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Master thesis
Construction Management
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Bridge to Collaboration

Aligning asset owners for their
infrastructure renewal challenges



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by

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Preface

This master's thesis report marks the end of my studies at the TU Delft and the completion of the master's of Construction Management and Engineering. The last six years have been an enrichment, both at an educational and personal level, from which I have learned a great deal. Writing this thesis has been challenging and rewarding, and it was a very interesting process to go through.

During my bachelor's of Systems Engineering, Policy Analysis and Management, as well as the courses in the project and people domain from my master's program, I discovered that project management is a large interest of mine. This is why I wanted to conduct a research in that direction. This research into a collaboration between different asset owners showed the complex organisation within the various organisations, which I was not aware of at this level. The renewal task in the Netherlands is growing, which is becoming more clear and shown in the news, so I really liked having done this research and gain more knowledge about how it works in practice and why it is becoming a problem. The SSRV initiative is a fascinating case that offers valuable insights and effectively connects academic findings with a practical perspective.

First, I would like to thank my TU Delft supervisors, Marcel Hertogh, Erik-Jan Houwing, and Martijn Leijten, for their critical and constructive feedback, which helped me move forward with my thesis after every meeting. Marcel's insights into the renewal problem have always been interesting and useful. The biweekly meetings with Erik-Jan were very valuable, providing confirmation and advice on how to continue, as well as simply chatting about the progress of the thesis. Martijn's feedback made me rethink some of my research choices, which helped clarify key aspects of the thesis report. The comment that it was up to me to make chocolate from all my findings will always remind me of this thesis research process.

I would also like to thank Rens Ampting and Jon Bellis for giving me the opportunity to conduct my research at APPM. Graduating at APPM has been a pleasant and welcoming experience from the beginning. The weekly meetings with Rens were valuable for discussing the progress of my thesis, answering all my questions about SSRV, and for personal guidance throughout the process. I would like to thank Jon for his critical thoughts and questions, which I did not always have an immediate answer for, but were very useful in encouraging me to think outside the box.

Additionally, I would like to thank my family and friends for all their support over the past months. Especially my parents for always picking up the phone when I was walking home and needed to share my accomplishments or challenges, and my roommates for listening to all my stories even though they were sometimes all over the place.

Lastly, I want to thank all the participants of the interviews for sharing their perspectives with me and telling me about how they have experienced the problem and the collaboration.

I wish you, the reader, a pleasant read, and I hope you find it as interesting to read as I did to conduct the research.

*Fien de Mol van Otterloo
Delft, August 2025*

Executive summary

Context and research design

The Netherlands is facing a significant challenge in renewing its infrastructure, such as bridges and viaducts, over the next few decades. The infrastructure assets are owned by various asset owner organisations, including municipalities, provinces, and Rijkswaterstaat. Much of the infrastructure was constructed after the Second World War and has a lifespan of 60 to 120 years, which means that the end-of-life of these assets is nearing in the following decades. At the same time, asset owners struggle with a decreasing ability to handle the renewal of their infrastructure assets independently due to limited manpower and resources. A solution proposed by TNO (2023) is for asset owners to collaborate and tackle this renovation and replacement task together. This would be useful for maintaining accessibility, utilising resources optimally, and aligning goals and interests. However, collaboration between various organisations for renovation and replacement is complex and brings several challenges as asset owners often have different interests and priorities. For this research, the aim is to explore how such a collaboration can be initiated and developed for the renewal task involving various asset owners. This can be useful for other organisations that want to initiate such a collaboration. The focus lies on what the exact problem is with the renewal task and why collaboration is required, the key components of collaboration, how the participation of asset owners in collaboration can be stimulated, and what the key components are for developing this collaboration. The research question that is formulated is:

How can an effective collaboration be initiated and developed between infrastructure asset owners in large-scale renovation and replacement projects?

Methodology

To answer this research question, this study employs three methods: a literature review, a single-case study, and interviews. The case study is an initiative of the province of Noord-Holland that aims to connect the asset owners of Noord-Holland so they can tackle the renovation and replacement of the 14.500 infrastructure assets together; this initiative is called 'Samen Slimmer Renoveren en Vervangen' (SSRV), which is translated as 'Together Smart Renovation and Replacement'. The participants of the interviews are some of the asset owners in Noord-Holland and others involved in this SSRV initiative.

Literature review

The literature review identified several key characteristics of renovation and replacement projects. A renovation or replacement project will be carried out when the infrastructure reaches its end-of-life. This can occur when the object no longer meets the required standards (technical end-of-life), when it no longer functions properly (functional end-of-life), or when maintenance becomes too expensive (economic end-of-life). The renewal of infrastructure involves multiple stakeholders, which makes decision-making complex due to conflicting interests or objectives.

The key factors for a successful collaboration, as found in the literature, were trust, transparency, early involvement of stakeholders and shared goals. The key challenges highlighted are unclear goals, weak management, organisational misalignment, lack of trust, communication issues and cultural and behavioural differences. These challenges can be barriers that prevent organisations from participating in a collaboration.

Additionally, four frameworks were found in the literature that highlight important components of collaboration and can serve as a basis for developing an effective collaboration between asset owners for the renewal task.

Findings case study and interviews

The next part of the research focuses on the SSRV initiative and how the collaboration between asset owners has developed in Noord-Holland over the past two years within this initiative. The initiative

started in 2023 and has since worked on connecting the asset owners of Noord-Holland to build a network that focuses on renovating and replacing infrastructure assets in Noord-Holland. This renewal task is becoming too large for asset owners to handle on their own, and this is only getting worse due to the decrease in manpower and knowledge. There is a shortage of manpower due to ageing and fewer civil engineers returning. This also causes a loss of knowledge. Another issue is that the sector works project-orientated, which also causes knowledge to disappear after the completion of a project. The aim of the SSRV initiative is to work more task-orientated and focus more on the bigger problem. The collaboration is perceived as a necessity, not only a practical solution.

During the interviews, the participants mentioned several challenges and barriers that hinder participation in the collaboration network. These barriers include a lack of time for asset managers to consider and participate in collaboration, a lack of relationship and trust between asset owners, and a fear of losing autonomy. Asset owners have a legal responsibility to take care of their assets and cannot let another organisation make decisions about their assets, especially organisations that they do not know or trust. This differs from renewing infrastructure assets of a single asset owner because in that case, the asset owner continues to be in charge of their own assets and is not losing autonomy. Also, it is easier to take more time because it needs to happen for that specific organisation and it is not in combination with other asset owners, which would take more time.

To stimulate asset owners to participate in the collaboration network, several key points were mentioned in the interviews. It is essential that collaboration is encouraged, rather than mandated. The collaboration is voluntary, and it should be appealing to participate; the FOMO principle was mentioned here, which stands for Fear Of Missing Out. This means that by showing concrete successes, even small ones, this demonstrates that the collaboration is working, and stimulates other organisations to want to participate in this network. A significant benefit of the collaboration is the sharing of knowledge, which will ensure that the organisations can learn from one another and assist each other with the renewal of their infrastructure. Additionally, it should be easy to join the network, and future contributions should also be as simple as possible, so organisations do not back out due to an excessive workload.

The important components of collaboration highlighted during the interviews are building trust, showing interest in the involved organisations, investing energy, utilising people with the right energy to make connections and clear communication. These components are mentioned by the interview participants, which means that they are essential for the collaboration between asset owners for the renovation and replacement task.

The SSRV initiative is a voluntary collaboration between asset owners for the renewal task. Participation is not mandated, but rather stimulated by creating an appealing environment. This contrasts with a mandated collaboration, which is usually initiated by a policy or legal obligation, where an external authority enforces the collaboration. In a voluntary collaboration for the renewal task, trust plays a crucial role, as the asset owners must rely on a shared vision and perceived benefits to participate in the collaboration. The fear of losing autonomy is significant here, as it involves asset owners with their own assets, ways of working, and regulations. The collaboration should be transparent, with open communication about expectations and actions from it. For the SSRV initiative, it is possible for the organisations to choose whether they want to participate in certain actions from the collaboration. These actions will be defined by communicating with the organisations involved and external facilitators will help this process. This makes it easier for organisations to explore whether the collaboration network is beneficial for them.

Analysis of the findings

The literature review and the interviews in the SSRV case provide valuable and interesting findings. Some of these findings correspond with each other, but also new insights into collaboration between asset owners were discovered. From both the literature review and the interviews, the importance of trust, transparency, and having a shared goal was emphasized for a successful collaboration. The challenges in collaboration, such as unclear goals, organisational misalignment, and a lack of trust, as mentioned in the literature review, are also reflected in the case study and interviews. Here, they are more specifically identified as fear of losing autonomy, lack of relationship, and lack of time. In the SSRV case, several steps were suggested to overcome these challenges, including encouraging participation in the collaboration network by showing successes and building relationships and trust

through informal meetings and workshops.

From these findings, the most important components for collaboration in general, and more specifically between asset owners, for the renewal task are identified. These components can help develop the steps for initiating and developing an effective collaboration between asset owners. The success components and strategies to stimulate participation in collaboration can help overcome the challenges that hinder collaboration. Together, the process of collaboration can be designed and implemented.

The participants of the interviews are all involved with the SSRV initiative. Based on their insights, the process description has been developed, but also more information about the characteristics of the current collaboration of the SSRV initiative came to light. The collaboration can be characterised as a voluntary collaboration, that works task-orientated, and the participation is not mandated, but stimulated. A network of asset owners is being built, which has a governance structure to explore possibilities for the collaboration, but it remains the choice of the involved organisations to participate in the actions.

Process description of developing a collaboration

To initiate and develop an effective collaboration, a five-step process is proposed in this research, as illustrated in Figure 1 on the next page. These steps are based on the process how the SSRV initiative has been developed and the findings from the literature review and interviews. This process includes several strategies for initiating and developing collaboration:

1. The reason for collaboration should be defined clearly and shared by the involved organisations.
2. The collaboration should start small to explore what organisations can handle and to build trust.
3. It would be useful to define shared goals to unite the organisations and ensure they share the same motivation as they work towards a common objective.
4. It is essential to work on building relationships and trust for an efficient collaborative process.
5. There should be transparency about the roles, responsibilities, and expectations of the involved organisations to prevent misunderstandings and conflicts.
6. The level of collaboration should be increased progressively and adapted to the ability of the organisations so they do not back out.



Figure 1: Process description for developing a collaboration

Recommendations and conclusion

The recommendations for initiating and developing a collaboration correspond with the strategies defined earlier:

- The collaboration should start small
- Small successes and quick wins have to be highlighted
- The collaboration should be appealing
- The organisations must be treated as equals
- It is important to explore the problem thoroughly and define a shared problem with the involved organisations
- The actions from the collaboration have to correspond with the ability of the organisations

The challenge of renewing 14.500 infrastructure assets triggered the development of the SSRV initiative in Noord-Holland, as it is too large and complex for asset owners to execute themselves. In this research, the process of this development has also been explored, and some interesting insights have been found, for which the following recommendations can be made:

- Continue working on the relationships and the level of trust between the asset owners
- Make the actions from the collaboration easy and approachable
- Inform asset owners about the progress of the collaboration network
- Define small concrete goals that the organisation can work towards together

In conclusion, this research demonstrates that an effective, voluntary collaboration between asset owners for the renewal task of infrastructure assets depends on building trust, sharing successes, inclusiveness, and ensuring clear communication and transparency. The SSRV initiative in Noord-Holland serves as an example of how collaboration for the renewal task can be initiated and developed, highlighting the key factors in this process.

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Glossary

Definitions of terms

Term	Definition / Translation
Asset	A physical infrastructure element, such as a bridge or viaduct, managed by an asset owner
Asset manager	The person within the asset owner organisation that has the function of controlling and maintaining the assets owned by that organisation.
Asset owner	The organisation that owns infrastructure assets, such as a municipality, province or Rijkswaterstaat.
Bridge brigade	Bruggenbrigade, a community of asset managers to share knowledge and ask questions about infrastructure assets.
Core team	Kernteam
Market group	Marktgroep
Ministry of Infrastructure and Water management	Ministerie van Infrastructuur en Waterstaat
Municipality	Gemeente
Province	De provincie
Object	A specific infrastructure asset, such as a bridge or viaduct, managed by an asset owner
Renewal task	Vernieuwingsopgave, the task of prolonging the life of many infrastructure assets in the Netherlands.
Renovation and replacement task	Renovatie en vervangingsopgave, the task of renovating or replacing infrastructure assets in the Netherlands that are reaching their end-of-life.
SSRV	Samen Slimmer Renoveren en Vervangen, initiative in the province of Noord-Holland that aims to tackle the renewal task together with the asset owners.
Steering committee	Stuurgroep
Transition team	Transitieteam
Transportation region	Vervoerregio
VVV-principle	Verbinden, Verslimmen, Versnellen, a principle within the SSRV initiative of connecting, working smarter and speeding up.
Water authority	Waterschap

1

Introduction

1.1. Background

Infrastructure owners in the Netherlands face a significant challenge of renovating and replacing their infrastructure assets, such as bridges and viaducts, in the following decades, according to a TNO (2023) prognosis report, which indicates that many infrastructure owners have insufficient insight and understanding into the task ahead of them. The owners of infrastructure in the Netherlands include Rijkswaterstaat, ProRail, 12 provinces, 342 municipalities, and 21 water authorities. Together they own tens of thousands of civil objects. Infrastructure owners have to pay more attention to the renovation and replacement task, as currently only 12 municipalities and 4 provinces have shared their prognosis for the renovation with TNO. This low score is likely because larger tasks that are within the policy period have more priority, and only what is agreed on in a coalition agreement is currently implemented. The renewal task is not a priority, and due to limited manpower and resources, the preference is given to other larger tasks. Additionally, there are limited people, and this situation is only worsening because the inflow of technical students is very small. A collaboration between infrastructure owners appears to be an opportunity to tackle this renovation and replacement task more efficiently. (TNO, 2023)

In projects, there are several key components that are crucial for a successful outcome. One of these components is “project stakeholder management”, according to Herath and Chong (2021). They describe stakeholders as “a person or an organisation who or which is committed and stands to gain or lose from the project, irrespective of whether they affect and/or are affected by the project deliverables” (Herath and Chong, 2021). Stakeholder management is crucial for the success of a project, and in the event of poor stakeholder management, there is a higher likelihood of project failure. Working collaboratively is considered essential throughout the entire life cycle of construction projects (Shelbourn et al., 2007). Collaboration is a complex concept that depends on the parties involved and their interests and goals, which can make it difficult to structure. Collaboration in the renewal task would involve multiple organisations that manage various infrastructure assets, making it even more complex, as these organisations also have their own regulations and priorities.

1.2. Problem statement

The problem with the renewal task in the Netherlands is that it is becoming too large, and there are not enough people and resources to handle it. There are many other problems and tasks, such as the energy transition, for which also people and resources are required. A way to tackle the renewal task in the Netherlands is to start a collaboration between multiple public organisations, such as municipalities, provinces, and Rijkswaterstaat, that have infrastructure in the same area or region.

However, the renovation and replacement of infrastructure brings some challenges in collaboration due to misaligned goals, different priorities, and varying interests of asset owners. This complexity can increase due to budget restrictions, limited resource availability, and lack of structure. For infrastructure projects involving the renovation and replacement of multiple assets, it would be beneficial for the asset owners of the infrastructure to collaborate and renew their infrastructure together with other asset

owners. There are various reasons why this would be useful, for example:

- **To maintain accessibility.** By collaborating with infrastructure asset owners in the same area, agreements can be made regarding when infrastructure will be renewed to ensure that this does not occur simultaneously or that the traffic detour will not cause excessive congestion.
- **To use resources optimally.** Renovating or replacing infrastructure is a large-scale project that requires numerous resources. By sharing resources, such as knowledge, designs, or even material resources, this can save time and costs.
- **To align goals and interests.** Different asset owners may have varying goals and objectives, and failing to align them can lead to conflicts. By collaborating to align interests and combine budgets, asset owners can increase the value of their efforts and ensure a more efficient process with less conflicts.

Collaboration between asset owners to renew their infrastructure seems like an efficient way, but it brings some problems. There is great complexity in large-scale infrastructure projects that involve the renovation and replacement of multiple assets, as well as the involvement of numerous asset owners with diverse interests and goals. Renewal projects differ from new building projects because the work must be done within existing infrastructure and with the parties that are concerned with this infrastructure. An example of such a project was the renovation of a bridge on the A7 road near Purmerend (NOS Nieuws, 2023). The renovation of that bridge was scheduled to take five months, but this was extended by 1,5 months (Nu.nl, 2024). The news article by NOS Nieuws (2023) described that the province of Noord-Holland only has two large entry roads, one of which is the A7. Every day, 81.000 cars and trucks drive over this bridge, which illustrates the significant number of people involved in a bridge renovation. This traffic has to be rerouted to provincial roads and will cause congestion there and disturbances in the cities around them. This example indicates how many people are involved in the renovation of only one bridge and some of the issues that arise with it. For the renewal task, the aim is for multiple bridges to be renovated or replaced together, which would involve even more people and organisations. It would be helpful to have a structure in place for developing such collaborations in renovation and replacement projects with various asset owners involved. This structure can give insight into why asset owners would be motivated to join a collaboration for renewing their infrastructure instead of doing it alone and demonstrate the important components of initiating and developing such a collaboration. Currently, there is no clear approach to encourage asset owners to collaborate on large-scale infrastructure tasks involving renovation and replacement, and to align their interests to achieve a mutual goal. A structure would be beneficial for efficiently and successfully tackling the renewal task in the Netherlands.

1.3. Knowledge gap

The knowledge gap that this research aims to fill is how collaboration can be developed and stimulated between asset owners with similar types of infrastructure that need to be renovated or replaced. Collaboration has been extensively researched over time; however, specifically collaboration in renovation and replacement projects involving multiple asset owners is lacking in the existing literature. This research aims to explore the potential of this type of collaboration in more detail, specifically examining how it can be stimulated and what motivates asset owners to participate in a collaboration network, so an effective collaboration can be developed.

1.4. Research design

1.4.1. Research objective

The aim of this research is to explore how effective collaboration can be structured between asset owners of infrastructure that requires renovation or replacement. To achieve this aim, several key components are important to explore. These are:

- What the problem is with the renewal of the infrastructure, and how collaboration can be used to address this problem.
- What the key components are for a successful collaboration, and what barriers and challenges could hinder the collaboration.

- How the collaboration can be stimulated between asset owners and which factors are essential in this stimulation.
- What the key components are in developing a collaboration between various asset owners.

To achieve this, a description will be provided to explain how effective collaboration can be designed with the key components that come with it. In particular, the motivation of asset owners to participate in a collaboration network is explored. This motivation is a significant component of an effective collaboration, as without the asset owners, there would be no collaboration.

1.4.2. Research scope

This research focuses on developing an effective collaboration framework for asset owners of infrastructure that needs to be renovated or replaced. The types of infrastructure are similar, such as bridges or viaducts, and are reaching their end-of-life. The study will focus on an ongoing initiative in the province of Noord-Holland, which aims to have asset owners collaborate and renew their infrastructure together. The research examines how collaboration between the asset owners can be stimulated and developed when they have different interests and goals. The asset owners included in this research are organisations such as government agencies and municipalities.

1.4.3. Research questions

To achieve the objective of this research, the following main research question is formulated:

How can an effective collaboration be initiated and developed between infrastructure asset owners in large-scale renovation and replacement projects?

To answer this main research question, six sub-questions are defined to break down the main question and address different aspects of the issue. These sub-questions are:

- SQ 1: What are the characteristics of renovation and replacement infrastructure projects?
- SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?
- SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?
- SQ 4: What are existing frameworks for collaboration?
- SQ 5: How can the participation of asset owners be stimulated within the collaborative framework for renovation and replacement projects?
- SQ 6: How do the roles, interests, and priorities of asset owners influence the collaboration dynamics?

The first sub-question will describe the characteristics of renovation and replacement projects. These characteristics can explain when and why a renovation or replacement of an infrastructure asset is necessary and what is involved in such a project. The second sub-question focuses on the success factors of a collaboration. These success factors are important to know because these factors have a significant influence on why organisations would want to participate in a collaboration. In contrast to these factors, the challenges of collaboration, which will become clear from sub-question 3, can indicate why organisations do not want to collaborate and which challenges need to be overcome for effective collaboration. The fourth sub-question will show existing frameworks for collaboration. These existing collaboration frameworks can highlight essential components of collaboration that need to be considered and indicate how collaboration can be developed and established. These frameworks can serve as a basis for the process description that is aimed to be developed with this research. The fifth sub-question will explain how asset owners can be stimulated to participate in a collaboration for the renewal task, which is crucial in developing an effective collaboration, as without participants, there will be no collaboration. The last sub-question aims to explore how the different interests of asset owners affect collaboration. When there is a great influence, this can hinder collaboration, which is why understanding these influences is beneficial.

1.5. Practical relevance

In the following decades, the Netherlands faces a significant task of renewing a large amount of infrastructure. This task is complex, and requires a lot of resources and knowledge, which can be challenging for the infrastructure asset owners. This research is practically relevant because it explores how a collaboration between asset owners, that are facing this renewal task, can be initiated and developed, which can ensure the renovation and replacement to be executed more efficiently. The outcome of this study can demonstrate to other organisations that want to initiate such a collaboration what the important steps are, which challenges can arise here, and how to overcome these challenges. It can show a more coordinated and efficient way to renew infrastructure together.

1.6. Thesis outline

The research report will be structured in the following way. In this chapter, the background and the problem statement are given, and the research design is explained with the objective, scope, and research question. In Chapter 2, the methods used in this research to answer the research question will be explained. The first method is the literature review. The findings of the literature review will be explored in Chapter 3, with a conclusion of these findings at the end of the chapter. Here, sub-questions 1, 2, 3 and 4 will be addressed. In Chapter 4, the case study used in this research will be explained and the interview participants are introduced. The findings of these interviews will be explored in Chapter 5. In these chapters, sub-questions 2, 3, 5 and 6 are going to be addressed. In Chapter 6, an analysis of these findings will be given to explain more about what the findings are and how they relate to the research question. In Chapter 7, the findings of this research are discussed with an interpretation of the findings and a generalisation. The answers of the research questions are given in the conclusion in Chapter 8. Lastly, in Chapter 9, the recommendations of this research are explained and some research limitations are defined.

