process to ensure the effectiveness of the solution?*
- *Is there an agreement to establish an iterative decision process for possible future adaptation of the solution?*

Forward-looking justification

- *What was the vision or future scenario of the project?*
- *What role did scenarios and visions play during the process?*
- *What future developments could potentially influence the functionality of the navigation lock?*
- *How were these scenarios included in the final decision?*

Closing question

- *Would you do something different if you could do this project over again?*