2

Methodology

This chapter outlines the methodology for achieving the research objective. The research is structured in three parts that together answer the main research question. The sub-questions, as defined in Chapter 1.4.3, will be addressed using these three research methods. Figure 2.1 presents the overall research design, indicating which sub-question will be addressed using which method. As illustrated in the figure, certain sub-questions require more than one method to be answered completely. In this chapter, the three different methods are explained in detail, and it is discussed why these methods are helpful for this research.

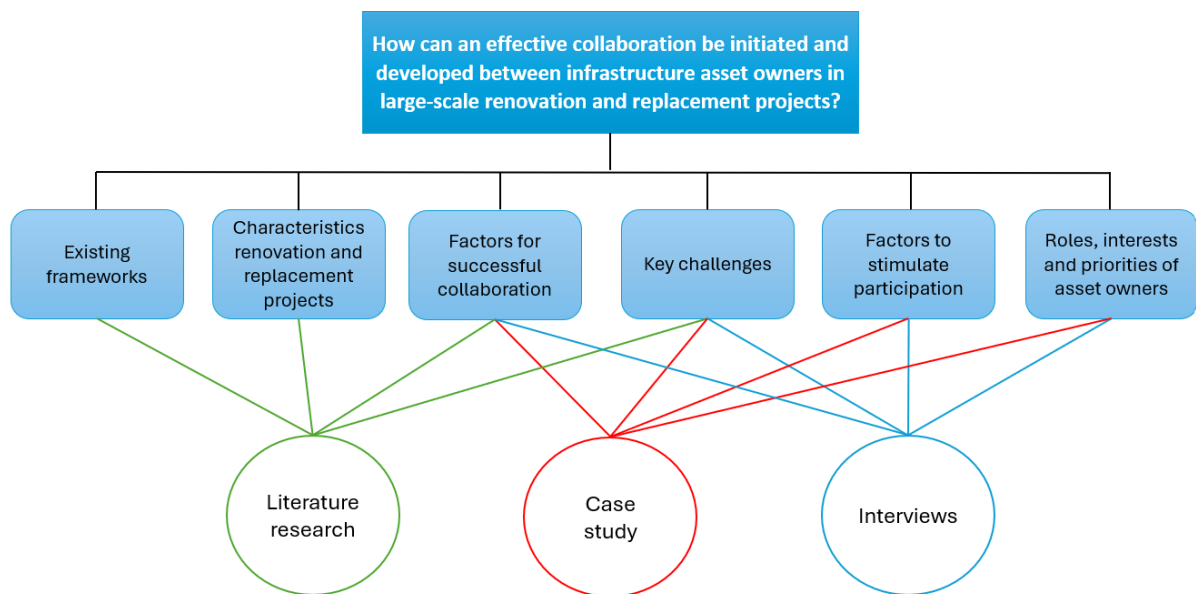


Figure 2.1: Overview of research methods

2.1. Literature review

For the first part of the research, a literature review is conducted to gain insight from previous research on various components of collaboration and renewal projects. Examining previous research is useful for gaining knowledge of established components of collaboration. For this research, the literature review aims to (partly) answer four of the sub-questions. The literature will look into the following sub-questions:

- SQ 1: What are the characteristics of renovation and replacement infrastructure projects?
- SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?
- SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?
- SQ 4: What are existing frameworks for collaboration?

Besides these sub-questions, the literature review will also examine collaboration in general and various types of collaboration to determine which kinds of collaboration most closely correspond to the case for which this research is conducted. By defining these types of collaboration, the search for useful literature can be more specific, and the right challenges and success factors can be determined.

To find the most relevant and useful academic literature, Google Scholar and Scopus are used as search engines. Terms such as “renovation and replacement infrastructure”, “collaboration success factors”, “collaboration framework”, “challenges renovation and replacement projects”, “challenges collaboration”, “alignment in collaboration”, and “collaboration renewal infrastructure” are used in the literature study, specifically for Google Scholar. For the search engine Scopus, more specific searches were done with terms such as “collaboration AND frameworks”, “critical success factors” OR “success factors” OR “critical factors” AND “collaboration”, “collaboration AND challenges AND renewal”, and “challenges AND collaboration AND asset-managers”. For some searches, the year of publication was set to 2014 or later to examine recent literature; however, this was not the case for all searches, as some older literature was also useful in this research.

The literature review aims to gain deeper insight into collaboration and its key components, thereby contributing to answering the defined sub-questions. These findings can be useful for developing an effective collaboration process and as a basis for the interview questions used in this research. At the end of the literature review, a research gap is identified with points that remain unclear and for which further research is necessary.

2.2. Case study

The goal of this research is to develop an effective collaboration between asset owners involved in the renewal of their infrastructure. Infrastructure renovation and replacement is necessary in the whole country. For this research, the focus will be on the province of Noord-Holland that has started an initiative for the renovation and replacement of the province’s infrastructure. This involves a collaboration with its asset owners to achieve this. This initiative will be explained in more detail in Chapter 4.

A case study can be explained as a method to “explore and investigate contemporary real-life phenomenon through detailed contextual analysis of a limited number of events or conditions and their relationships” (Zainal, 2007). Case studies often select a geographical area or a limited number of people as the subject of the research. For research, it is a method “used to generate an in-depth understanding of a contemporary issue or phenomenon in a bounded system” (Coombs, 2022). There are typically three types of case studies: (single) instrumental case study, collective (multiple) case study, and an intrinsic case study (Coombs, 2022).

For this research, a single-case study is employed. In a single-case study, the researcher focuses on a specific issue and selects a bounded case to study (Coombs, 2022). Gustafsson (2017) explains that single-case studies are less time-consuming and ensure the writer has a more in-depth understanding of the subject being explored. This means that information from a single-case study is qualitatively more complete and presents a more profound understanding and insight into a specific situation. The participants of the interviews will be asset owners and other people of the province of Noord-Holland,

who are involved in the initiative that is used as a case for this case-study. A single-case study was chosen because this allows for a more in-depth understanding on how collaboration can be developed. By exploring one case, it can be examined more thoroughly and a more detailed understanding of the dynamics and challenges can be made, which is useful in this research because these details are important to understand in the development of collaboration.

For this research, the case study will answer the following questions (partly):

- SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?
- SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?
- SQ 5: How can the participation of asset owners be stimulated within the collaborative framework for renovation and replacement projects?
- SQ 6: How do the roles, interests, and priorities of asset owners influence the collaboration dynamics?

The case study is used here to provide a further explanation of the problem, and more specifically, in Noord-Holland where the province aims to tackle the challenge of renovating and replacing its infrastructure by collaborating with various municipalities and other organisations in the region. The initiative of the province of Noord-Holland is being executed with the help of APPM. This company will provide the resources and participants necessary for this research. That is why this case is chosen here for the single-case study. The case is described in Chapter 4, based on documents provided by APPM regarding the initiative and the plans of the province of Noord-Holland to tackle this task as well as their existing progress.

2.3. Interviews

The purpose of the research is to understand how effective collaboration between asset owners can be developed in large-scale renovation and replacement tasks. Asset owners of infrastructure have different objectives and goals that need to be considered as they can influence their willingness to participate in a collaboration. The literature review aims to identify existing knowledge about collaboration, its success factors, and challenges. To explore how a collaboration can be set up in practice, the interviews will provide additional knowledge on the success factors and challenges of collaboration that have been observed in practice. The interviews aim to uncover practical challenges and motivations for asset owners to participate in a collaboration that may not be captured in existing research articles. The interview questions are partly based on the findings from the literature review and will further examine these findings to explore how they are perceived in practice. By conducting interviews within the case study, a more in-depth understanding of the different objectives and goals, and how they influence the willingness to participate among asset owners, becomes clear. The questions to be answered through the interviews are as follows.

- SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?
- SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?
- SQ 5: How can the participation of asset owners be stimulated within the collaborative framework for renovation and replacement projects?
- SQ 6: How do the roles, interests, and priorities of asset owners influence the collaboration dynamics?

The interviews are structured as semi-structured interviews, which allow for additional questions to be asked during the interview. This is useful because it allows for more in-depth questions beyond the pre-defined ones, which can be helpful during the research and can provide an even deeper understanding of the information from the participants.

The purpose of the interviews is to discuss with the participants how they see effective collaboration

and what challenges can arise during a collaboration. In addition to this, participants are asked what would stimulate them to participate in a collaboration, what would hold them back, and whether they perceive their objectives and interests as influencing a collaboration with other asset owners. Additionally, the initiators of the initiative will be interviewed to gain a deeper understanding of the complexity of renovating and replacing the infrastructure together. This will help to formulate the questions for the asset owners.

2.3.1. Participants of the interviews

The participants who are interviewed consist of different types of people from the initiative of Noord-Holland. In Chapter 4, an overview of all the participants is provided; however, a brief explanation of the types of participants is also included here. In Noord-Holland, there are 44 municipalities and other organisations, such as Rijkswaterstaat and the province of Noord-Holland, that own bridges and viaducts. The initiator of the initiative is the province of Noord-Holland, so three of the participants are from the province of Noord-Holland, each with a different function in the initiative. Besides this, some people from municipalities were interviewed, and also external parties involved in the initiative contributed to the interviews in this research, which also involved individuals with different functions within the initiative. The participants were gathered with the connections of APPM and their role in the initiative. They were approached by receiving an email with information about the research and were asked if they were willing to contribute to this study. Sixteen people were emailed, of which twelve responded that they wanted to contribute to the research. A consent form with information about the study and how the data would be stored was sent before the interviews and signed by the participants, this consent form can be seen in Appendix B.

2.3.2. Analysis of the interviews

The interviews were conducted in various ways; nine of the interviews were held on Microsoft Teams, two were in person, and one was via Google Meet. The interviews were recorded with the consent of the participants, which was done using Microsoft Teams, Google Meet or the Dictaphone app. With Microsoft Teams, a transcription was automatically made, which already excluded some unnecessary words and formulated semi-correct sentences. This transcription was reviewed after the interviews, while listening to the recording of the interview, to finalise the transcription and ensure that the sentences were understandable and it was possible to get the correct information from the transcriptions. The transcripts are anonymised; the personal information and names have been deleted from the transcripts. The transcripts consist of information on the renewal task and the collaboration that is being designed now in Noord-Holland. The perspectives and experiences of the interview participants in the collaboration are explained, as well as their viewpoints on the renewal task. The Data Management Plan for this research can be seen in Appendix C.

Two lists of interview questions have been formulated; and these can be seen in Appendix A. The first list consists of questions for the initiators of the initiative and the individuals from the parties who are more involved in the design of the initiative and the definition of its actions. These questions delve deeper into why collaboration is essential, what they perceive as the problem with the renewal task, and how collaboration might help address this. Also, bottlenecks and other issues that have already arisen are discussed here. The questions, among others, include:

- *What are the most significant bottlenecks you see in motivating the asset owners to join the collaboration?*
- *Is collaboration essential in the renewal task? And why/why not?*
- *What are learning points so far in encouraging asset owners to work together?*

The other list of interview questions was more focused on the asset owners of the infrastructure involved in the collaboration as members of the network. These questions are more about how they perceive the collaboration and how it would be helpful to them. In these interviews, the focus was also on how the asset owners would be stimulated to participate in this collaboration network and what is important for them in developing this collaboration. These questions, among others, include:

- *What is your added value in doing the renovation and replacement of infrastructure together?*
- *What is crucial for you to collaborate in the renewal task?*

- *What is essential to you in the renovation and replacement task?*

The anonymised transcripts of the interviews were imported into the program ATLAS.ti to categorise the data found from the interviews. Each interview was coded to get the first insight into the data. After coding all interviews, these codes were added into groups that structured the codes with other codes. Some examples of these groups are "Stimulating the participation", "Connecting", and "Gaining insight in the renewal task". Upon examining these codes and code groups, the findings can be explained, and they have been summarised into instances. The findings in Chapter 5 are presented based on the instances. The instances are again categorised on the basis of the research gap of the literature review.

3

Literature review

This chapter presents a literature review to explore collaboration and the characteristics of renovation and replacement projects. By examining previous research, this chapter aims to provide more insights into the nature of collaboration in general and the factors and challenges that collaboration presents in projects. The literature will (partly) answer the following sub-questions:

- SQ 1: What are the characteristics of renovation and replacement infrastructure projects?
- SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?
- SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?
- SQ 4: What are existing frameworks for collaboration?

The structure of this chapter is as follows. Chapter 3.1 explores the characteristics of renovation and replacement projects (SQ 1). Chapter 3.2 focuses on collaboration, where in Chapter 3.2.1, collaboration in general will be discussed, followed by an exploration of success factors for collaboration in Chapter 3.2.2 (SQ 2), a discussion of challenges for collaboration in Chapter 3.2.3 (SQ 3), and a review of existing frameworks in Chapter 3.2.4 (SQ 4). After that, in Chapter 3.3, similar initiatives to the initiative for the renovation and replacement of the infrastructure in Noord-Holland are highlighted. The chapter concludes with a summary of the key findings and a definition of the research gap in Chapter 3.4.

3.1. Characteristics of renovation and replacement projects

In the following decades, the Netherlands will face the challenge of renewing its current civil infrastructure to remain a safe, accessible, and habitable country (Rasker et al., 2023). A renovation or replacement project differs from a new construction project, which is why it is essential to understand the characteristics of renovation and replacement projects and the reasons behind their execution. In Chapter 1.1, it was already explained why the renovation and replacement task should be carried out in collaboration with other asset owners of infrastructure, so in this chapter, more information about the characteristics of the renewal task will be provided.

During the Second World War, many infrastructure objects were destroyed in many countries that needed to be rebuilt, which resulted in a large peak in the 1960s and 70s for the building of bridges (Hertogh et al., 2018), shown in Figure 3.1. The average lifespan of civil infrastructures is around 60 to 120 years, which makes the peak for renovation and replacement of civil infrastructure larger than that of roadways and railway tracks (Bleijenbergh, 2021). Rijkswaterstaat, ProRail, the 12 provinces, 342 municipalities, and 21 water authorities collectively manage the civil infrastructure of the whole country. Because the infrastructure was built many years ago and the properties are unique, the task of renovation and replacement is unpredictable, and there is no one-size-fits-all approach (Ministerie van Infrastructuur en Waterstaat, 2024).

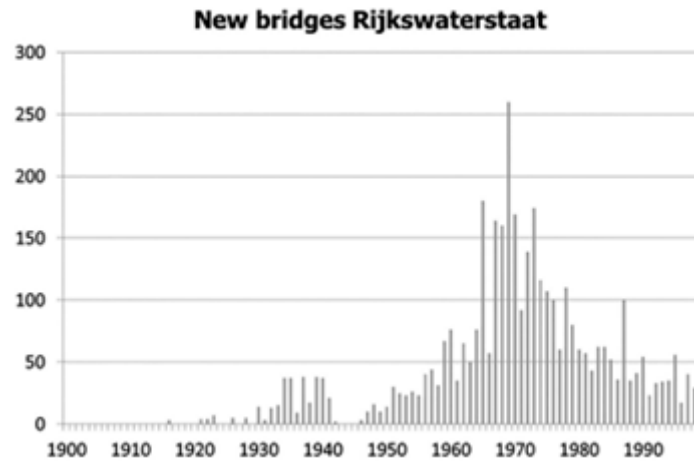


Figure 3.1: Number of new bridges at Rijkswaterstaat (Hertogh et al., 2018)

For Rijkswaterstaat networks, there are two distinct plans for conserving infrastructure: management and maintenance, and replacement and renovation (Klatter, 2022). Management is focused on regulating the use of the infrastructure and maintenance on realising the intended lifespan of the infrastructure. On the other hand, replacement initiates a new life cycle for a new object, and renovation aims to extend the lifespan of an existing object. Renovation and replacement do not involve constructing new or expanding existing infrastructure; this is classified as construction. The shift from management and maintenance to renovation and replacement happens when the end of the technical lifecycle is reached. This means that regular maintenance is no longer achieving the legally required level of safety or agreed performance. Infrastructure can reach its technical end of life due to ageing, changed usage, such as heavier traffic, applied techniques that are no longer supported, or a change in standards, which results in objects no longer being suitable for use. De Raat (2023) explained that renovation and replacement of infrastructure will be executed when the object has reached its end-of-life due to economic or technical reasons. Economic means that the maintenance is getting too expensive to continue, and technical means the object is no longer functioning properly (De Raat, 2023).

Rasker et al. (2023) explained that distinguishing between different measures for end-of-life infrastructure is not always easy. Terms such as "improvement", "renovation", "replacement", and "maintenance" are all used but can have slightly different meanings. This is partly due to the policies governing the allocation and expenditure of budgets for the various measures. For instance, maintenance involves measures to restore the object to its original condition and falls under the operating budget. Maintenance aims to achieve the initially planned life duration of a certain object, while renewal aims to extend the technical life span of an object. With renewal, both renovation and replacement are meant, and it results in the preservation object's functionality or even improving it. This is paid from the investment budget.

As mentioned earlier, the renovation of infrastructure focuses on extending the life span of an object. Renovation and replacement of infrastructure can be used to give the networks an upgrade that is better suited for future economic and environmental challenges (Van Vuren et al., 2015). This upgrade is not only beneficial for the asset managers of the infrastructure but also for the users and other stakeholders (Hertogh et al., 2018). It does mean that a shift in thinking is necessary, as investment in infrastructure typically focuses on new infrastructure; however, renewing existing infrastructure can also be a measure to improve the networks (Van Der Vlist et al., 2015).

A prognosis of the costs for renewing all the infrastructure in the Netherlands has been made by Rasker et al. (2023). The prognosis indicates an increase in costs in the following decades, from 2.4 billion euros per year between 2021 and 2030 to 3.7 billion euros per year in 2080. These costs are divided among the different asset owners of the infrastructure. In Figure 3.2, it is shown what percentage of the costs is directed to which asset owner. On average, the costs are 55% for the municipalities, 9% for the provinces, 13% for the water authorities, and 23% for the national asset owner. Most of these costs are for the municipalities because these also include sewage systems and roadways.

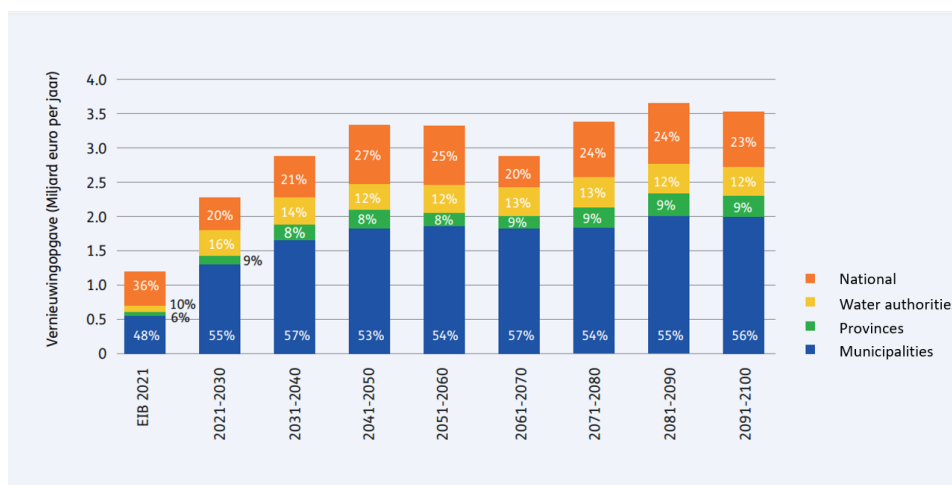


Figure 3.2: Distribution of total costs per asset owner (Rasker et al., 2023)

For the civil constructions only, the distribution is slightly different, as shown in Figure 3.3. These costs will increase to 2,2 billion euros per year in 2060 and then to 2,6 billion euros per year. 70% of the total costs will be allocated to the national asset owners and municipalities.

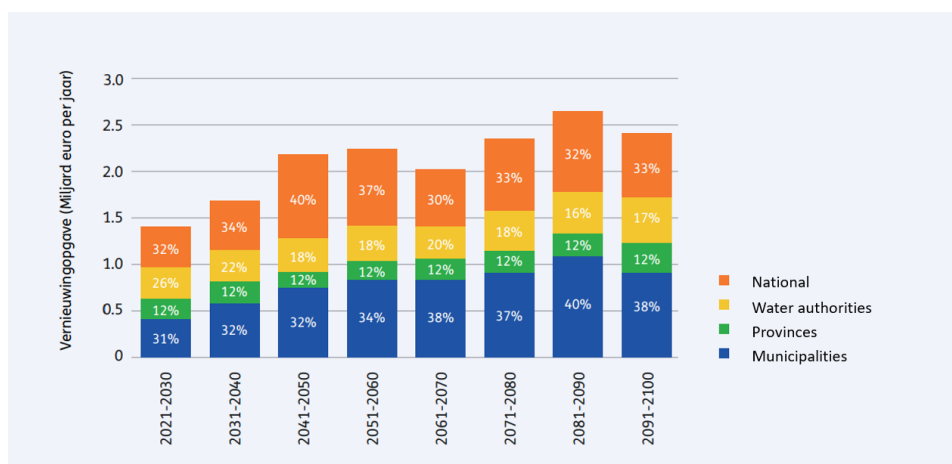


Figure 3.3: Distribution of costs for civil infrastructure per asset owner (Rasker et al., 2023)

When a bridge is no longer functioning correctly and nearing its end-of-life, the traditional approach is to take down the old bridge and construct a new one (Klein et al., 2021). In a circular economy, the aim is to preserve the value of the old bridge and reuse it. The options for reusing the bridge are the following preferred options:

- **Prevention:** The bridge remains at the exact location and maintenance of focused on keeping the bridge functional for as long as possible
- **Functional reuse:** The bridge remains a bridge with a similar function in a different location
- **Reuse with another function:** The bridge will get another function
- **Reuse of parts:** A part of the bridge will be used for something else
- **Recycling of materials:** Parts of the bridge will become raw materials again

In renovation projects, the diverse roles of the various actors involved are crucial to include in the decision-making process, which can lead to better solutions, and improved cost and time efficiency (Prieto et al., 2023). This provides an overview of the actors involved in each phase of the project. In the research by Prieto et al. (2023), respondents were asked to identify the most significant bottleneck

in the renovation process for each phase of the project and to indicate which they perceived as necessary to be solved to make the renovation process more efficient. The main categories that came up the most were a lack of information, unclear definitions, communication and coordination issues, unclear responsibility, and technical challenges. Mainly a lack of information, and coordination and communication issues were identified as the main bottlenecks. In the initial phases, the lack of information was the most recurring bottleneck, but when construction started, coordination and communication were identified as crucial to increase efficiency. The bottlenecks would hinder the renovation process the most, according to the respondents in this research, and needed to be eliminated to increase the efficiency of the project (Prieto et al., 2023).

For asset owners, effective decision-making can be challenging. There are four main challenges that asset owners can face when planning for a renovation and replacement project of their infrastructure, according to Schraven et al. (2011):

- **Aligning decision areas.** Three decision areas are defined: decisions regarding the infrastructure objectives of public agencies, the performance-related situations of the agency's infrastructure, and interventions by the agency on its infrastructure. These areas are interrelated, and the alignment between decisions in these areas is not straightforward or sequential, which makes prioritisation complex (Schraven et al., 2011).
- **Defining objectives.** The definition of objectives poses a challenge for public agencies, as it provides the rationale for evaluating the condition and performance of the infrastructure and prioritising renovation and replacement activities (Dekker, 1996; Schraven et al., 2011). Public agencies often face challenges in defining objectives that are consistent with their strategic policy goals.
- **Managing multiple stakeholders.** Infrastructure assets are often multi-functional, which means that multiple stakeholders are involved or affected by the decisions. Their expectations are important to consider in asset management decisions and in defining objectives (Schraven et al., 2011).
- **Infrastructure asset characteristics.** The function of these assets is complex, and there are norms necessary to define the benefits and failure of the assets. These norms are difficult to quantify or measure (Dekker, 1996). Also, when asset owners define these norms and functions differently, this makes collaboration more complex.

To sum up, a lot of the civil infrastructure needs to be renewed in the Netherlands because it is reaching its end of life. The infrastructure in the Netherlands is managed by various asset owners, including Rijkswaterstaat, ProRail, the provinces, municipalities, and water authorities. This makes the renovation and replacement of the infrastructure even more complex. Renovation and replacement are required when an asset reaches its end-of-life. This can occur due to three reasons, a technical, economic, or functional end-of-life, which means the infrastructure is degrading, maintenance is becoming too expensive, or the infrastructure is no longer functioning properly due to external changes (Hertogh et al., 2018). This presents an opportunity to upgrade infrastructure to address future economic and environmental challenges. The costs for renewing the infrastructure are expected to increase significantly in the following decades. For civil infrastructure, the costs are projected rise to 2.2 billion euros per year in 2060.

Renovation and replacement projects have some key challenges that are important to acknowledge. The decision-making process is complex, the objectives of public agencies are unclear, there are multiple stakeholders that need to be managed, and defining the performance and norms for this is complicated. Besides these challenges, for renovation and replacement projects, it is crucial to have complete information, and communication and coordination need to be clear. Additionally, the scope of the project must be defined clearly.

The key findings here are:

- **Renovation and replacement projects will be carried out when the infrastructure reaches its end-of-life.** The end-of-life of an object can occur due to three reasons: technical end-of-life, which means the object no longer meets the required standards; functional end-of-life, which

means the object no longer functions properly; or economic end-of-life, which means that maintenance is becoming too expensive.

- **The renewal of infrastructure involves multiple stakeholders**, such as governing agencies, which require strong collaboration and coordination. This makes decision-making complex, for example, due to conflicting interests and unclear objectives.
- **The main bottlenecks in renovation and replacement projects** are the lack of information, unclear project definitions, miscommunication, and technical uncertainty, which can occur at different levels within an organisation or even between different levels. This can lead to inefficient time management and high costs.

3.2. Collaboration

3.2.1. Collaboration in general

As explained, collaboration is necessary to take on the renewal task. This task is increasing and will become a bigger priority in the coming decades. It was described that to handle this renewal task, collaboration is required because it will be almost impossible for organisations to handle it alone. To understand how collaboration can work for stakeholders in a renovation and replacement task, it is essential to understand how collaboration works and what the key components are. Collaboration is a broad concept with various types, dimensions, and components. For the renewal task, the collaboration will be mainly between public organisations with different interests, which is a different type of collaboration than, for example, between private organisations.

In Chapter 3.1, it was established that renovation and replacement projects involve multiple stakeholders, for which collaboration and coordination are required. Savage et al. (2010) defined collaboration as social partnerships, describing them as “collectivities of organizations that come together to solve ‘messy problems’ that cannot typically be solved by an organization acting alone”. With such partnerships, new technologies can emerge leading to new products in the market. The study explains three factors that motivate organisations to work together. (1) Collaboration enables organisations to achieve outcomes that otherwise could not have been achieved. (2) It allows organisations to address social or macro-environmental issues that cannot be solved by working on the problem alone. And finally, (3) the organisations can achieve an adaptive advantage. This is the ability to collaborate as a strategic response to complexity, uncertainty and turbulence. As mentioned in the introduction, asset owners face the challenge of renewing their infrastructure over the next few decades. This task is becoming too large for them to execute alone, which is described here as a factor for organisations to collaborate. Therefore, it would be useful for the asset owners to approach the renewal task together.

In the article of Savage et al. (2010), Trist (1983) emphasised the importance of an appreciative component in building collaboration. This refers to the need for parties to recognise they are independent, to believe that collaboration will provide mutual benefits, and to develop a shared definition of the problem that is going to be tackled (Gray, 1994; Gray and Hay, 1986). This can only work when there is a structure for the interaction between the parties in the collaboration, outlining how decisions will be made, and if there is access to the necessary resources to address the problems. Additionally, all the parties must be willing to share their resources.

Collaboration does not follow a one-size-fits-all approach. For different projects, different forms of collaboration are required. There are many types of collaboration, but not all of them correspond to the type of collaboration required for the renewal problem. To gain more insight into collaboration for the large-scale renewal task, different types of collaboration were identified as relevant to the situation where multiple public organisations, such as municipalities and provinces, work together without a structured hierarchy. The following types were identified through looking into research on collaboration using the following search terms in Google Scholar: “collaboration public organisations”, “multi-actor collaboration”, “governance AND collaboration”, and “opgavegericht werken”. From these search terms, several types of collaboration emerged. Besides the forms explained below, the forms of collaboration that emerged were, among others, public-private partnerships, horizontal collaboration, and strategic alliances. The three types of collaboration explained below were found to correspond most with the renewal task and are, therefore, chosen for further analysis. Why these types of collaboration correspond with the renewal task will also be explained for each type.

Task-orientated working

Task-orientated working is becoming increasingly common among municipalities and provinces and is being integrated into their steering philosophy, objectives, and collaborative approach (Anderson, 2018). Task-orientated working can be defined as an organisational principle where social tasks are defined and realised in cooperation with external actors, and employees and administrators are positioned and managed based on these tasks. It differs from working project-orientated in that for task-orientated working, objectives are defined and realised with external actors, and for project-orientated working, these are defined internally. So, the two important components for task-orientated work are that it is organised based on tasks and that these tasks are formulated and realised in collaboration with external parties.

An example of task-orientated working is the draught problem in the east of the Netherlands. At the end of the summer of 2019, the province of Gelderland, the water authority Rijn en IJssel, the water utility Vitens, the agriculture sector, and the nature preservers came together because they all share a responsibility for the water levels in that area (van Delden et al., 2020). The involved parties collectively decided that the draught problem was an issue for the parties together. They researched the problem and its consequences. While working together, it became clear that organisations apart from each other have knowledge on how to tackle the problem, but this knowledge is often not shared (enough). This task-orientated approach to tackling the problem was relatively new in the Netherlands and has enabled these organisations to be ahead of their peers in their own country and internationally in addressing the draught problem.

Additionally, the province of Zuid-Holland is becoming increasingly task-orientated. The objective for the future is to work less from departments and more on realising specific social tasks by engaging the right people in the organisation (Provincie Zuid-Holland, 2024). Eight ambitions have been formulated for the province, and the goal is to achieve these ambitions by working task-orientated. An example of these ambitions is “Bereikbaar Zuid-Holland”, which aims for the province to be easily accessible and a pleasant place to live and work (Provincie Zuid-Holland, 2025). Together, they seek solutions to make the management and maintenance of, for example, infrastructure safer and more sustainable by exploring possibilities to utilise existing infrastructure before building new infrastructure (Provincie Zuid-Holland, n.d.).

In Amsterdam, a program called “Koppelkansen” (linking opportunities) was started in 2019 (Kenniss-ActieProgramma, n.d.). In this program, the municipality of Amsterdam, Waternet and Liander work together to create a sustainable and circular city. Together, they tackle tasks and ambitions for the management and development of the city by seeking innovative and integrated solutions. These solutions arise from collaboration and those involved from different positions, specialities, and organisational levels. They operate in three areas of the city: Amstelstad, De 9 Straatjes and Haven-Stad (Openresearch.amsterdam, 2019). It examines not only the technology and daily practices but also the regulations, ways of thinking and the infrastructure that shapes this.

It corresponds to the renewal task because this task involves the renovation or replacement of various infrastructure assets. The focus will not lie on one project for which multiple stakeholders are involved; instead there are multiple tasks from different asset owners or other stakeholders, which the aim is to tackle together. The different goals for the task will be formulated before and with all involved parties.

Inter-organisational collaboration

Inter-organisational collaboration can be defined as an activity where two or more organisations work together to increase public values by collaborating rather than working separately (Kozuch and Sienkiewicz-Małjurek, 2016). The importance of this type of collaboration is being promoted by policymakers, researchers, and large businesses because it enables organisations to develop strategically relevant responses and compete by moving past their traditional approaches (Ganeshu et al., 2024). Inter-organisational projects allow organisations to benefit from additional resources available in other organisations (Nezami et al., 2022). These can include complementary skills, facilities and knowledge. Inter-organisational projects give the possibility for organisations to look beyond their boundaries and limitations. The risks and responsibilities of the project can be shared through this collaboration, which enhances the ability of organisations to respond to new challenges. Inter-organisational projects are supported by inter-organisational collaboration to realise and develop the projects. In the study by

Nezami et al. (2022), a literature review was executed, and various definitions for inter-organisational collaboration were provided. The final definition is formulated as “an internal process of collaboration based on trust, honesty, and openness in which multi-disciplinary teams from various organisations share their resources, such as skills, expertise, and data, to create a synergy that meets their common goal(s) and thereby delivers the best possible solution” (Nezami et al., 2022). Inter-organisational collaboration allows organisations to share information and learn about how they relate to one another (Hardy et al., 2003).

Inter-organisational collaboration aligns with the renewal task because it involves two or more organisations working together with the aim to increase public value, as the assets to be renewed are located in the public space and can be used by everyone. The approach to the renewal task is not traditional, and the aim is to utilise the resources of other organisations involved.

Collaborative governance

Collaborative governance is “the collaboration between public agencies and non-state actors to address public policy issues” (McNaught, 2023). The implementation of collaborative governance involves complex interactions between many independent actors, but it is argued that these interactions are not simple or spontaneous (Bianchi et al., 2021). Collaborative governance is implemented by transforming good intentions and protocols in formal respect into real collaboration. However, even well-designed collaborative programs can fail due to the diversity of stakeholders involved and the lack of suitable models to support leadership in promoting a strategic learning process among the actors involved, which is essential to manage conflicts, build trust, share a common vision, and identify and evaluate results. The definitions for collaborative governance differ, but all address the involvement of a diverse cross-section of stakeholders in addressing public problems using a collective and continuous decision-making approach (McNaught, 2023). In a study by Shen et al. (2024), collaborative governance is explained as an effective form of various organisations joining together to address complex public problems, which has been used widely by countries in a variety of policy settings. In this study, the renewal of residential buildings is researched, and collaborative governance is explained as an inevitable choice for the renovation and governance of these buildings. The way collaborative governance is formed and its function, as well as the factors that influence its implementation and development, vary based on the situational and contextual setting, along with the specific task and purpose it aims to achieve (Hysing, 2022). This means that there is not a standard form of collaborative governance. It must be shaped depending on the goal or task it needs to achieve. Hysing (2022) explains that collaborative governance has to be undertaken while keeping in mind a clear purpose to ensure the resources are used responsibly, the expectations are clear to participants, and to facilitate monitoring and ensure accountability is improved.

The type of collaboration corresponds with the renewal task because, in the end, it will involve collaboration with public agencies and also non-state actors, such as market organisations. For this research, only the collaboration between the public agencies is explored. Collaborative governance is a collaboration between independent actors, which the municipalities and provinces are in this task. Additionally, in collaborative governance, public problems are addressed, which is also the case for the renewal task.

3.2.2. Factors for a successful collaboration

To determine what can stimulate organisations to participate in a collaboration, it is important to explore the factors that influence a successful collaboration because when a collaboration is not successful, organisations are less likely to participate in a collaboration or join an already existing network that is not successful. In this subchapter, several factors are described that are necessary for collaboration to be successful, as found in previous literature.

Hysing (2022) describes that the success (or failure) of collaborative governance depends on incentives, structures and procedures, and public management. Two types of collaborative governance, distinguished by their strategic purposes, were elaborated on in the research: “collaborative governance to generate policy support and collaborative governance to induce voluntary action” (Hysing, 2022). These types are seen as the two different ends of a spectrum that ranges from government-orientated to society-orientated. The main purpose of collaboration for policy support is to gather input from non-state actors on public policy initiatives, thereby improving policy, making implementation easier, and

gaining legitimacy. Here, stakeholders can express their opinions and, by contributing knowledge, influence the formation or implementation of the policy. The main purpose of collaboration to further policy implementation through voluntary actions is to encourage non-state actors to take action in support of public policies, goals, and programmes. Interaction is facilitated by public agencies, and provides expert support, persuasive arguments, and mediation to convince non-state actors to take voluntary action, for example, through voluntary agreements. This way, public agencies receive input that can help to refine or change their policies and programs, as well as their implementation and management approaches.

Rönndahl et al. (2025) explore in their study how collaboration is enacted and made sense of by participants of infrastructure construction projects that use CPDM. CPDM (collaborative project delivery model) is here defined as a delivery model for projects that involves close collaboration and trust among stakeholders to promote a more efficient and effective project process through improved communication, coordination and integration, which can lead to better project results (Chen et al., 2022; Engebø et al., 2020). With CPDMs, relational governance and contractual governance are combined, and this approach is used more in the construction of infrastructure. The study of Rönndahl et al. (2025) highlights that the early stages of a project are crucial to involve stakeholders for setting the tone in collaboration. Additionally, flexibility is crucial, especially in complex and uncertain projects where sense-breaking is more common, and collaboration can be a tool to navigate challenges effectively. Sense-breaking is described as the process of breaking down the interpretations and understandings of specific aspects of the project (Pratt, 2000).

The construction industry has encountered problems such as lack of collaboration and trust, poor communication, and conflicting relationships between the involved organisations. New forms of collaborative approaches have been researched, including partnerships, the establishment of shared spaces for problem-solving in construction, as well as communication, trust, transparency, and commitment (Nursin et al., 2018). Some boundary spanners have been identified that influence the success of project team collaboration, including providing a shared workspace and social space, feeling equal in the nation and language, and having structured project indicators. These indicators were found to be the most influential in the collaboration model researched (Nursin et al., 2018).

Another important component of developing collaboration is sharing a common goal (Schöttle and Tillmann, 2018). Goals are defined as “guides for action” and provide a basis for the resolution of conflicts and a requirement for assessment and evaluation. For multiple stakeholders to work on a common project, a group goal is helpful in motivating them to work together towards a shared achievement. Commitment towards these group goals can be achieved by making the goals specific, measurable, feasible, and relevant to the stakeholders, and the goals need to be formed by the group of stakeholders that are collaborating (Johnson and Johnson, 2009). By setting a goal, stakeholders can be motivated to collaborate on the project, and it provides a basis for conflict resolution. The study by Schöttle and Tillmann (2018) showed that goal-setting and tracking were the most important factors in helping to align involved organisations in a collaboration. The measurement of the goals helps to see whether things are going in the right direction or if there is something that needs to change. For this research, setting a goal for the renovation and replacement task for multiple infrastructure types with multiple asset owners is more complex. There is no concrete objective that needs to be achieved, but the goal is more a vision, such as establishing an effective approach for the collaboration between the asset owners.

By conducting an extensive literature review, Patel et al. (2011) defined six main factor categories that are essential for successful collaboration: context, support, tasks, interaction processes, teams, and individuals. Besides these categories, some overarching factors that were relevant for all or most of the factor categories were identified. The main factors all have sub-factors which were extensively elaborated upon in the research. First, context determines the type of organisations or people involved in the collaboration and what kind of task needs to be executed. This affects the collaboration process and effectiveness of the team. Next to that, collaboration between organisations requires effective and appropriate support. This can make a significant difference between a successful and an unsuccessful collaboration, as management support and resources are required to meet goals and collaborate with the appropriate stakeholders. Completion of the right tasks is necessary to meet the defined goals. Team task performance is as important as collaborative performance, which is why task characteris-

tics are identified as one of the main categories that affect collaboration. Besides that, interaction processes, such as learning, coordination, and decision-making, are components of a collaborative working environment where parties engage. The teams complete tasks and accomplish goals through these processes. The teams are made up of different organisations or individuals that share tasks to reach a common goal. Individuals are also a crucial attribute, and the performance of individuals is very important for the performance of teams. The overarching factors were identified by Patel et al. (2011) because they were found to be relevant to all the main factors explained above. These include trust, conflict, experience, goals, incentives, constraints, management, performance and time. Trust is given as an example of how it is a relevant factor that falls under all or most of the other main factors. Trust is a central component of team performance as individuals and teams have to trust each other and have to believe they are given the best support to execute their tasks. They trust that these tasks are important and that they are receiving the structure, security and environment for optimal performance. Also, trust is necessary for the technology used and the information provided to the parties involved. This shows that trust falls under some of the main factors. This is also the case for the other sub-factors that were defined for the overarching factors.

Trust has been identified as a crucial component of collaboration in numerous articles. Edelenbos and Klijn (2007) have researched the importance of trust in decision-making and organisational arrangements for a project in the municipality of Voorburg. They analyse how the development and existence of trust influence the process and the outcomes. In their research, they explain that in horizontal collaboration, voluntary relations are becoming increasingly important, and trust appears to be crucial as a coordination mechanism, as not all uncertainties can be organised through hierarchical power. Within inter-organisational collaboration, trust is receiving more attention because of this. It was concluded that it is clear "that with the growing importance of horizontal governance in policy-making and decision-making, we should look more at the influence of trust in these processes." (Edelenbos and Klijn, 2007). There are often fewer hierarchical rules or supervision, and the collaboration is more voluntary; therefore, trust here seems to be a mechanism for coordinating the collaboration.

To summarise, this chapter outlines the key factors for successful collaboration in renovation and replacement projects. Collaborative governance is further explored, and it can vary based on the situational and contextual needs of the project. The Collaborative Project Delivery Model (CPDM) is described as a key model for collaboration, as it integrates relational and contractual governance, which can enhance efficiency and communication between the involved parties. Additionally, trust is defined as a crucial component of collaboration, especially in voluntary collaboration, as a coordination mechanism when there is no hierarchy in the collaboration.

The key findings for factors for a successful collaboration are:

- **Trust and transparency are crucial for a successful collaboration.** Trust is important because it reduces conflicts and promotes an effective project process. A lack of trust is defined as problematic in collaboration. Transparency prevents misunderstandings in communication, decision-making and resource sharing among involved parties.
- **Early involvement in the project sets a foundation for project success.** Involving stakeholders early in the project can help align objectives and responsibilities, and establish clear communication methods.
- **Setting goals is important for alignment in the project.** By having clearly defined goals from the beginning, these can serve as a guide for the stakeholders and help resolve conflicts. The goals should be specific, measurable and relevant to ensure that involved parties stay committed.

3.2.3. Challenges of collaboration

Collaboration brings challenges during the process and barriers that must be overcome for an effective collaboration. In this chapter, some of these challenges and barriers are explained. These challenges and barriers are important to know because they can hinder the participation in a collaboration and should be mitigated. The challenges and barriers can correspond with the success factors previously described. When there is a lack of these success factors, it can be a barrier or challenge in collaboration.

Moradi and Kähkönen (2022) describe different definitions of a successful project from different literature studies. Technical performance goals and project stakeholders' satisfaction can be components

of a successful project, but also the realisation of certain expectations for involved stakeholders is mentioned. The definition of construction project success is stated as “the realization of specific objectives of the project (the reason(s) for which the project is undertaken) while succeeding in six main challenges: (1) on time completion, (2) on-budget completion, (3) meeting quality requirements, (4) stakeholder satisfaction, (5) accident-free construction, (6) low waste generation during construction, and (7) no harm to the local environment and people during and after construction phase.” (Moradi and Kähkönen, 2022). For collaboration between the involved parties, the challenges of on time and on-budget completion, as well as meeting requirements for quality and the satisfaction of stakeholders are the most important of the challenges mentioned. They describe a collaborative delivery model “as the joint design, planning, control and management of construction projects by the key parties based on their early involvement in the project, trust-based relationships, open communication, and fair share of risk-reward” (Moradi and Kähkönen, 2022).

Saukko et al. (2020) executed research to explore the challenges and preconditions that can arise for inter-organisational collaboration in industrial engineering projects. They describe inter-organisational collaboration as a collaboration between organisations and explain that it is often linked to behavioural drivers and relational attitudes, such as trust, open and honest communication, a shared vision and objectives, and social interaction. The quality of communication, uncertainty of the project, the owner’s organisational efficiency, change orders and trust seemed to have the most significant impact on the level of collaboration, and because of that, also on the transaction costs. In the article, the challenges were described for each project phase. The first phase was the decision for the level of collaboration, so here, a plan was created for the collaborative practices within the project. The key challenges described here were that the goals were unclear, and there was a lack of knowledge for some of the involved parties about the best practices of collaborative project management. Also, cultural differences are defined as a challenge as this may not support collaborative practices. In the next phase, this is also a challenge that was defined. Here, the challenge is that project organisations want to keep up their traditional culture. This phase is the pre-engineering phase, during which general technological plans and decisions are made. According to the interviewees in this research, project organisations wanted to maintain the old project culture, where common goals may not have been formulated clearly and agreed upon.

Literature on collaboration barriers in the construction industry is mainly focused on supplier-contractor collaboration or partnering (Morel et al., 2020). The barriers to supplier-contractor collaboration that were discovered by Bemelmans et al. (2012) in a literature review are a lack of top management commitment, a poor understanding of the concept, an inappropriate organisational structure for coping with the concept and a lack of belief in mutual benefits. For partnering, the barriers described include a lack of trust, organisational boundaries, and conflicting objectives and values (Gadde and Dubois, 2010).

Lozano et al. (2021) researched the elements, benefits and challenges of collaboration. The focus of the research is on the role of collaboration in the contribution of organisations to sustainability. They describe some challenges that organisations face when collaborating to become more sustainable:

- Information asymmetry – Unclear who benefits and potential hidden agendas.
- Bargaining issues – How the benefits are divided
- Free-riding – Organisations that benefit without participating as much as others
- Coordination problems – Aligning the tasks between the participants
- Resource risks – Risk of losing important and unique resources
- Conflicting needs – Differing interests among the participants
- Relationship conflicts – Problems between participants that can hinder the process
- Data conflicts – Inaccurate data or having trouble accessing data
- Value conflicts – Differences in culture or strategic values
- Structural conflicts – Structural differences in organisations that can create barriers
- Operational dependencies – Activities that require coordination to avoid conflicts

These are challenges in collaboration for organisations to become more sustainable, but can also occur in collaboration between organisations with other goals, such as the renovation and replacement of infrastructure.

Parlikad and Jafari (2016) have identified several challenges for collaboration between infrastructure owners. The first challenge, which has been mentioned before in other articles, is the diverse requirements of different stakeholders. Infrastructure assets involve multiple stakeholders, such as asset owners, managers, operators and users. Their requirements are varying and need to be aligned, which can be challenging. Next to that, infrastructure organisations are often structured in siloes, which means that the responsibility for the maintenance of a bridge structure might differ from that of the bridge's pavement and so on. This makes collaboration even more complex.

A study by Arena and Sim (2024) reveals several challenges in stakeholder collaboration for asset maintenance projects in Australia. Communication gaps are often described as a significant barrier to collaboration, particularly in projects that involve stakeholders from different organisational cultures or geographical locations. Technological tools are useful for collaboration because they provide real-time data, and this can improve decision-making. However, the tools are adopted unevenly due to smaller organisations that fall behind because of cost constraints. Other critical components of collaboration success discussed here are trust and leadership. It was found that projects that are led by experienced and empathetic leaders are more likely to achieve better outcomes.

So, to sum up, the challenges and barriers for collaboration are outlined in this subchapter. The key findings that were identified here are:

- **There were barriers identified that hinder collaboration**, which include unclear goals, weak management, maintaining traditional organisational structures, organisational misalignment and mistrust. Also, specifically for infrastructure collaboration, the differing stakeholder requirements and complex asset management are creating barriers.
- **Challenges for collaboration that were described include trust and relationship issues.** Lack of trust, unclear goals and communication problems have a significant impact on the effectiveness of collaboration.
- **The success of collaboration is also dependent on leadership and involvement of the stakeholders.** Strong leadership, early involvement and a fair risk-reward sharing system are important for collaboration
- **Cultural and behavioural differences need to be recognised.** Conflicting values in the organisational culture can be a large barrier to collaboration.

3.2.4. Frameworks for collaboration

For this research, the objective is to design an effective collaboration between asset owners of infrastructure that requires renewal. Therefore, it is useful to examine frameworks for collaboration and identify which components are frequently used and may be important for stimulating asset owners. In this chapter, some of these frameworks will be explored, and in the end, the most important findings are explained. In the frameworks, the important components for collaboration are illustrated, which can align with the findings from the previous literature research. The frameworks examined encompass collaboration in general for project productivity, collaborative governance and its key components, which was mentioned as a type of collaboration in Chapter 3.2.1, how collaborative governance can be stimulated, and collaboration in construction projects and how this can be established. The frameworks serve as a basis for developing effective collaboration in this research.

In the first framework in Figure 3.4, Schuh et al. (2014) developed a framework for collaborative practices that is detailed into three collaborative dimensions: communication, coordination and cooperation. All three dimensions have two collaborative practices that facilitate collaboration. The framework outlines the key components of collaboration and what falls under these components, which can be helpful for understanding collaboration.

First, communication involves the means to share information and facilitate sense-making. In collaborative activities, sharing information is crucial as it can improve the overall productivity of a project. Sense-making is helpful for understanding complex situations and assessing the consequences of

possible measures by interpreting existing information. The result of sense-making is new information that is received through the interaction of the members of the organisation and through effective communication in particular.

Secondly, with coordination, the dependencies between activities are managed. Available resources are managed, tasks are synchronized, and activities are aligned with coordination. Coordination has a direct line to productivity. The example given is that the productivity of a supply chain relies on the efficiency of coordinating its members, resources, and activities. The costs and throughput time can be decreased. In the framework in Figure 3.4, resource pooling and goal-congruence are placed as collaborative practices that are central to coordination. Resource-pooling can be defined as the allocation of information, equipment and human resources in order to achieve a collaborative goal, to assign tasks and to determine the time allocation of resources to activities. Goal-congruence is crucial for resolving competition for resources. It describes the mutual understanding and agreement among collaborating entities with the same overall goal. Productivity can be increased with a high degree of goal-congruence as it aligns the objectives with the activities of the decision-makers.

Lastly, cooperation implies that the entities involved recognise the importance of the overall goal and collaborate to achieve it. Cooperative behaviour leads to better organisational performance and requires facilitation and encouragement through leadership. Cross-functional activities and the empowerment of employees are two key components of cooperation. These behaviours are based on the idea that it is desirable to empower decentralised decision-makers and give away control from central entities, while also interconnecting the decision-makers within different functions and divisions. This enables the utilisation of local information and global knowledge simultaneously, allowing for better decision-making and increased productivity.

The collaborative dimensions can be linked with the success factors found in Chapter 3.2.2. Trust and transparency are essential for effective communication, which facilitates information-sharing and ensures a mutual understanding through sense-making. The early involvement of stakeholders contributes to a stronger coordination with the support of goal-congruence, and it enables a more efficient resource-pooling because it is clear early in the process what resources are available from which stakeholders and what their interests and goals are. Setting goals also falls under the coordination dimension of this framework. Aligned goals prevent conflicts and formulate a mutual understanding in the project.

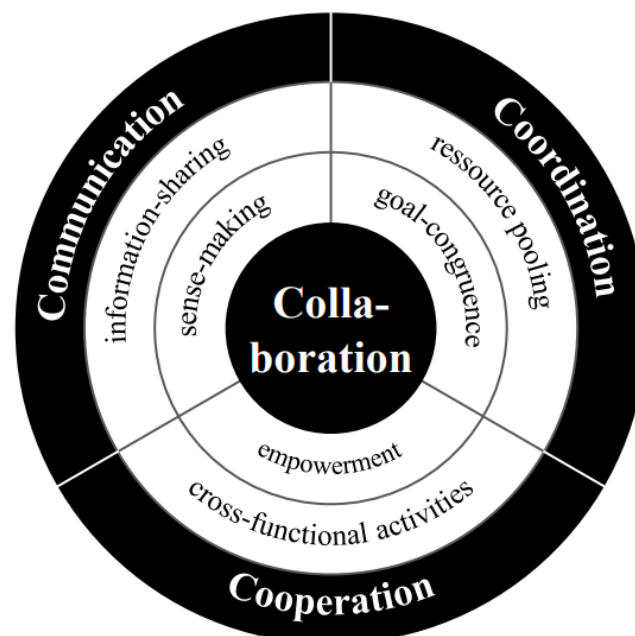


Figure 3.4: Framework for collaborative practice (Schuh et al., 2014)

Yang (2016) identified several important procedural attributes from different articles in the previous literature that are useful for effective collaboration. These include (1) the effective participation of important social actors and the availability of diverse resources, (2) the context of collaboration, (3) implementation and organisation of collaboration, (4) communication, (5) shared learning and building trust, (6) fair distribution of potential benefits, (7) mechanisms to resolve conflict, and (8) governance methods for experiment-extension. These attributes addressed some of the questions about the participants involved, how they collaborate and communicate and how benefits are distributed. Based on this, with regard to the principles of collaboration in institutional design, eight key elements of collaborative governance are defined. These can be seen in Figure 3.5. These elements were used to define successful collaborative governance in the research that was conducted here. The elements described here are important for the performance of collaborative governance. Some of these factors can also influence the willingness to participate in the collaboration, which could be useful to consider in the framework for this research.

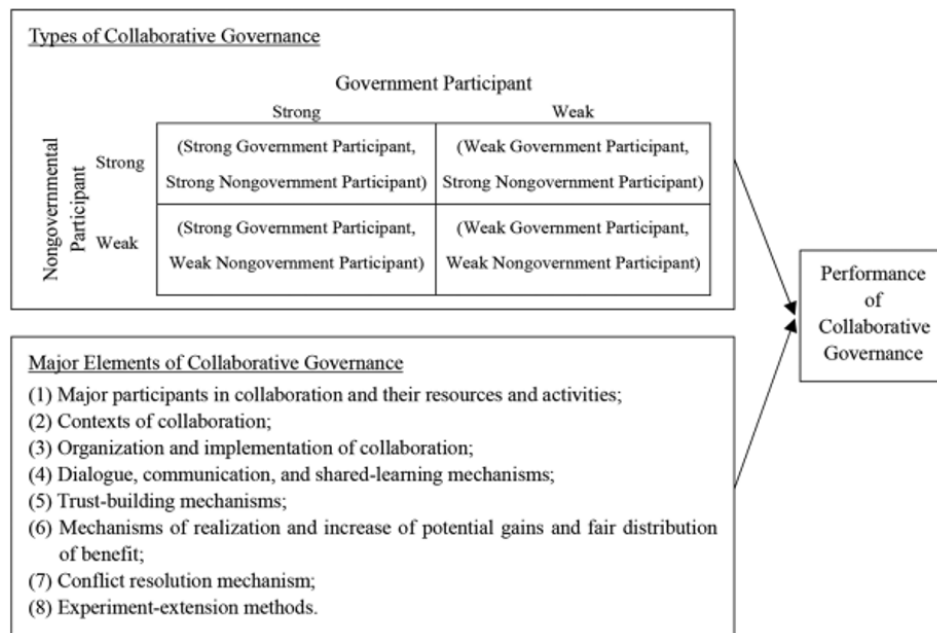


Figure 3.5: The theoretical framework for analysing collaborative governance in desertification control (Yang, 2016)

The next framework that offers useful components for collaboration and stimulation of collaboration is the framework proposed by Ansell and Gash (2007). Ansell and Gash (2007) conducted a study with the goal of establishing a contingency approach to collaboration that can identify the conditions under which collaborative governance will be more or less effective in terms of policy-making and public management. They describe collaborative governance as “A governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-orientated, and deliberative and that aims to make or implement public policy or manage public programs or assets” (Ansell and Gash, 2007). A model was designed based on the author’s findings from previous research on collaborative governance and its related components, as shown in Figure 3.6. In the model, the collaborative process is central, and the starting conditions, institutional design, and leadership variables are conditions to or contexts for the collaborative process.

Starting conditions

The starting conditions establish the basic level of trust, conflict and social capital, which serve as resources or liabilities during the collaboration. These can either encourage or discourage collaboration among stakeholders and between stakeholders and agencies. The critical starting conditions are narrowed down to three variables: the imbalance between the power or resources of different stakeholders, incentives for stakeholders to collaborate and past conflicts or cooperation among different stakeholders.

A power imbalance can occur if some stakeholders do not have the capacity or resources to participate as equally as the other stakeholders; the collaborative process can then be prone to manipulation by the stronger stakeholders. The conclusion drawn was that in cases of power or resource imbalance between stakeholders, such that important stakeholders are no longer able to participate in a meaningful way, a commitment to a positive strategy of empowerment and representation for the disadvantaged stakeholders is required by effective collaborative governance.

For the incentives for stakeholders to engage in collaborative governance, it is also important to understand the factors that shape these incentives. The incentives for participation partly depend on the stakeholder's expectations about the kind of results the collaborative process will yield. Incentives increase when stakeholders recognise a direct relationship between their participation and concrete policy outcomes; however, they decrease if stakeholders consider their input to be solely advisory or largely symbolic. If stakeholders can achieve their goals independently, the incentives for participation are also low. Two conclusions were made here: if stakeholders can pursue their goals unilaterally, a collaboration will only work if the stakeholders perceive themselves as independent, and if the collaboration is conditional, then sponsors have to be willing to execute the work of getting alternative forums such as courts and legislators, to respect the outcomes of the collaborative process.

From the literature, the authors found that a history of conflicts or cooperation between stakeholders can either hinder or promote collaboration. However, it was also noted that when stakeholders are highly interdependent, conflicts can create a powerful incentive for collaborative governance. The conclusion drawn was that if there is a history of conflicts, collaborative governance is unlikely to be successful unless there is a high degree of interdependence between the involved stakeholders or positive steps are taken to address the low levels of trust and social capital between them.

Facilitative leadership

Facilitative leadership is important for bringing stakeholders together and motivating them to engage with one another for collaboration. It is also crucial to set clear ground rules, build trust, enable effective communication, and explore mutual benefits. The empowerment of stakeholders is also part of leadership aimed at involving and mobilising them to enhance collaboration and for the empowerment of weaker stakeholders.

Institutional design

The institutional design refers to the basic ground rules for collaboration, which are crucial for the process of the collaboration. One of the most important components here is that the collaboration must be open and inclusive for all stakeholders, and broad participation must be sought. Additionally, literature suggests that clear ground rules and process transparency are important design features for the collaborative process. This ensures that the process is fair and open, reassuring the stakeholders involved.

Collaborative process

The collaborative process is represented as a cyclical process because it is repetitive and nonlinear. Collaboration appears to be dependent on a virtuous cycle consisting of communication, trust, commitment, understanding and outcomes. It was found to be challenging to represent, and it was suspected this is because of the cyclical nature. A description of the collaborative process was challenging to begin with, but as communication is fundamental to collaboration, the authors decided to start with face-to-face dialogue.

Face-to-face dialogue is necessary to identify opportunities for mutual gain between stakeholders, but it is more than only the medium of negotiation. It plays a crucial role in building trust, mutual respect, a shared understanding and commitment to the process, and is essential for breaking down stereotypes and other barriers to communication.

A common starting point for collaborative governance is often the lack of trust between stakeholders. The collaborative process is often viewed as merely about negotiation but is also very important for building trust among stakeholders. In case of a history of conflicts, the stakeholders should take extra time to rebuild the trust. If this is not possible, they should not embark on a collaboration.

The commitment of involved stakeholders is one of the most crucial factors in successful collaboration. Commitment is closely linked to the motivation for participation in collaborative governance, but the

motivation can be solely to ensure their perspective is not neglected. Commitment means that there is a belief that bargaining for mutual benefits is the best way to achieve the desirable common outcomes. It is also tricky because it requires a willingness upfront to follow the rules and actions that have been decided upon in the collaboration, even if they have to do something they do not support. Ownership implies a shared responsibility that requires stakeholders to adopt a different perspective regarding their relationship with other stakeholders in which responsibilities are shared. Trust is also a critical component here.

Shared understanding in this cycle means that the stakeholders must align on what they want to achieve together. It can also mean an agreement on the problem or what knowledge is necessary to address it. This development can be seen as a larger part of the “collaborative learning process”.

Collaboration is more likely to occur when the potential benefits and advantages of the collaboration are clearly defined and “small wins” can be achieved through the collaboration. The intermediate outcomes are represented as critical outcomes of the process, which are essential for building momentum and can lead to successful collaboration.

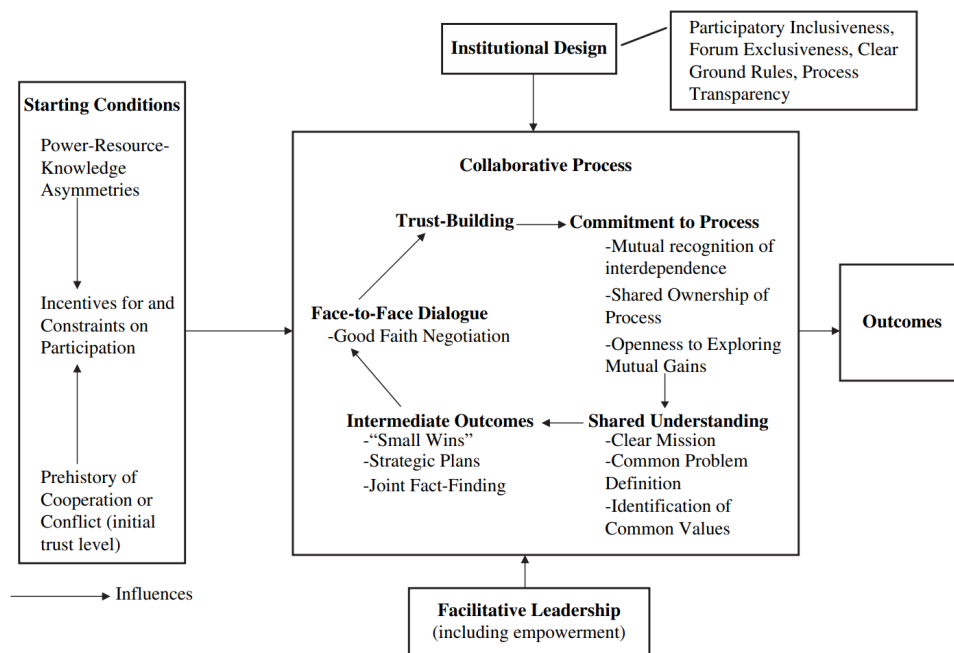


Figure 3.6: A model of collaborative governance (Ansell and Gash, 2007)

Faris et al. (2022) focus their study on construction projects and the lack of collaboration in these projects. They explain that this lack of collaboration has been determined as a significant obstacle to the performance in the construction industry. A wide range of collaboration benefits has been determined from various studies, for example, less conflicting relationships, reduced delays, reduction of costs, minimizing environmental impacts, reaching long-term goals and improvements, client satisfaction, improvement of productivity and sustainability, and have a better competitive advantage on the market. The authors describe that there is a large amount of literature on factors of collaboration, but it is lacking in the literature on how these factors should be delivered and at what stage. Therefore, a framework was developed that distributes the factors of collaboration over the life cycle stages of a project. It provides construction managers with a guide to implement the framework. For each factor in the framework, a set of tasks or conditions is provided for the factor to be able to be delivered; this can be seen in Figure 3.7.

First, in the beginning, a shared project vision is established; this is one of the most important components that contribute to project success. The project vision needs to be understood, credible, motivational and demanding. After establishing a project vision, a collaboration champion has to be appointed to manage the process. It is described as beneficial to have a collaboration champion to help deliver

specific project outcomes that have already been recognised, as this person can assist in transferring information and legal obligations between the involved organisations.

After the preparation stage, many new parties are involved, which increases the complexity of the construction projects. Design teams may need professionals to assist with their duties, in addition to having members of the design team already involved. It is essential that potential partners are identified at the beginning of the design stage and that their roles and responsibilities are defined.

When these roles and responsibilities are identified and clear, the next step is to determine how the involved parties will interact with each other and communicate. Clear communication lines could minimise problems happening on the construction sites. To enable effective communication, it is important that there are adequate technologies, hardware and software packages. This can be as simple as emails or using the cloud for sharing information. However, this can still be complicated for some parties, which is why another task here is to appoint skilled staff for this technology.

Next, it is essential for project stakeholders to agree on a systemic process to deliver the project, which should include methods for risk sharing, resolving conflicts, and evaluating performance. This systematic process is crucial to have been determined before awarding contracts and starting the construction work.

The contractual documentation is also an important factor in the framework. The agreements made in the previous steps have resulted in terms for the contracts. All parties have to trust these contract terms to build an effective collaborative environment. When these contracts are selected, all the involved parties have to sign them. This must be completed before the start of the construction stage.

In all the stages and factors in the framework, the behaviour of the participants is essential. This affects projects from the beginning to the end of the project delivery. Adopting collaborative approaches requires the participants to adopt a change in behaviour and attitude. The cultural and behavioural differences need to be recognised and respected, and the involved parties should still provide and share resources despite these differences to achieve a collaborative process.

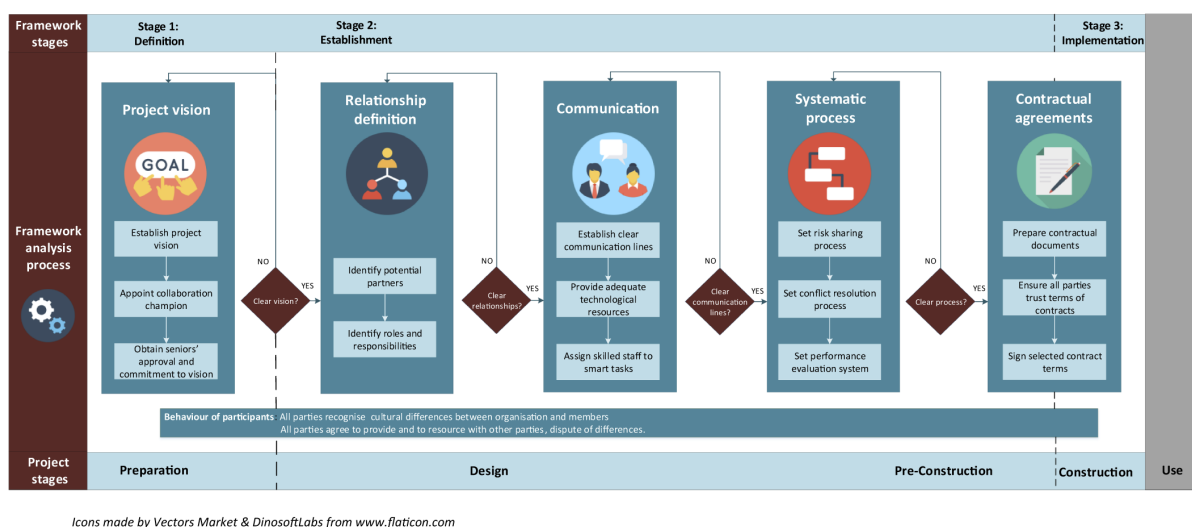


Figure 3.7: The developed framework for improving collaboration (Faris et al., 2022)

Four different frameworks for collaboration have been discussed in this subchapter, and each has distinct components that are important for improving or shaping collaboration.

In the first framework, Schuh et al. (2014) structured collaboration into three dimensions: communication, coordination and cooperation. Communication involves sharing information and enabling sense-making. Coordination manages dependencies between activities, resources, and task-alignment. Also, understanding and agreement on a mutual goal are important in coordination. Cooperation ensures that the involved parties are aware of the importance of the overall goal and that they will work together to achieve it.

Yang (2016) described important elements of collaborative governance that influence performance. These include the effective participation of important participants, the availability of resources, the context of collaboration, the implementation and organisation of collaboration, communication, shared learning, building trust, a fair distribution of potential benefits, mechanisms to resolve conflicts, and governance methods for experiment-extension.

Ansell and Gash (2007) designed a comprehensive framework for collaborative governance, where the collaborative process is central, and the starting conditions, institutional design, and leadership variables are conditions or contexts for the collaborative process. The starting conditions include the power-resource-knowledge asymmetries, the incentives for participation in collaboration, and the history of conflict, as well as how these factors influence each other and can either encourage or discourage collaboration. The institutional design involves the ground rules for the collaboration. Leadership is crucial to bring stakeholders together and motivate them to collaborate. The collaborative process is a cyclical process that is primarily dependent on communication, trust building, commitment, mutual understanding, and intermediate outcomes.

Lastly, Faris et al. (2022) found that there is a lack of collaboration in construction projects, which is a large obstacle to performance in the construction industry. They developed a framework in which the factors of collaboration are distributed across the life cycle stages of a project. For the first stage, the project vision should be clear, and a collaboration champion has to be appointed to manage the process. Then, potential partners should be identified, and their roles and responsibilities must be defined. After that, communication lines need to be defined and clear for everyone. Next, stakeholders have to agree on a systemic approach to deliver the project. Lastly, the agreements made in the previous step have to be transformed into contracts and signed by the involved parties. Over all the stages of the project, the behaviour of participants is crucial and can affect the project. Cultural and behavioural differences should be recognised and respected.

The key findings from the described frameworks are:

- **Collaboration requires structured governance and decision-making.** To manage asymmetries in power, resources and knowledge, clear ground rules are important. Also, involving participants in decision-making is beneficial for collaboration.
- **Trust, communication and identifying a mutual goal** are important components of effective collaboration. These are all useful for managing collaboration and eliminating conflicts.

3.3. Similar initiatives in the Netherlands

As explained before, the infrastructure in the whole country has to be renovated or replaced, which means there are different organisations trying to find a way to execute this as efficiently as possible. For this research, the focus will lie on the province of Noord-Holland and their initiative to work together with the municipalities and other involved asset owners to renovate and replace the infrastructure there. In Chapter 4, this initiative will be explained further as an introduction to the case study. However, Noord-Holland is not the only organisation that came up with an idea for efficiently working together to renew the infrastructure. In this subchapter, a few other initiatives in the Netherlands will be explained.

In Noord-Brabant and Noord-Limburg, all the technical installations, including locks, dams, movable bridges, and pumping stations around the Maas, will be renovated or replaced (Ministerie van Infrastructuur en Waterstaat, 2025). Additionally, regular maintenance will be performed simultaneously. To execute this task, first, extensive research is done, and technical designs are created to ensure that all of the infrastructure is fitted with modern technology. The infrastructure is renewed piece by piece, which can result in temporary blockages of the waterways. The parties concerned have the opportunity to express their wishes and demands, such as the limitation of hindrance for users of the waterway and agreements with the water authorities regarding water management during the renovation of a pumping station.

The provinces Zeeland and Brabant have also set up an initiative called ZEBRA. Their goal is to set up a renovation and replacement program for concrete viaducts (Platform Bruggen, n.d.-b). In this program, clients and contractors will collaborate, share knowledge, and learn from each other. This program is part of a larger platform called "Platform Bruggen" (Platform Bridges), which aims to combine forces,

initiatives, and knowledge from all parties in the bridge sector. By sharing knowledge, initiatives are accelerated, which will contribute to a more efficient and effective renovation and replacement task (Platform Bruggen, n.d.-a)

Earlier, in Chapter 3.2.1, Zuid-Holland was already mentioned as an example of a province that works task-orientated. One of their initiatives is “Zuid-Holland Bereikbaar”, which is an organisation made up of seven public organisations: the province of Zuid-Holland, the municipalities The Hague and Rotterdam, metropolitan area Rotterdam - The Hague, the Ministry of Infrastructure and Water management and Rijkswaterstaat (Connected Worlds, 2024). Each of the organisations has much information, but it is not shared enough. The infrastructure requires maintenance to remain safe and accessible in the future (Zuid-Holland Bereikbaar, n.d.). Collaboration is important here to minimise disruption by making agreements and working during periods of less traffic. It is stated that everyone is needed to do this right.

“Samenwerken aan Kunstwerken” (Collaborating on civil infrastructure) is an initiative where Rijkswaterstaat also works together with the water authorities of the Netherlands to renew civil infrastructure and ensure safety (Noorderkwartier, 2024). The goal here is to finish by 2050, which means that every three weeks, one infrastructure asset is safe. To achieve this goal, the task needs to be taken up faster and in collaboration. Knowledge sharing is again important here, as it enables the organisations to learn from each other and work efficiently.

3.4. Conclusion

In this chapter, a literature review was conducted to explore previous research on four of the defined sub-questions. Two of these sub-questions have been answered through literature review, and the other two will be answered more completely after the case study and interviews. The findings from the literature review are presented here per sub-question, and a general conclusion for the literature review is provided. In the end, a research gap is identified that still needs to be addressed through the case study and interviews. This gap gives a basis for the interview questions and what needs to be analysed during these interviews.

Answers sub-questions

SQ 1: What are the characteristics of renovation and replacement infrastructure projects?

The characteristics of renovation and replacement projects are researched, and it is found that infrastructure will be renovated or replaced when it is reaching its end-of-life. This can be because of three reasons: an economic, functional, or technical end-of-life, which means that the maintenance costs are rising too high, the object is no longer functioning properly, or the technical end-of-life is reached because of ageing or changed usage. These kinds of projects involve multiple stakeholders with different interests and objectives that can be conflicting or unclear. This makes decision-making complex. The components that were perceived to cause the most hindrance were a lack of information, unclear definitions, communication and coordination, and uncertainty about who is responsible when a task will be executed. Renovation and replacement projects differ from new building projects because the work takes place with an existing object and there are many more factors to consider, such as the space, people who live around it, and the traffic that uses the object.

SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?

This sub-question was defined to explore the factors that contribute to a successful collaboration in large-scale infrastructure projects involving renovation and replacement. Trust and transparency have been identified in multiple studies as crucial components for a successful collaboration. Besides that, involving the stakeholders early in the project can help align the objectives and goals of the involved parties, which is very useful for a successful collaboration and the success of the project. When stakeholders are involved early in a project, their interests and goals are clear from the start of the project, and it is easier to implement them in the plans. This is also useful for another key factor in a successful collaboration, which is setting goals for the project. Clearly defined goals, which are the same for all involved parties, help to align the objectives and expectations of the stakeholders and can serve as a guide to follow. This will also help resolve and eliminate conflicts. For the renovation and replacement

task of this research, setting a goal is more complicated as there is not just one specific goal that needs to be achieved. It is more a vision or a goal, such as a way of collaborating with other asset owners. Collaboration can provide benefits for all the parties involved, but only if there is a structure for the interaction, outlining how decisions are made, and how resources are allocated for the task they have to tackle.

SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?

The key challenges for asset owners in collaboration that were identified in the literature review fall under different categories. There are a couple of barriers that hinder collaboration, which are defined here. The most important barriers identified are unclear goals, weak management, and organisational misalignment and mistrust. Lack of trust and unclear goals were also defined as challenges for collaboration, along with communication issues. Leadership and the involvement of stakeholders were also found to be an influence on the success of collaboration, which can be seen as weak management, one of the defined barriers. Something different from what was mentioned before is the cultural and behavioural differences. Literature shows that it is essential to recognise these differences, as this can also be a significant barrier to collaboration. Cultural and behavioural differences are found to be a challenge in the way different organisations work, and if these do not align or even conflict, this can pose a challenge to collaboration. Another difference in organisations is how they define the characteristics of their infrastructure assets. One of the challenges defined for asset owners when planning a renovation and replacement project is that characteristics of infrastructure assets and the norms that define their benefits and failures can be defined differently, making it more complex. For renovation and replacement tasks, the main challenges mentioned were lack of trust, organisational boundaries, and conflicting objectives and values.

SQ 4: What are existing frameworks for collaboration?

Four frameworks were found in the literature study that are useful for this research on collaboration between asset owners for the renovation and replacement of infrastructure assets. Some of the frameworks are less useful than others but they still provide valuable insights into collaboration and the components. The frameworks explain different sides of collaboration and the key components for developing a collaboration, which is useful to find out how a collaboration can be initiated and developed between asset owners. The main findings from the described frameworks are that collaboration requires structured governance and decision-making process, for which participants should be involved. Also, asymmetries in power, resources, and knowledge should be managed, and clear ground rules have to be defined. Other important components for collaboration, which appeared in the frameworks, are trust, communication, and identifying a mutual goal. The framework of Ansell and Gash (2007) presents a model of collaborative governance, explaining the collaborative process and the components that influence it, which are helpful in developing a collaboration. The framework of Faris et al. (2022) shows how a collaboration can be established in a project. This differs from the collaboration for the renewal task, which is being researched here, but the steps in this development are still interesting as a basis for developing collaboration. The other two frameworks that are explained are those from Schuh et al. (2014) and Yang (2016). These frameworks explain collaboration and some of its key components. These components are useful to consider when developing a collaboration for the renewal task, as they are essential for effective collaboration.

General conclusion

Large infrastructure projects that involve renovation and replacement are very complex as they involve multiple stakeholders with sometimes varying, conflicting, or unclear interests. The literature indicates that successful collaboration is dependent on various components, some of which came up multiple times for different sub questions. These components include trust building and transparency, early involvement of stakeholders, and formulating clear goals that are shared by the involved parties. These factors positively influence collaboration success. However, when these factors are lacking, they act as challenges and barriers that hinder collaboration.

Research gap

The literature study has already provided many insights into collaboration models and the characteristics of renovation and replacement projects. Especially regarding stakeholder dynamics and decision-making among stakeholders with different objectives and goals. However, there is still a lack of understanding of how asset owners deal with challenges that arise in collaboration. There is a gap in the research in the following areas:

- **How to build and maintain trust and transparency over time.** Trust building is important in collaboration, as this was described in multiple previous articles as a crucial component in the success of collaboration or as a reason for the collaboration not to be successful when there was a lack of trust. Knowing how this can be built, can be useful in developing an effective collaboration between asset owners.
- **How to align goals when multiple organisations with different interests are involved.** Another success factor that was described is defining a mutual goal. Different organisations with varying interests can view a goal differently, which is why it is important to know how to align the goals to establish a mutual goal.
- **The specific key challenges in renovation and replacement infrastructure projects.** In the literature, challenges have been described for collaboration; however, there remains a lack of information on the key challenges in renovation and replacement projects involving multiple infrastructure assets and multiple asset owners. These are important to implement in the research to try to overcome these challenges and eliminate barriers to collaboration.
- **How can collaboration be stimulated between asset owners.** The aim of the research is to develop an effective collaboration between asset owners. For this, it is useful to know how collaboration can be stimulated.

The literature already provides much information on collaboration in general and the conditions necessary for it to be successful. It provides a promising basis for developing an effective collaboration, but certain components are missing from a practical aspect, as described before. These components specify infrastructure projects involving renovation and replacement, which can help answer the research question more fully.

4

Case study

The infrastructure in the whole country needs to be renovated or replaced in the following decades because it is reaching its end-of-life. For this research, the collaboration between asset owners is studied to explore how an effective collaboration can be designed so the renewal task can be executed efficiently. To explore this collaboration in a renovation and replacement task, a case has been chosen that has taken on the challenge of collaborating with multiple asset owners to combine resources and knowledge for the renovation and replacement task. These asset owners include, among others, municipalities, Rijkswaterstaat, and the province of Noord-Holland. The case is an initiative by the province of Noord-Holland called “Samen Slimmer Renoveren en Vervangen”, which is abbreviated as SSRV, which entails the collaboration of the entire province to collectively take on the task of renovating and replacing its infrastructure. How this task is going to be taken on exactly will be explained later in this chapter.

In the province of Noord-Holland, there are around 14.500 bridges and viaducts that are going to be renovated or replaced in the following decades. The province of Noord-Holland is going to work together with the 44 municipalities, Rijkswaterstaat, ProRail and the transportation region Amsterdam (Binnenlands Bestuur, n.d.). These organisations are all asset owners of infrastructure assets in the province. These municipalities are illustrated in Figure 4.1. Within the collaboration partnership, the aim is for the municipalities to undertake actions together, which results in a more efficient renewal of the infrastructure, for example, by tendering a couple of the same type of bridges from different municipalities together. The goal is to save costs, raw materials and manpower. Sustainability, safety, and accessibility are also important components of the task. Of the 14.500 bridges and viaducts, there are 730 movable ones. The fixed bridges consist of 5915 concrete road bridges, 3755 steel road bridges, 3755 wooden bicycle and pedestrian bridges, and 290 concrete bicycle and pedestrian bridges. There is a high possibility that these bridges share similarities and, by mapping out these similarities, the renovation and replacement could be carried out more efficiently. A complete one-to-one replacement in Noord-Holland will cost between 15 and 20 billion euros.



Figure 4.1: Municipalities of Noord-Holland (JungleKey, n.d.)

The province of Noord-Holland has asked APPM and DHM to help with the formulation of the SSRV initiative to renovate and replace the infrastructure with a collaboration as external parties. First, the ‘why’ of the whole assignment was formulated. It was found that the number of infrastructure assets to be renovated and replaced is growing, the network is expanding and becoming more vulnerable, and there are higher demands for sustainability and the network performance. On the other hand, there is a decreasing number of organisations that can realise this, which is creating a tension. Shared ownership through collaboration is seen as a way to reduce this tension by strengthening the capacity to realise the task with more manageable proportions. APPM and DHM are working according to the VVV-principle which they have realised. This principle consists of “Verbinden” (connecting), “Verslimmen” (smarter) and “Versnellen” (speeding up). The first part of connecting is focused on in the first phase of the SSRV initiative, as connecting is crucial for building trust. Trust is essential as a building block to take on the task further towards “Verslimmen” and “Versnellen” collectively.

The aim of the network “Samen Slimmer Renoveren en Vervangen” is to create a better position for collaboration to achieve the renovation and replacement task with the available capacity by working together. The network focuses on asset management, particularly the renovation and replacement of assets in Noord-Holland. The focus is primarily on issues that require collaboration, rather than those that can be addressed by the participating parties independently. The participating parties will remain independent and participate voluntarily to align their roles and activities in the long term or engage in activities together in order to develop a more connected and effective way of working on issues for

which collaboration is key. The network has developed multiple initiatives that are supported by its members. For 2024-2025, three initiatives have priority and are being worked on:

- **The Noord-Holland asset-based approach to bridges and viaducts.** Based on the asset-based approach in Amsterdam, an analysis of the assets is done in which individual objects are subdivided into families. From this analysis, the goal is to create a visualisation of the assets in Noord-Holland and their planned renewal date. In a later step, it is also possible to show which parts of the city will no longer be accessible when, for example, a particular bridge is being renovated and cannot be used.
- **The connecting of long-term asset management to RegioRegie.** This is an analysis of opportunities to create a long term maintenance forecast for important road and waterway routes.
- **The Noord-Holland bridge brigade.** This is a community of involved asset managers who share knowledge and expertise of bridges and viaducts. This community gives asset managers the opportunity to share knowledge and ask each other questions in an approachable way. It is also a way for asset managers to meet the other asset managers in their region of the province.

These are all initiatives that require collaboration. As mentioned before, the participants can join the network on a voluntary basis but are not obligated to participate. The renovation and replacement task requires collaboration between the asset owners of the infrastructure in Noord-Holland, where they combine their activities and knowledge to develop a shared language and knowledge so activities can be picked up together.

As mentioned earlier, the SSRV initiative was developed by the province of Noord-Holland, this happened in 2023. In the last two years, numerous developments have occurred, a governance structure is created, and there have been meetings and workshops where the organisations have come together to get to know each other and discuss the options for the SSRV initiative. The governance structure is as follows:

- **The steering committee** (*in Dutch: stuurgroep*) is composed of directors and management members of the organisations affiliated with the network. This group is responsible for the decision making of their autonomous organisation.
- **The taskforce** of SSRV provides a strategic direction and represents the interests of the organisations involved. In 2024, it consisted of eleven asset management organisations and a representative from the industry associations to ensure a strong connection between the SSRV initiative and the individual organisations involved. The three initiatives described earlier were selected by the taskforce.
- **The core team** (*in Dutch: kernteam*) consists of a program team and an implementation team. The program team supports the taskforce with the direction they are going, sets up a program, works on expanding the network of participants, and monitors the progress. The implementation team is responsible for realising the implementation plans and the coalition that came from these plans.
- **The market group** (*in Dutch: marktgroep*) consists of industry organisations that have regular discussions. A representative of the market group takes place in the taskforce.
- **The involved organisations in the network** are all the other organisations in the province of Noord-Holland that are invited or want to participate on their own in the network. These organisations can attend organised events such as workshops, a festival and a Hackathon.
- **APPM and DHM** support the SSRV initiative in Noord-Holland through process facilitation. These organisations are external parties that facilitate the SSRV initiative, for example, as chair of the taskforce to be impartial in the decisions.

The participants of the interviews are individuals from these different groups in the governance structure. These are presented in Table 4.1. The transition team consists of the initial initiators of SSRV. The asset managers have this function on an operational level and can be seen as part of the involved organisations in the network in the governance structure.

Table 4.1: Participants and their functions in the initiative

Participant	Organisation	Function in the initiative
1	Rijkswaterstaat	Core team (kernteam)
2	Province of Noord-Holland	Transition team
3	Municipality of Waterland	Asset manager
4	Municipality of Purmerend	Taskforce
5	Province of Noord-Holland	Taskforce
6	DHM	Core team (kernteam)
7	Province of Noord-Holland	Transition team
8	Municipality of Amsterdam	Taskforce / initiator
9	Stadswerk 072	Taskforce
10	Municipality of Haarlem	Taskforce
11	Municipality of Edam-Volendam, municipality of Amsterdam	Asset manager
12	APPM	Core team (kernteam) / Taskforce

During the course of creating the SSRV initiative, multiple meetings and workshops have already been organised. One of these meetings was a Hackathon where young professionals engaged in the SSRV initiative and explored challenges and potential solutions related to the renovation and replacement task. This was in May 2024. In addition to this, there have been several thematic meetings that explicitly focused on one theme, such as a network or volume approach. There have been multiple meetings for each theme throughout the year in 2024. Additionally, a festival about the future was organised for all the organisations involved in the SSRV initiative and the network, as well as other interested organisations, where implementation plans and results were shown to illustrate what collaboration can bring and how organisations can join the network.

5

Findings

In this chapter, the findings of the interviews are described. These findings are divided into sections, in which the different components of the collaboration, the challenges of the process, and the renewal task are elaborated. First, in Chapter 5.1, the renewal task is described; here, the findings indicate how the interview participants view the renewal task and what problems they identify. After that, in Chapter 5.2, the challenges of collaboration and the barriers that hinder it are explained. In Chapter 5.3, the ways the organisations can be stimulated to participate in the collaboration network are described, along with different motivations and stimulation methods. In Chapter 5.4, the important components of collaboration mentioned during the interviews were explained to emphasise what the participants find important in a collaboration. Lastly, in Chapter 5.5, the current process of SSRV is explained from the perspective of the interview participants. Chapter 5.6 provides an overview of the instances of the interviews that are the key findings.

5.1. The renewal task

To understand how collaboration can be stimulated, it is essential to understand the renewal task and why it is becoming a problem for which collaboration could be a solution. In the problem statement in Chapter 1.2, the issue was already explained through the research from TNO, but here, the problem will be elaborated on again with the insights obtained from the interview participants. In this section, the renewal task will be explained from the perspective of the interview participants. It will be about what the task entails, why it is becoming a problem, and why collaboration is necessary for this.

The participants in the interviews all had knowledge of the problem and provided different reasons why it was a problem, as well as the aspects that contributed to it. The problem here is that the renewal task is becoming so large, making it very hard for organisations to tackle it on their own. There are multiple reasons why this is becoming too difficult and these will be explained later. Participant 4 described the problem as:

“[Through the taskforce], we actually saw that the task ahead of us in the field of civil constructions is so substantial that we could not actually handle it alone, and you should not take alone very literally, but rather that the impact on the infrastructure is so extensive that it affects many parties.”

The impact of the task and the infrastructure is described as very extensive, affecting many parties, which makes the task even more complicated. The more parties involved, the more complex a problem can become, and the methods of solving it can also become more complex. However, one of the reasons the renewal task is becoming a problem is that there are fewer people that are able to work on it, and there are other tasks for which people are necessary, such as the energy transition. Participant 6 described the following:

“So you can see that we are also facing competition from the other transitions. So aside from the fact that these organisations already have fewer people internally, they are also occupied with other matters. So yes, it seems that on all fronts, the capacity to find solutions is decreasing, while the

challenges are only growing.”

As described, there are fewer people available for the renewal task. Due to ageing, many people are retiring, and there are fewer new individuals returning with the right education and knowledge. The engineering knowledge currently available is too little, and there are too few engineers to handle this problem. Participant 5 said about this:

“So in a way, it is actually a miracle that we have always managed to do it, but the combination of a shrinking workplace and the ageing of our entire asset base, which we now have to rebuild and replace, is, I think, becoming a real problem.”

The ageing and retirement of civil engineers also cause a significant loss of knowledge. A significant amount of knowledge is not being transferred when someone leaves the organisation because there is no replacement yet or the securing of the knowledge is not being done sufficiently. Participant 9 explained this as follows:

“There is a lot of ageing in the workforce; many people are retiring, taking their knowledge with them. Of course, you hope some of that knowledge has been secured within the organisation, but in practice, replacements are often lacking, so a great deal of expertise is simply lost and that is a real shame.”

Retirement is not the only way knowledge is being lost. Within organisations, especially smaller ones, knowledge is sometimes obtained by conducting research on how to renovate a specific, relatively unique bridge. It is possible that this type of bridge is the only one in the municipality, and therefore, there is no need to renovate a similar bridge in the next 20 years. In this case, this knowledge is not needed in this organisation for 20 years, so the information obtained through this research could easily be lost. However, there could be a similar bridge in another organisation for which this knowledge can be very useful, but it is not shared because it is located in another organisation, and these organisations are not aware that the same problem is present in both organisations. This can lead to doing the same work twice, which is very inefficient. In addition, investing in research can almost be described as a waste of time and money if it is only used once. This example was given by participant 10, who mentioned:

“I know it is difficult because we are all employed by individual provinces and municipalities that each function as its own entity. But we also tend to retain knowledge strictly within our own municipal boundaries. I believe there is still room for progress here; we should work towards making knowledge and capacity more broadly accessible.”

Additionally, the sector is working project-orientated, which means that the focus will be only on a project and not a larger task. This difference was already described in the literature in Chapter 3.2.1. By working project-orientated, the knowledge obtained during the project will likely be lost after the project. Participant 7 explained this:

“What I have noticed is that our sector has a rather poor capacity for qualitative learning. We are very project-orientated, and once a project ends, not only does the organisation dissolve, but also a significant part of the knowledge disappears with it.”

The interview participants have all mentioned and recognised the growing task; however, not all participants have chosen to join the SSRV collaboration initiative because of the growing task. Participant 11 mentioned that for their organisation, the main reason was the sharing of knowledge and building a network with municipalities and organisations around them, which can be helpful when they encounter, for example, a problem they have not encountered before or a type of tender they are not familiar with. By joining a network, it becomes easier to make connections, ask questions, and learn from one another.

So, to conclude the problem in short:

- The renewal task is getting larger, but the manpower is decreasing due to ageing and fewer civil engineers.
- Knowledge is being lost, and trying to regain it costs time and money.
- The sector is project-orientated, which causes knowledge to disappear after a project is completed.

- The reason for participating in the collaboration is not only to tackle the renewal task together but also to share knowledge and build a network to ask questions and learn from each other.

5.2. Challenges and barriers to collaboration

In the literature review, some challenges and barriers to collaboration have already been discussed. The key findings of the previous literature included unclear goals, weak management, differing stakeholder requirements, a lack of trust, and relationship issues. In addition, cultural and behavioural differences were found to be important components to consider in a collaboration. From the interviews, some of these challenges came up and were discussed, and additional challenges were also explained. The challenges highlight the reasons why organisations may be reluctant to participate in the collaboration and what hinders a collaboration.

First of all, infrastructure asset managers are usually already very busy and view this task as a problem for the future or something they do not have time to consider, so a solution is simply to break down the whole object and build a new one. This saves time by avoiding the need to research the state of the object and explore whether it may only require renovation, which can be done efficiently with other bridges within the organisation. Especially smaller municipalities do not have time to execute this research due to other tasks that also need to be done. Asset managers in smaller municipalities often have multiple tasks and are also responsible for other management in the public space. During the interviews, some participants described a little reluctance from asset managers and the organisations involved. Participant 10 explained that they were trying to convince their asset manager to go to a workshop with other municipalities to get to know each other. This asset manager was not easy to convince because his focus was on the tasks that were needed to be fixed now, and looking into the future and forming a network was not a priority. Participant 10 mentioned:

“I do notice that I find it difficult to motivate him, he is enthusiastic about the initiative, but his focus is mainly on the here and now rather than looking ahead.”

What is found to be difficult here is that it takes time at this moment, but it will save a much time in the future. Different participants mentioned different comparisons that explained this problem. Participant 7 illustrated:

“It always reminds me of the story of the lumberjack [...]. A lumberjack is chopping wood in the forest when a passer-by stops and watches for a moment. He then taps the lumberjack on the shoulder and says: ‘You know, I have been watching you for a while, and I think you should sharpen your axe; it would make your work much more effective’. To which the lumberjack replies: ‘I really do not have time for that; look at how many trees I have to cut down!’”

By taking a little time to sharpen the axe, the work would be much more effective. The problem is that asset managers do not take the time to sharpen their axe, even though it can save time in the future. Additionally, taking the time to explore a collaboration, such as the SSRV initiative, can sometimes be difficult for people in organisations. Especially for smaller municipalities, it was found to be challenging to find time to consider whether a collaboration would be beneficial for them. Asset managers sometimes have more than one function and are responsible for many other tasks within the organisation. Asset managers have to be pushed by their management, which means that the municipality's management also needs to be convinced that the collaboration is beneficial.

Another challenge identified in the literature and frequently mentioned in the interviews was the lack of a relationship between the people or organisations that are supposed to work together to tackle the renewal task. One of the key components of collaboration is trust, and when people do not know each other, trust cannot be established, which needs to be built. So, in a collaboration, the first step is to get to know each other. Within Noord-Holland, the lack of knowledge about other asset managers was shocking. Participant 6 explained what he had witnessed during one of the first meetings to get to know each other:

“Then there was the asset manager from municipality 1 and the one from municipality 2, and they shook hands, and it turned out they had never met before, even though their municipalities are right next to each other. And that is when I thought, wow, is this really where we stand? They have both worked there for five years and had never crossed paths. I found that quite shocking.”

Not knowing the other asset managers or people in organisations close to yours is a significant barrier to collaboration and is crucial to overcome when creating an effective collaboration. When this relationship is formed, it can be easier to work together on tasks such as the renewal task. However, something else that can be difficult, even when a relationship is formed, is losing autonomy. Each organisation is responsible for its own assets and has the right to decide what will happen with these assets and when. It is also a legal responsibility for the organisation. All participants explained that this is a problem and how it can be difficult to give away this autonomy. Some explained that this is not even possible because then other organisations get to make decisions about their assets and maybe even their money. Participant 10 mentioned that this is not possible because it is the responsibility of the alderman of the municipality:

“The alderman can not get away with saying: ‘I have handed it off, it is no longer my responsibility, it is with the province, or it is part of a collaboration.’ No, sorry, alderman, you are still accountable.”

Giving away autonomy is, for most organisations, a large barrier to joining a collaboration. Municipalities want and need to be in charge of their organisation and cannot simply let another municipality or the province control their assets. Municipalities have their methods of operation and rules, and they might not want to let this go. Participant 9 said about this:

“It is a bold step to let go of your own domain, your municipal rules or established ways of working, and to enter into a collaboration with another party.”

In the literature, it has been found that cultural and behavioural differences must be recognised in a collaboration. The different ways of working and the rules in various municipalities can serve as examples of cultural or behavioural differences that need to be taken into account when designing a collaboration. When this is not the case, organisations can be reluctant to join a collaboration, which creates a barrier to collaboration.

For municipalities, this aligns with their plans for when they want to work on their assets. In the event of collaboration, and a plan will be made for when each asset of specific municipalities is going to be renovated, and when something urgent and unplanned happens in a municipality, the concern is how flexible this planning is and if it is possible to make changes in this plan. Participant 4 said about this:

“If you agree together that municipality 1 will replace a bridge in August, because municipality 2 is scheduled for July and something else is planned in municipality 3 for October, then what happens when something unexpected comes up in your own municipality? How much flexibility do you still have to adjust the planning, to shift things around, and so on? How much control do you really retain over certain aspects in your own city? That is still quite uncertain.”

So, to sum up, the main barriers and challenges that hinder collaboration are:

- There is a lack of time for asset managers to consider collaboration and participate in a collaboration.
- There is a lack of a relationship between the asset owners.
- The people in the organisations do not know each other, which results in a lack of trust.
- It is not possible for organisations to give away their autonomy because it is their legal responsibility.
- There is uncertainty about how the collaboration will be structured and handled.

5.3. Stimulation of the collaboration

The first thing that is important in the SSRV initiative is that the collaboration will not be forced, but the goal is to stimulate participation in the collaboration. The collaboration is described as voluntary but not entirely free of obligation; however, the organisations will not be compelled to join the collaboration network but rather stimulated to do so. In this part of the results chapter, how this can be stimulated will be explained. In the literature chapter, stimulation has not been discussed yet, so there is not really a clear comparison to make. In the framework of Ansell and Gash (2007), they did mention the starting conditions that can be incentives or constraints in a collaboration. A power imbalance could be a constraint to joining a collaboration. When stakeholders do not have the same capacity or resources

in the collaboration, this can lead to manipulation by the stronger parties. In the interviews, some participants expressed concern that the larger parties in the SSRV initiative, such as the province of Noord-Holland and Rijkswaterstaat, would decide what would happen and when. Participant 10 mentioned:

“We should not end up in a situation where the province decides what we do, how we do it, and when we do it.”

However, most participants have mentioned that within the initiative, all organisations are treated equally, and this has a significant influence on being part of the network. Participant 10 also mentioned that equality between organisations is crucial for collaboration in renovation and replacement projects. For the question of what the key was for a successful collaboration, the answer was repeatedly that it is important to keep seeing each other as equal partners. Participant 10 explained that they thought that the way the initiative is structured currently is nice and open, and it is possible to contribute in the way you want; they said:

“We need to make sure that everyone works together based on equality. And I have to say, the province has done well in that regard; they took initiative but also acknowledged that they are by no means the largest asset manager of civil structures or infrastructure in Noord-Holland. In fact, they have taken a step back and allowed the municipalities to take a more prominent role.”

When discussing this concern with participant 12, who is not part of an organisation of Noord-Holland, they mentioned that they understand the concern but do not see it happen directly. They explained that the current way the network is built can actually be useful for taking concrete next steps. The larger parties are more focused on processes and facilitating collaboration and action, while the smaller parties are more focused on taking action. They are more flexible, can act on initiatives faster, and implement new ideas more easily. They explained it as a dynamic game:

“So that dynamic, I actually see it as a valuable enrichment: having both the more action-orientated doers and the more process-focused thinkers. I believe you need both to truly become smarter in how you work. And the acceleration, in the end, comes through doing.”

Therefore, it is essential in a collaboration for renovation and replacement projects to treat each other equally and utilise each other's strengths. This is important to show to organisations that are not yet involved in the collaboration, as a demonstration that it is easy to join, and also for the organisations already involved to continue being part of the collaboration.

The thing that every participant mentioned when asked what would stimulate other organisations to participate in the collaboration was showing results. The initiative is relatively new, so there are no large achievements to show yet. However, according to the participants, small successes also need to be shared. Showing successes can make other organisations enthusiastic about the collaboration and convince them that this is something they want to be part of and contribute to. Participant 8 explained that there are two sides to showing concrete successes:

“One aspect is showcasing a success that others can adopt. Learning from each other and sharing knowledge. But what we also try to demonstrate in the implementation plans is the added value of truly working together. So it is not just about sharing but about actually doing things together.”

Sharing the successes is valuable in collaboration because other municipalities can learn from them, but also, by showing the successes, the other municipalities know which organisation they have to contact to ask questions. The participants in the interviews, who are part of an organisation in the province of Noord-Holland, all mentioned that a significant benefit of the collaboration was that they could share knowledge with other municipalities and ask each other questions. In the initiative, the Bridge Brigade was founded, a network of asset managers in Noord-Holland where they meet and share their knowledge. It is an approachable way, which has already proved to be a positive outcome of the initiative. As mentioned earlier, the asset managers did not really know each other well before the initiative, and now they believe it is very useful to get in touch more easily. Participant 9 explained:

“I also think there is much less need to constantly reinvent the wheel. If you have developed something for a specific asset and you share that knowledge, others can either build on it or apply it

directly. There is no need to consult the market again for the same research, the same inspection, or the same calculations. So I believe there is a great deal to be gained from sharing knowledge."

One of the concrete successes that are already being shared are maps of the areal in Noord-Holland and the municipalities. These maps consist of data from the municipalities on the locations of their bridges and when they are planned to be renovated or replaced (in case there is a plan for this). One of these maps showed what would happen to a specific part of a municipality when, for example, a bridge went out of use because it was being renovated. This demonstrated how well this part would remain accessible and how it would be reachable. One of the participants said that in their organisation, the management team was aware of the collaboration, but there was not a great deal of interest. However, when a presentation was given, and the maps were shown illustrating what would happen with the accessibility of the city, there were many more questions and thoughts. Participant 4 said about this:

"I have talked about SSRV several times already. People find it interesting, some ask a follow-up question, but most just nod and move on with their own work. But this time, I gave a presentation that included the maps, showing things like accessibility, what happens to the accessibility of a neighbourhood when a bridge is out of service, for example. [...] And then you notice a shift, they start asking questions. Because while it may seem to be just about civil structures, which it is fundamentally, but it also affects the accessibility of the city."

This indicates that when something is visible, interest will grow, which can stimulate other organisations to participate in the collaboration and also convince the management of a municipality to support the collaboration and invest time and money in the initiative.

Another benefit mentioned by some participants in the interviews is that the organisations can learn from each other. This is in line with sharing knowledge with other organisations. When, for example, one of the municipalities lacks knowledge on how to handle a specific tender, another municipality can demonstrate its approach and, in a way, teach this method to the other municipality. Other organisations can learn from the knowledge obtained by others and apply it in their organisations. Participant 7 said about this:

"And that there is a genuine effort to explore each other's approaches: How did you handle it, how did I handle it, and what can we learn from each another?"

Participant 6 also mentioned that they see this happening more frequently due to the connection of asset owners because of the initiative. The asset owners are also more willing to learn from each other, and this did not happen much before collaboration was being explored. Participant 7 mentioned that because the sector is working very project-orientated, this learning ability is relatively low at this moment, but by collaborating, this can increase a lot.

Some participants described the stimulation of the collaboration as an oil slick that spreads further and further. By showing success, more people are encouraged to contribute to the network. Additionally, people bring others from their organisation to workshops to meet other people and share knowledge. If the initiative and its plan inspire these people, they can bring in even more people, and the collaboration spreads out. This works, for example, within a municipality as well as with neighbouring municipalities. Participant 11 explained:

"I have not yet experienced that individual members are asked: 'Hey, could you give your neighbour a call? Do you know them, and could you maybe convince them to join the group?' That might actually be something to consider."

By asking members who are already part of the network to bring other people from their organisation or those they know who might benefit from the collaboration, it becomes more approachable for them to attend a workshop or meeting, as they already know someone and there is no pressure. Participant 11 also mentioned that in their organisation, there was a new asset manager who did not have experience with this function before. They explained that for this asset manager, the network was beneficial in learning from others how to handle certain things without having to do it alone. This is another reason why organisations could want to join the collaboration.

Something that was mentioned in almost all the interviews as a factor that would stimulate the participation of organisations in the collaboration was that it should be appealing. A principle that was

mentioned multiple times was the FOMO principle, which stands for Fear Of Missing Out. This means that organisations should be “afraid” that they will miss something that would be very useful to be part of. Participant 10 said about this:

“At one point, we even used the term FOMO; it should be so appealing that you simply do not want to miss out.”

The maps with the data that were previously mentioned are also part of this. By showing organisations what sharing their data could lead to, they might be more likely to share their data as well. And, if they do not have this data, they might search within their organisation and try to gather their data together so they can also be part of the maps and make use of them.

Another way to make it more appealing is to make it easy to use. It should be easy to join the network, and there should be no constraints, especially in the beginning. Also, if future obligations arise, these should also be relatively easy. For example, participant 11 explained that if, in the future, a financial contribution is needed and the municipality’s management needs to approve it, it can be difficult or require a large effort to write this proposition. They gave an idea:

“Try to facilitate this as much as possible so that someone does not think: ‘Oh no, I have to write a formal policy proposal, which I have never done before and do not know how to approach, I will just say that it is too complicated in our organisation and rather step back.’”

For example, by providing a template for a policy proposal, it becomes easier for asset managers to adapt it to their municipality rather than having to write one from scratch. This saves time and makes the process more efficient, which can increase the likelihood that they will follow through.

So, to summarise the main points on how to stimulate the participation in the collaboration:

- It is important that the collaboration is stimulated and not forced or mandated.
- The organisations in the network should be treated equally; this encourages participation in the collaboration.
- Showing concrete successes, even small ones, helps to stimulate interest and involvement in the collaboration.
- Sharing knowledge is perceived as a key benefit of the network. It allows organisations and their asset managers to learn from each other and help each other.
- Sharing knowledge also means the involved organisations can learn from each other and teach other organisations about specific knowledge.
- The collaboration spreads organically. Already involved members can bring their colleagues or neighbouring municipality asset managers to join the network, making it more approachable.
- Joining the network must be appealing to encourage participation. Here, the FOMO principle is mentioned as being used. Other organisations should want to be part of the network.
- It has to be easy to join the network, and future contributions should be as simple as possible to ensure that people do not back out of the collaboration due to an excessive workload.

5.4. Important components of collaborating

In the literature in Chapter 3.2.2, factors that influence a successful collaboration were identified. The key points were that trust and transparency are crucial for a successful collaboration, early involvement in a project sets a foundation for success, and setting goals is essential for alignment. From the interviews, components were also described that are important in the collaboration among the participants. Some of these align with the findings from the literature, but also new findings were discovered and will be described in this chapter.

The first component that is crucial in collaboration, and which was mentioned by almost every participant, is trust. In the literature, trust was mentioned as a key component in collaboration. Without trust in the other people in the network, sharing data and knowledge can be hindered because organisations are afraid to share it or do not want to open up completely, but first, wait and see what happens. Participant 8 explains why it is important for organisations to build a relationship first to build this trust:

“I think it is important to invest heavily in building connections during the initial phase. That mainly means getting to know each other because once you do, you start to understand what others bring to the table, and you begin to build mutual trust. [...] When someone comes up with a smart solution, you are not likely to adopt it just like that. It is much easier to do so when there is a foundation of trust and familiarity. That is why investing in a connection from the start is so crucial.”

Getting to know the other organisations is very important in building trust. The development of trust is difficult because it takes time and is very personal. Trust cannot simply be imposed on people or organisations but it needs to grow. The development of trust can be stimulated by, for example, doing things together and having informal meetings. This is not the only thing mentioned in the interviews. When the initiative began, two people from the province of Noord-Holland visited all municipalities to discuss their problems and the renewal task they might have ahead of them. This showed interest and made municipalities feel seen and heard, which was the right step in building the network. This made it easier for municipalities to come to the first meeting and get to know the other interested parties. Building trust also takes time and is not established after a single meeting with other organisations. The meetings with other municipalities are perceived as a nice and informal way to get to know other people and slowly build trust. When asked what will help to build trust, participant 9 answered:

“I think the low threshold approach is especially important, as well as the visibility of SSRV. SSRV has been at many events, [...]. By showing up and continuously demonstrating progress, step by step, you create visibility and show tangible results. That helps organisations see the value for themselves and encourage them to contribute. I also believe that personal contact plays a key role, [...], which likely also lowers the threshold for others to get involved.”

This low threshold approach is crucial for initiating a collaboration, especially for the renewal process. As the people in the municipalities are already very busy, joining the network must be perceived as easy. To prevent participants from leaving the collaboration, it was explained that there should not be too much pressure and mandatory activities and tasks. This can cause people to get too busy and drop the collaboration, as it might not be their priority.

Another important component of a collaboration is the energy that will be invested into the collaboration. This can be perceived in different ways. First, the people involved in the collaboration or attending meetings should have the right energy to want to meet others and invest in the collaboration. Participant 4 explained that at the beginning, it is useful not to send the exact right person to the meetings, but rather to send the people who are more extroverted and can get into contact with external people more easily. They said:

“At the start, put the right people in position, not necessarily those with the most knowledge, but those with the most energy.”

Another perception of energy is that participants must put in energy in the collaboration network. The network will not work or work slowly when the participants involved do not take action and wait and see where the collaboration will take them. Participant 5 explained:

“It does take energy to get things off the ground, but it really comes from a sense of intrinsic motivation.”

Participant 1 gave an example of an automated system. A lot of energy has to be put in to get it working, but when it does, it will pay off all the effort. They said:

“I always compare it to setting up an IT system, you have to invest a lot of energy up front to get it working. But once it is running at 75 or 80% capacity, it starts to pay off on its own. The problem is that we often do not allow ourselves the time to reach that point. And that is understandable because we have to keep moving because tomorrow I might be facing an urgent issue with the structural safety of a bridge.”

This is a problem in collaboration that was mentioned earlier, which is that there is a lack of time. When people in organisations do not have the time to invest in collaboration, it will not work most efficiently. Moreover, it takes time, but this will eventually pay off if the collaboration network works successfully.

The last component crucial in collaboration is communication. Communication between the various participants in the collaboration, as well as communication with and from the initiators of the SSRV

initiative. Currently, there are no rules or conditions yet to join the network, except that the asset owners should be part of the province of Noord-Holland and manage bridges or viaducts. However, the collaboration is voluntary but not without obligation. This means that there are expectations, and if an organisation cannot follow through on these expectations, they should communicate this clearly. Participant 12 explained:

“Ideally, you want to avoid a free-riding situation, where parties join in name but do not actively contribute. Unless, of course, that is the starting point: if you are a smaller municipality with limited resources, no money, no staff, but you benefit greatly from the outcomes, that is perfectly fine, as long as that is agreed upon upfront. In that case, it is entirely acceptable.”

The same applies to communicating about the actions that result from the collaboration. An example that was given here multiple times was that when a particular bridge of a municipality is planned to be renovated in a few years, but the same type of bridge of the neighbouring municipality is planned earlier, there can be made agreements that one of them will be renovated earlier or later so they can do it together and more efficiently. By sharing the data on their assets, this can become clear, and then the municipalities can communicate with each other and reach agreements. This is not possible without clear communication and also without data sharing.

So, to summarise the important components of a collaboration:

- Trust is considered one of the most important components of a collaboration. Without trust, organisations can be less willing to share knowledge and data. Trust can be built by developing a relationship and taking the time to get to know one another.
- Showing interest in organisations makes them feel heard and makes them participate in the collaboration more easily.
- Putting the right people in with the right energy can help build a collaboration; this does not have to be the person with the most knowledge.
- Putting in energy is necessary for a collaboration to work.
- Communication is essential in a collaboration. This should be communicating about how much the asset owners can contribute to the collaboration and communication between asset managers to see if they can work together on tasks.

5.5. The process of SSRV

In Chapter 4, the “Samen Slimmer Renoveren en Vervangen” (SSRV) initiative was described and the participants of the interviews were introduced. During the interviews, the process of SSRV was also explained by some of the participants, so in this subchapter the findings about the process of SSRV will be explained to provide a deeper understanding of how the collaboration network has been built in Noord-Holland.

The initiative began with participant 2 and participant 7 visiting all the municipalities in Noord-Holland to discuss the renewal task before them and find out if there was a problem and what the asset owners considered the most significant problem in this task. Participant 7 explained that asset owners can be divided into different levels: political, strategic, tactical, and operational. They wanted to talk to the operational level because they understand the issues best that they are facing with their assets. They perceived that the initial response was positive because they thought the municipalities appreciated that the province showed genuine interest in what they believed was a problem; participant 7 said:

“That is exactly what strengthens the approach, by engaging with genuine interest and sincere questions, not with preconceived notions like ‘you are probably not doing it right’ or ‘you must have a problem’. Instead, it is about truly asking: ‘What keeps you up at night?’, ‘What is on your mind’, ‘How do you see the future?’”

That was the first step of the initiative. After that, the next goal was to connect the organisations and asset managers. This was done by organising a festival for all the municipalities and different other meetings where all the asset owners could go, to meet the other organisations, as explained already in the previous chapter. This was the start of the first phase of Connecting. The organisations that wanted to participate differed from each other. Some municipalities with a large number of infrastructure assets

are more eager to participate because they have a large task ahead of them. However, some of these municipalities have it more under control and have less need for collaboration. On the other hand, municipalities with fewer infrastructure assets can also view the task as less daunting because they do not have a lot of infrastructure, which makes it easier to manage. However, these municipalities are likely smaller and have fewer people, and thus less knowledge, which can make it beneficial for them to participate in the network, as they do not have to handle it alone. So, the willingness to participate differed per municipality, its size, and the number of infrastructure assets.

The initiative began two years ago and is slowly growing in terms of the number of participants and actions resulting from it. The goal of the initiative is to play a facilitating role that connects organisations and can help with, for example, issuing a call for tenders together. Participant 9 said about this:

“I see it more as a facilitating role and a platform that creates awareness: this is what is coming up. Maybe there is an open invitation or outreach like, ‘Would you like to join?’ And then the organisation or the board can decide case by case: yes in this instance, no in another. That makes it so much more non-committal, and I believe it increases the chances of success.”

Currently, there are no rules or conditions to join the network, except that you should be an organisation in the province of Noord-Holland and should be an asset owner of bridges or viaducts. In the future, this might change, for example, when maybe a financial contribution is necessary for the network to continue. It was explained that as they proceed further into the process, additional agreements may need to be made. This is difficult because it is essential for participants to remain part of the network, but when there are too many agreements, it could scare them off if the process is moving too quickly. It was described by two participants that there should be a balance, which can be complicated to maintain. Participant 7 explained:

“So, on the one hand, do not move faster than the asset managers can keep up with, but on the other hand, try to maintain momentum and prevent things from losing steam. It is really about finding the right balance.”

Participant 12 mentioned that maintaining a balance is also difficult in terms of showing successes. They said:

“We are at a point where we need to take steps that clearly demonstrate success, that show in concrete terms what can be achieved when you do choose to collaborate and are willing to make some concessions in autonomy in order to move forward together. [...] At the same time, we have to be careful not to aim too high, [...], because then it may fail or parties may disengage. So it is a delicate balancing act: identifying where the real potential lies, spotting promising initiatives that can truly take collaboration further, bringing the data together in a meaningful way.”

There have already been achievements where the collaboration and facilitating role of the SSRV initiative have worked positively for the asset owners. The tooth-ridge construction has been in the news frequently, which has raised questions. SSRV informed all asset owners about the construction and what the problem was. A webinar was held, where everyone could obtain the necessary information, and everyone was informed very quickly. Participant 12 described it as:

“Quickly bringing everyone back to the same level of knowledge, that never really happened before. Of course, these are not revolutionary steps, but they do show that tangible progress can be made simply through collaboration.”

This shows a way SSRV can be used in a facilitating role to help the asset owners in Noord-Holland.

5.6. Overview of the instances

In this last subchapter of the findings, an overview of the instances is shown in Table 5.1. This table provides an overview of all the key findings per subchapter, categorising the findings by theme. First, an explanation of the themes will be given.

In the conclusion of the literature review in Chapter 3.4, a research gap was identified consisting of four key points. These points are the basis for the themes in which the instances are divided. However, not all instances fit correctly into these four themes, so two additional themes are included in this list. These have been chosen because these two themes can divide the instances that do not refer to external collaboration or specifically relate to the case in which the instances were found. The themes in which the instances are defined are as follows:

1. **Building trust and transparency.** Trust and transparency were identified as important components in both the literature and the interviews. The instances demonstrate how this can be built and what is important for it.
2. **Aligning goals for organisations with different interests.** A collaboration between different asset owners is complex because it involves different interests and goals. The instances show important components for this.
3. **Key challenges of renovation and replacement projects.** These instances highlight some of the key challenges specific to the renewal task and why it presents a problem.
4. **Stimulation of collaboration.** This theme highlights the key benefits of collaboration and provides strategies for stimulating organisations to participate in a collaborative network.
5. **Internal dynamics of an organisation.** These findings demonstrate how the internal processes of an organisation can impact collaboration and the willingness to participate. This theme was added during the coding of the interviews.
6. **Case specific insights.** Some of the interview findings were specifically about the SSRV initiative in which the interviews were conducted. That is why this theme was added during the coding.

Table 5.1: Overview of instances and themes

#	Instance	Theme
The renewal task		
1	The renewal task is getting too big, and it is getting harder for organisations to tackle it alone	Key challenges of renovation and replacement projects
2	There are fewer people to work on the problem due to less civil engineers and other transitions	Key challenges of renovation and replacement projects
3	Many people are retiring, and fewer civil engineers are coming back	Key challenges of renovation and replacement projects
4	There is less knowledge, and the knowledge is being lost	Key challenges of renovation and replacement projects
5	Information is not being shared, which leads to doing the same research twice	Key challenges of renovation and replacement projects
6	The sector is project-orientated	Key challenges of renovation and replacement projects
7	A significant reason for joining the collaboration is building a network and sharing knowledge	Stimulation of collaboration
Challenges of the collaboration		
8	There is no time for asset managers to think about what the benefits of a collaboration could be and what they have to do with their infrastructure	Key challenges of renovation and replacement projects
9	Asset managers of smaller municipalities often have multiple tasks and are also responsible for other things in the public space	Key challenges of renovation and replacement projects
10	Asset managers can be less enthusiastic about the collaboration due to lack of time, so it can be harder to stimulate them to go to workshops	Internal dynamics of an organisation
11	Investing time in the initiative will save time later	Stimulation of collaboration
12	There are multiple layers of an organisation that have to be convinced about the collaboration	Internal dynamics of an organisation
13	A relationship has to be built to build trust	Building trust and transparency
14	The asset managers do not know each other	Building trust and transparency
15	Organisations want to keep their autonomy as this is a legal responsibility	Aligning goals for organisations with different interests
16	The municipalities want and need to be in charge of their organisation with their method of operation and rules	Aligning goals for organisations with different interests
17	How flexible is the planning in case of collaboration when something unexpected happens in a municipality	Aligning goals for organisations with different interests
Stimulation of the collaboration		
18	The participation in the collaboration will be stimulated and not forced	Case-specific insights
19	The organisations are treated equally	Stimulation of collaboration
20	It is possible to contribute in the way that the organisations want without judgement	Stimulation of collaboration
21	Large parties are more focused on processes and facilitating action, while smaller parties are more focused on taking action and doing	Aligning goals for organisations with different interests
22	Sharing successes is a crucial way to stimulate other organisations to participate in the network	Stimulation of collaboration
23	Sharing data helps with knowing which municipality can be reached for questions	Stimulation of collaboration
24	The bridge brigade is an approachable way for knowledge sharing between asset managers	Stimulation of collaboration

#	Instance	Theme
25	Sharing knowledge is a significant benefit of the collaboration	Stimulation of collaboration
26	Showing concrete successes to management teams can convince them about the collaboration	Stimulation of collaboration
27	Letting people bring other people to workshops and telling other people about the collaboration can help with expanding the network	Stimulation of collaboration
28	The network can be beneficial for asset managers who do not have a lot of experience	Stimulation of collaboration
29	The FOMO principle can help stimulate organisations	Stimulation of collaboration
30	Joining and being part of the collaboration should be easy and approachable	Stimulation of collaboration
Important components of collaboration		
31	Trust is a key component in collaboration	Building trust and transparency
32	When there is no trust, organisations might wait and see instead of actively contributing	Building trust and transparency
33	Building trust takes time	Building trust and transparency
34	Meetings with other organisations are perceived as a nice and informal way to get to know each other	Building trust and transparency
35	A low threshold approach is crucial	Stimulation of collaboration
36	Put in the people with the right energy instead of the right knowledge to start building the network	Internal dynamics of an organisation
37	The network will not be successful when there is no energy put into	Internal dynamics of an organisation
38	Communication is key in collaboration	Building trust and transparency
39	Asset managers have to communicate if they do not have much time to participate but still want to be involved in the network	Internal dynamics of an organisation
40	Asset managers have to communicate about doing tenders together	Building trust and transparency
The process of SSRV		
41	Engaging with genuine interests and no judgements shows asset owners that they are being heard, and this strengthens the approach	Building trust and transparency
42	The willingness of the organisation differs per organisation	Internal dynamics of an organisation
43	SSRV has a facilitating role in the network of collaboration	Case-specific insights
44	Currently, there are no rules or conditions in the initiative; this can change when further in the process	Case-specific insights
45	Having more conditions could scare off the participants when it is going too fast	Case-specific insights
46	It is important to keep the balance between keeping momentum and not going too fast	Stimulation of collaboration

6

Analysis of the findings

In this chapter, the analysis of the findings will be explained in different parts. First, the sources of the findings will be explained in Chapter 6.1. This will indicate whether the findings were from the literature review or the interviews, or if they were mentioned in both. In Chapter 6.2, a comparison between a voluntary and mandated collaboration is given and the key components for each type will be explained. In Chapter 3.1, a collaboration for a renovation and replacement task is specified and it will be explained what is especially important in such a collaboration. To connect this with the SSRV initiative, in Chapter 6.4, the connection between collaboration, the renewal task, and the SSRV initiative is explored. For the initiation and development of an effective collaboration between asset owners, is a process description of five steps provided in a model in Chapter 6.5. The strategies for this are explained in Chapter 6.6. In Chapter 6.7, the place of the SSRV initiative in the framework is explained. Lastly, a short validation of the findings is given in Chapter 6.8.

6.1. Different findings from literature and interviews

In the articles from the literature review, some key findings on collaboration were mentioned. From these key findings, some were also mentioned in the interviews, but not all. Additionally, new findings were discovered during the interviews. In Table 6.1, the sources of the findings are indicated.

Table 6.1: Key findings from literature and interviews

#	Key findings collaboration	Literature	Interviews
1	Trust is crucial for a successful collaboration	x	x
2	Transparency is important in a collaboration	x	x
3	Early involvement of stakeholders sets a foundation for project success	x	
4	Setting mutual goals is important for alignment in the project	x	x
5	Collaboration requires structured governance	x	
6	It is important to involve participants in the decision-making	x	x
7	Communication is crucial	x	x
8	Lack of trust hinders collaboration	x	x
9	Information asymmetry is a large bottleneck	x	
10	Success of collaboration is dependent on leadership	x	
11	Cultural and behavioural differences need to be recognised	x	x
12	Organisational misalignment can hinder collaboration	x	x
13	Knowledge asymmetries can cause problems	x	x
14	Norms for infrastructure asset characteristics can be defined differently	x	
15	Participants in a collaboration have to be treated as equal	x	x
16	Collaboration should be stimulated, not forced		x
17	Showing successes can stimulate participation in the collaboration	x	x
18	A collaboration network can grow organically when involved people bring others to the meetings to join the network		x
19	It should be appealing and easy to join the collaboration		x
20	Lack of a relationship hinders collaboration	x	x
21	Using people with much energy can build a collaboration. This does not have to be the person with the right knowledge		x
22	Energy is needed for a collaboration to work		x
23	An important benefit is sharing knowledge	x	x
24	Lack of time hinders a collaboration		x
25	Learning from each other is a large benefit	x	x

The first finding that was not in both research methods is that the early involvement of stakeholders sets a foundation for project success. The interview participants did not specifically mention this. However, it was mentioned that showing interest in the involved parties would be a good start in setting up a collaboration. The next key finding is that collaboration requires structured governance. This was also not mentioned in the interviews. The initiative does have a structured governance to work on building on the collaboration, but none of the participants mentioned that this is required for collaboration. The collaboration from the initiative is voluntary and there is no hierarchical structure to facilitate it, which is also why the finding that the success of collaboration is dependent on leadership is not mentioned in the interviews. In the literature, information asymmetry is mentioned as a significant bottleneck. During the interviews, this was not explicitly mentioned. However, sometimes, the participants were not informed about some of the future plans and how to continue. The finding from the literature that norms for infrastructure asset characteristics can be defined differently was not mentioned in the interviews. It was mentioned that some asset owners do not have complete data about their infrastructure assets, which can hinder data sharing and make it difficult to determine the state of the asset. A significant component in stimulating collaboration from the interviews was that it should be encouraged and not forced; however, this was not supported by the literature found for this research. Also, how a collaboration network is being built, was not something that came back in the literature review. Both the finding that a collaboration should spread out organically and that it should be appealing to join were, however, mentioned in the interviews. This corresponds with the type of people who are useful for building a relationship for collaboration. Although this was not mentioned in the literature, it did come up during the interviews. The finding that energy is needed for the collaboration to work was also not

mentioned in the literature. Lastly, the finding from the interviews that lack of time hinders collaboration was also not mentioned in the literature in the same way as it was in the interviews. In the literature, time is described as a resource that can be saved by collaborating, while in the interviews, the lack of time of asset managers is described as a challenge that hinders their participation in the network for collaboration.

6.2. Comparison of voluntary and mandated collaboration

The collaboration developed in Noord-Holland is on a voluntary basis. Municipalities and other asset owners can choose whether they want to participate in the network for collaboration. There is a distinction between a collaboration on a voluntary basis and a mandated collaboration. This has an influence on the factors that determine success and failure, as well as the way the collaboration is developed. It is essential to understand this distinction to identify the relevant factors for collaboration in large-scale renovation and replacement tasks. In a voluntary collaboration, the organisations decide to work together because they see a shared challenge and recognise opportunities in collaborating with other organisations, or view them as equal partners. The motivation for this type of collaboration is often intrinsic, and these collaborations often evolve organically by trust and relationships. A mandated collaboration is usually organised top-down and governed by a higher organisation, such as a province. This type of collaboration can lead to faster decision-making and is a more coordinated collaboration approach.

For a voluntary collaboration, some factors are more important than in a mandated collaboration. The first is trust; this has been mentioned before as an important component in collaboration, but for a voluntary collaboration, it is even more important. In this type of collaboration, there is less obligation, which means that the agreements made are based on trust. The organisations have to trust the others to participate as they have agreed, but there is not a way to control this. Ansell and Gash (2007) describe in their framework that if there is a history of conflicts and the stakeholders do not take extra time to rebuild trust, these stakeholders should not participate in the collaboration. This suggests that without trust, collaboration is very difficult to establish and may be destined to fail. Another important component is having a shared vision and goals. Collaboration is often built because organisations recognise a shared challenge, so their motivation to participate actively is determined by the goal that they have and share. One challenge of a voluntary collaboration is the lack of a clear structure for coordination. This can lead to larger parties dominating the smaller parties, or for the collaboration to become dependent on these larger parties, as also mentioned by some of the interview participants. This can be mitigated by making the collaboration easily accessible and highlighting the benefits, such as learning from one another and sharing knowledge.

A mandated collaboration, on the other hand, is often initiated by a policy or legal obligation and occurs when an external authority initiates and enforces a collaboration between organisations to achieve, for example, specific policy outcomes (Kim and Sullivan, 2024). This type of collaboration is structured as an effective tool for achieving goals and implementing policies (Ansell and Gash, 2007). There is often a more structured leadership and division of roles within the collaboration. With a clear definition of agreements and roles, it is evident to all involved stakeholders who is responsible for what. A key aspect of a mandated collaboration is that the involved organisations are convinced that the collaboration is both relevant and necessary (Hysing, 2022).

The collaboration of SSRV in Noord-Holland is on a voluntary basis, to build a network of asset owners that can together tackle the renovation and replacement task ahead of them. Connecting asset owners and building a relationship between them is a priority at the moment, as it helps to establish trust and enables organisations to get to know each other. There is also a structure within the collaboration with different roles. However, these groups do not decide which projects will be taken on by different asset owners, but rather explore how the collaboration can continue. Within these groups, the different asset owners are represented, so the collaboration is not mainly dominated by the larger organisations. On the other hand, the collaboration of the SSRV initiative was mentioned by the interview participants as necessary, and it is initiated because there is an urgency for it. The asset owners cannot handle the renewal task on their own so a collaboration is beneficial for this. They can choose whether they want to participate in the collaboration network, which makes it voluntary, but it is also a necessity, which could not make it voluntary.

6.3. Collaboration in renovation and replacement tasks

The renewal task in the Netherlands involves the renovation and replacement of numerous infrastructure assets owned by multiple asset owners. Renovation and replacement tasks involving more than one asset owner require a collaboration that differs from building a new asset. There are a few specific components that differ for renovation and replacement projects, some of which were also mentioned during the interviews.

First, renovation and replacement projects occur in an existing location where the asset is placed. This means that there needs to be more coordination and communication with other asset owners regarding disruption, timing, and diversions. Additionally, because assets of different asset owners can have different characteristics and lifespans, it is complex to renovate or replace them together. These differences must be communicated and transparent if asset owners decide to collaborate on the renewal task.

In the collaboration on the renewal task, multiple asset owners are involved, each of whom is in charge of their organisation and its assets, and needs to maintain their autonomy. By collaborating with other organisations, there is a significant concern about losing this autonomy. This fear is greater for renovation and replacement tasks because the existing infrastructure assets are owned by different organisations that cannot let go of their responsibilities. Additionally, with the renewal task, the parties in the collaboration have their own interests and goals for their assets, and cannot entrust another party with this responsibility.

As mentioned before, when comparing a voluntary collaboration with a mandated collaboration, trust is especially important in a voluntary collaboration because there is no obligation to participate; therefore, trust serves as the basis for the collaboration in renovation and replacement tasks. Without trust, no agreements will be made, and no knowledge or ideas will be shared. Building trust in renovation and replacement tasks can be achieved by continuously meeting each other, starting to get to know one another, and eventually building a relationship. This does take time because asset owners also have other responsibilities to work on. Also, by sharing experiences, for example, by executing a small task together, and honouring agreements that have been made, trust can be built.

Something else mentioned earlier as a significant benefit of collaboration is the sharing of knowledge with other organisations. This is especially necessary for the renovation and replacement task because there is a shortage of manpower, and knowledge is being lost as a result. This makes it even more important that knowledge is being shared. An organisation can have only one asset with special characteristics that requires research on how to renovate it correctly, but another organisation might have already conducted this research and can share its knowledge. This can save time and money and avoid duplication of work. This also corresponds with learning from each other.

Lastly, something that is especially important in renovation and replacement tasks is formulating a shared goal or vision. The voluntary collaboration is based on organisations coming together because they recognise a shared challenge. To keep all the organisations involved, it is important to formulate a shared goal and direction for which the collaboration is necessary. In the renovation and replacement task, different goals may apply and depend on the organisation involved and their interests and priorities.

6.4. Link renovation and replacement, collaboration and the SSRV initiative

In this research, three components have been examined: collaboration, the renewal task, and the SSRV initiative. In this subchapter, the connection between these three components will be explained, and the differences and similarities are mentioned.

The Netherlands faces a significant challenge in renovating and replacing a lot of its infrastructure over the next few decades. This infrastructure was mostly built after the Second World War and is now reaching the end of its life. The renewal task is large and complex, and there are many stakeholders involved. In addition to this, there is a decrease in manpower available to handle this task and knowledge is also being lost, which makes it even more difficult to take on this challenge as an infrastructure asset owner.

Collaboration can take on various shapes and sizes, and it has some general success factors and barriers that influence its success or failure. In the literature, these factors were identified, and some key findings on collaboration in general and collaboration in infrastructure projects were presented.

In response to the growing renewal task, the SSRV initiative was initiated to establish a collaboration between the asset owners of bridges and viaducts in the province of Noord-Holland. The initiative aims to connect asset owners in the province, enabling them to undertake the renewal task together and share resources and knowledge. It was explained that the collaboration between asset managers was a necessity, not a luxury, but it was still a voluntary collaboration, meaning asset owners are free to choose whether they want to participate.

The need for this kind of cooperation is supported by the prognosis report of TNO (2023), which describes collaboration as a strategy to handle this challenge more efficiently. In the province of Noord-Holland, this collaboration is being explored in the SSRV initiative. The reason why a collaboration is necessary became clear from the interviews, which primarily indicated that the renewal task is increasing, but the manpower and knowledge are decreasing. During the interviews, it was confirmed that organisations struggle to prioritise renovation and replacement because the urgency is not high, there are limited resources, and a lack of knowledge makes the renovation of an asset difficult, time-consuming and costly. In the literature, factors have been identified that are found to be important in collaboration, as described in Chapter 6.2 and Chapter 6.3, especially in voluntary renovation and replacement collaboration tasks. A couple of the key factors here are that communication and coordination are important between asset owners, trust needs to be built, and this takes time, there is a fear of losing autonomy, and it is essential to have a shared goal or vision.

Currently, the primary focus of the SSRV initiative is to connect the asset owners and ensure they get to know each other. This is the first step in collaborating, as it marks the beginning of building a relationship, which can eventually lead to the development of trust. This also leads to more communication between the asset owners. There are some important components for voluntary collaboration for the renewal task that are missing in the SSRV initiative. These findings emerged during the interviews and through an examination of the case documents, and were compared with the results from the literature on collaboration. These missing findings are explained here:

- **Uncertainty about decision-making and responsibilities.** Within SSRV, there is a structured governance that consists of the transition team, taskforce, core team, and individual organisations. This structure provides guidance on collaboration and strategic direction. However, there is sometimes a lack of clarity for individual organisations that are not part of one of the groups about what the next steps are and who is responsible for the decision-making on actions for the collaboration. These organisations can become reluctant to collaborate when there is uncertainty about what will happen to their assets.
- **Definition of concrete goals.** A key point emphasised in the literature is the importance of a collaboration having concrete and shared goals. In SSRV, a vision is defined to work toward a more efficient way of renewing infrastructure with the asset owners in the province of Noord-Holland, creating optimal conditions for collaboration. It would be useful to create concrete goals for asset owners that they can work towards and unite them. However, these goals can only be defined when clearer projects are defined within the initiative and asset owners can participate in these collaborative projects. At this stage, some example projects and goals can be defined to give asset owners an idea of what they are working towards.
- **Uncertainty about autonomy.** As mentioned earlier, the loss of autonomy is a significant concern for many infrastructure asset owners in this initiative. It is their legal responsibility to manage their assets, and it is not possible to let another organisation be in charge of these assets. Currently, there is uncertainty about how this autonomy will be handled, and asset owners want to have more clarity on this matter. When this is unclear, asset owners may be reluctant to participate in the collaboration.
- **Building a deeper level of trust.** The importance of trust in collaboration has been frequently mentioned throughout this research. SSRV began by building trust by connecting asset owners with one another and allowing them to get to know each other. However, to truly start a successful collaboration, it is essential that this trust extends not only on the surface but also deeper within

and between the organisations. The flow of people leaving and joining organisations is fast, which means that relationships between two organisations can easily be lost when someone leaves an organisation. By building trust that is not just between two people of two organisations, but also between the organisations, collaboration and relationships are more likely to be maintained. How this deeper level of trust will be built is not yet clear in the SSRV initiative.

6.5. Process description of developing a collaboration

Figure 6.1 provides an overview of the five steps involved in initiating and developing a collaboration. The steps describe who is involved in that step, what should happen, what challenges can come up and how to overcome these challenges. First, the steps will be elaborated on and explained. After this, an overview of the strategies for setting up a collaboration will be given in Chapter 6.6. The model provides a description of the process of setting up a collaboration between asset owners for a renovation and replacement task, in which many assets managed by different asset owners need to be renewed. From this collaboration, multiple separate projects can be developed.

The model was built based on the steps taken during the development of the collaboration for the SSRV initiative and the most important components of collaboration from the literature and interviews. The steps were formulated this way because they build collaboration in small steps, where the reason for collaboration is clear at the beginning, and an actual collaboration network is established at the end. The most important components of collaboration were trust, clear goals, and fear of losing control and autonomy, which is why these points are highlighted in the model. In the process of developing this collaboration, actions from the previous steps must continue to be executed. For example, it is essential to keep defining the problem to ensure it remains aligned for all involved organisations throughout the collaboration development process. The actions in the steps were partly identified based on the SSRV initiative and the findings from the literature. This applies to the challenges as well. The way to overcome the challenges was mostly found during the interviews.

1. Initiating:

Finding out what the problem is for a shared understanding

- *Who?*
At the start of the collaboration, large organisations are beneficial because they possess more resources. In addition to this, asset owners at different levels should be involved in this step to discuss what they perceive as a problem in their organisation in terms of renovation or replacement.
- *What?*
In this step, it is important to establish a shared understanding of the problem that may require collaboration, ensuring that each party has a consistent perception of the issue and understands the perspectives of the other parties involved. This can be explored by asking questions and looking into the problem. What is also important here is to explore what would happen when there is no action.
- *Challenges?*
A challenge is that the parties perceive the problem differently or not at all, making it difficult to formulate a shared understanding. In addition, a lack of time to investigate the problem can hinder the definition of the issue. For the renewal task, there can be uncertainty about the condition of an asset when this data is not up-to-date.
- *How to overcome?*
To overcome these challenges, it is essential to demonstrate genuine interest in the parties involved and to take the time to understand how they perceive the problem. By discussing it extensively, the problem will become clearer, and a shared understanding can be established.

2. Meeting:

Getting to know the other organisations

- *Who?*
To get to know the other organisations, representatives of the asset owners can start meeting

each other. It would be beneficial to have representatives from different levels, ensuring that all these levels are involved in the relationships from the beginning. External facilitators can help with setting up these meetings and guide the building of relationships.

- *What?*

By organising informal meetings or workshops, asset owners can meet each other in an approachable way. After this, more specific meetings can be organised about a specific theme that corresponds to the problem. With both of these meetings, the interests and goals of the organisations should be defined. This step can also involve the initial exchange of knowledge and data regarding the assets.

- *Challenges?*

Again, a lack of time is a challenge here; some organisations do not have the time to meet people from other organisations. This often corresponds to the challenge that collaboration is not a priority. In addition to this, the asset owners do not know each other, making it a large step to meet and get to know each other, which in turn results in a lack of trust. The fact that large organisations often initiate a collaboration can lead to the challenge that the influence of large organisations can be intimidating, as there is a fear of being dominated. Additionally, asset owners may have varying strategies and priorities, which can make it challenging to share data and knowledge.

- *How to overcome?*

To overcome these challenges, it is essential to ensure that meetings and workshops are informal and that there are no obligations associated with this step. Also, bringing other people to the meetings can help expand the network and make it more approachable, as it consists of familiar faces. Lastly, it can be useful to send more extroverted people to the meetings because it is easier for them to build connections. Additionally, there should be transparency about the different strategies, making it easier and more accessible to share data and knowledge.

3. **Trusting:**

Daring to leave it to the other organisation

- *Who?*

The representatives from the asset owners who met in the previous step should begin building trust in this step. Here, the initiators of the collaboration are also important because a relationship should exist between them and the smaller asset owners to sustain the collaboration.

- *What?*

When trust is beginning to develop, the first small things can be done together, and these results can be shared to show others the achievements of the collaboration. In addition, more in-depth meetings can be organised here to build a deeper trust within the organisations.

- *Challenges?*

By doing things together, there is a fear of losing autonomy and a fear of losing control, especially in the hands of larger organisations. As these organisations often have more resources and might have initiated the collaboration, smaller organisations could feel dominated by these larger organisations. Another challenge is that the relationship might not be deep enough to trust other organisations.

- *How to overcome?*

By having an approachable collaboration, there is a low threshold for organisations that want to participate in the network. Also, start by doing small things together to build trust and show quick wins. This can build confidence in the collaboration. To mitigate the challenges, it is also important here to formulate agreements regarding the execution of the actions so that all involved parties are aware of what will happen with their data and assets.

4. **Exploring:**

Talking about possibilities in a collaboration

- *Who?*

In this step, the participating asset owners, facilitators of the process, and the initiators should be involved to explore the possibilities of collaboration. In addition, people at the strategic level of the organisations have to be involved here because they know what is possible in terms of time and money.

- *What?*

In this step, the possibilities to collaborate are explored. Here, larger actions for renovation and replacement of multiple parties are considered, and more concrete ideas are developed. In addition, more concrete shared goals should be established here as targets to work towards.

- *Challenges?*

A challenge here may be that there is a difference in resources and knowledge between parties, which can lead to conflicts or difficulties in planning for the collaboration. Also, concerns about commitment can arise in this step; all the involved parties should be as committed to the collaboration. Another challenge is that there can be concerns about autonomy, ways of working, and flexibility. Organisations need to be in charge of their planning and often have their own ways of working that they may have to let go of a little.

- *How to overcome?*

By using the FOMO principle, organisations are stimulated to join the network. It should be appealing to join the collaboration and easy to participate in it. FOMO can be accomplished by sharing successes as this shows organisations what the collaboration achieves. Additionally, communicating about concerns is very important; this can make the challenges easier. Lastly, sharing knowledge and data among asset owners can help to be more aligned and learn from one another.

5. **Collaborating:**

Achieving a better result together

- *Who?*

All asset owners involved in the network must participate in this step, preferably at all levels. Additionally, the facilitators play a crucial role here.

- *What?*

Here, the actions that are defined in the previous step can be executed. The results and successes that come from this collaboration will be shared to show that the collaboration is working. In this step, the connection and trust should continue to be invested in so that they are not lost.

- *Challenges?*

A challenge here is that it goes too fast and momentum is lost. Because of this, the engagement of asset owners can be lost because they cannot keep up with or handle it. Also, when there are too many expectations from the smaller organisations, they may back down because they cannot handle them.

- *How to overcome?*

To overcome this, it is important to continue investing in the network. In addition, organisations that are not yet involved should be informed and encouraged to join the network allowing more organisations to share resources. Lastly, communication about how organisations can participate is very important to know what is possible.



Figure 6.1: Process description for developing a collaboration

To apply this framework in practice, the steps can be used by different people or organisations, depending on the goal. For other large organisations, for example another province, the framework can be used from the start to initiate and develop a collaboration. The model shows step by step which actions can be useful to apply, what challenge could arise, how to overcome these challenges, and which stakeholders have to be involved. To connect the involved organisations in the collaboration, the external facilitators can organise different meetings, where the asset owners can connect and get to know each other. This is important in the second and third step, and it would not be beneficial to proceed to the fourth step in case the relationships have not been developed enough to explore the next steps in the collaboration.

However, this does not mean that every step has to be taken after the completion of the previous step. The first step is important as start of the process. It is crucial to understand the problem and explore if this problem is shared with the other organisations. By defining this problem, the organisations will already start to meet and get to know each other. When the problem is defined, the meetings and workshops can start to be more about developing a relationship and building trust. The last step can start during the fourth step because the actions explored there can start to be executed when the organisations involved are confident it is the right time for this. This depends on the organisations and the level of their relationship and agreements.

Depending on the way the collaboration is developed, it differs who will be responsible for actions such as sharing successes and formulating agreements and goals. This can be the external facilitators that are involved in the collaboration, but it could also be the organisations that are participating in the collaboration. This depends on how the collaboration is structured. For example, for the SSRV initiative, there is a taskforce that consists of representatives of some of the asset owners, which comes up with ideas and initiatives on how to continue with the program.

6.6. Strategies for developing a collaboration

To initiate and develop a collaboration for the renovation and replacement of infrastructure assets owned by multiple asset owners, several strategies can be employed. Some of these have been implemented in the model in Chapter 6.5; however, in this subchapter, the strategies will be further developed and elaborated. These strategies have been defined based on the steps in the framework and the components that were important there. Also, the points that were highlighted by the interview participants as most important are part of the definition of the strategies.

1. Define the reason for collaboration

For the first strategy, the emphasis is on defining a problem that is shared between stakeholders. It is critical that the problem for which the collaboration is set up is shared and the organisations involved acknowledge that there is a problem and this problem is similar to what the other organisations perceive as a problem. This problem is the reason for the collaboration. For the involved organisations, there also needs to be a way to specify their motivation for participating in the collaboration and on which aspects they want to collaborate. When this is clear, and there is a structured overview of these motivations for all the organisations involved, there is clarity for everyone, and the organisations know where they stand and who wants to collaborate on what aspect. This makes it easier to explore the different actions of the collaboration because it is known for each organisation what they want to be part of, and there will be fewer surprises and uncertainties. And, by defining the reason for collaboration, this is clear for all the involved organisations and this makes it easier to work towards a common goal, as this is defined together.

2. Start small

When initiating and developing a collaboration for a renovation and replacement task involving multiple asset owners, it is essential that the start is small and low-risk. When the collaboration starts too fast and too big, there is a significant chance that it will not succeed because the participants in the collaboration cannot keep up with the actions and will withdraw from the collaboration. By starting with small actions, such as sharing knowledge, starting a pilot with a small group of assets, or working on a general part that many bridges have in common, participants can learn about the process and how other participants work. This can help build trust among the other participants in the collaboration and

will help them get used to working together with other organisations. Also, the quick wins that are aimed to be achieved should be small at the beginning. By achieving small quick wins together, the organisations can get used to working together, but it will not take too much time and effort.

3. Formulate goals for the collaboration

In a renovation and replacement task, it can be difficult to formulate one main goal because there are many infrastructure assets involved, owned by multiple asset owners. However, it would be useful to formulate a couple of small or general goals that apply to the collaboration being set up. This can be a timeline of when certain types of collaboration will occur, for example, in six months, a pilot project will have been started. However, it can also be general goals, for example, about how sustainable the projects in the task will be or how accessible the areas will continue to be. By formulating goals, the participants in the collaboration share a common goal that they are working towards together, which can provide more motivation to achieve the goals through collaborating. In addition to this, it allows for monitoring progress on the actions that have been developed in collaboration. This is different from defining the reason for collaboration because these goals are smaller and are meant to be achievements during the collaboration process.

4. Work on building relationships and trust

In a collaboration, multiple organisations work together, combining their ways of working to achieve a goal or execute a project. For these organisations to work together efficiently, it is essential that they establish a relationship and build trust in each other. Without a relationship and trust, it is very difficult for a collaboration to work. Especially in the renovation and replacement task because here multiple assets need to be renewed that are managed by various asset owners. If these asset owners do not trust each other, there is a slight chance that they will allow another asset owner to be in charge of renovating their assets. To build this relationship and trust, this should start with informal meetings to get to know each other. During the process of developing the collaboration, these meetings should continue to be organised because it is essential to maintain and build relationships between the participants of the collaboration. By having a relationship built on trust between the organisations, they can be more open about their challenges and needs. In the framework of Ansell and Gash (2007), face-to-face dialogue is identified as an essential point to identify opportunities for mutual gain between stakeholders. It plays a crucial role in building trust and mutual respect and helps to define a shared understanding and commitment to the process. By meeting face-to-face, it is easier to break down stereotypes and other barriers to communication. That is why for building relationships and trust, the informal meetings have to be organised face-to-face.

5. Transparency about roles, responsibilities, and expectations

There are multiple organisations involved in the collaboration for the renewal task, which is why it is essential that there is transparency regarding the roles and responsibilities of the organisations involved. When this is clear, every organisation is aware of how the collaboration is structured and who is responsible for specific aspects of it. In addition to this, the organisations should be clear about their expectations for the collaboration. This will help with formulating goals and building a relationship, as well as facilitating the development of collaboration in general, and will prevent misunderstandings and conflicts.

6. Progressively increase the level of collaboration

After starting small with the collaboration, this can be increased progressively. It is essential here that the level of collaboration aligns with what the organisations can handle in terms of time, money, and resources. Again, if too much is asked of the organisations, there is a chance that they will back out of the collaboration. By progressively increasing the level of collaboration, it will not happen too quickly, and it is easier to take a step back when the organisations cannot handle it. This makes the process more adaptable.

6.7. SSRV in the framework

The model built in the previous sub-chapter is partly based on the way the collaboration was developed for the SSRV initiative in Noord-Holland. That is why it is interesting to explore the steps that have already been taken in Noord-Holland already and what is still missing, or what they have done differently.

The first step of the framework is the initiation of collaboration. Here, the problem is explored, and a shared understanding of the problem is defined. For the collaboration in the SSRV initiative, two individuals from the province of Noord-Holland have visited every municipality to ask whether the municipalities perceived they had a problem and what this problem consisted of exactly. The problem has been clearly formulated through these visits, and the province of Noord-Holland is the initiator, being a large organisation in the area. The risks in the absence of action have not been explored completely, so this could be something useful for the initiative to examine. This can help stimulate organisations to participate as they will know what will happen when they do not participate in the collaboration. To explore the problem more thoroughly, specific thematic meetings were organised. In the framework, this was part of the second step.

The second step involves organisations getting to know each other and holding informal meetings for this purpose. For the asset owners in Noord-Holland, a festival has been organised at the beginning of the initiative so the organisations could meet each other informally and discuss their problems. As mentioned in the previous step, thematic meetings were also organised for this. Here, the different interests and goals of the organisations could be discussed. APPM and DHM were involved as external facilitators in these meetings. This is an important first step in defining the interests and goals, and it is essential to explore this on different levels within the organisations. Within SSRV, the first knowledge and data exchange occurs with the initiation of the Bridge Brigade and through the maps being created of all the province's infrastructure assets.

In the next step, the primary focus is for organisations to start building relationships and trust. Here, the first outcomes of the collaboration are shown. For the SSRV initiative, these can be the outcomes of the maps created with the data on infrastructure assets. These maps can be seen as a success from the collaboration, and this can be promoted to other organisations that are not yet involved. In this SSRV initiative, there remains a fear of losing autonomy and control among asset owners. This came up during the interviews, which suggests that there is uncertainty about how it will be handled. With this uncertainty, it is challenging to establish a relationship, which is why extra attention should be given to this step for the SSRV initiative.

In the fourth step, possibilities for collaboration will be explored. In the SSRV initiative, more concrete actions are being developed to work together on, for example, the renovation of multiple bridges owned by different asset owners. Additionally, there are already smaller actions being taken together, and there will still be worked on developing a relationship and building trust.

The SSRV initiative is starting to reach the last step in the model, which involves collaborating and executing the tasks explored in the previous step. These ideas are beginning to be executed, and the results are being shared with other involved organisations.

Currently, the SSRV initiative is at the end of the 'Exploring' step and is starting to reach the 'Collaborating' step. This does not mean that there have not been actions yet in which the organisations have collaborated. Sharing knowledge and data, and working together to define a shared understanding of the problem, is also collaborating in a different way than is meant in the last step. There, the collaboration is actually working on renovating specific assets or tendering together.

6.8. Validation of the findings

To validate the findings of the interviews and the process of developing the collaboration, a brief presentation was given to the taskforce of the SSRV initiative, where these findings were explained. In this taskforce, some members were interviewed for this research, but there were also members of the taskforce who were not approached and had less knowledge of the research. The validation was brief, so there was not much response; however, some interesting points were mentioned that are useful as a validation.

The first comment noted that it was a nice summary, which briefly outlined the situation of the problem and the key components involved. This participant said that it was nicely retrieved information from the interviews. These comments suggest that the concise findings were comprehensive and effectively illustrated the problem.

Another comment was made by someone who had not been interviewed in this research. They mentioned that for them, the attractive aspect of this collaboration is that it involves a change in mindset, where it is no longer possible for organisations to handle this task alone, given the size of the task. This should be given more emphasis. They said:

“This collaboration is not a matter of convenience; it is a necessity.”

The fact that collaboration is a necessity was already part of the research findings, but it should be more emphasised. It is an important aspect that needs extra attention. In the first step of the process of developing collaboration, this can be highlighted, and the reason why it is a necessity is also very important here.

The following comment that was interesting was about building trust. It was mentioned that it was good that building trust was put central in the findings of the research and that it fits with the VVV-principle (‘Verbinden, Verslimmen, Versnellen’) of the SSRV initiative. This participant mentioned that they think trust is starting to be built between the taskforce and the organisations, but that it is also essential that the organisations start to trust in the collaboration. This means another type of trust than was focused on in this research. Asset owners must trust that collaboration is beneficial and helpful to them, and this type of trust also needs to be established in some way.

The term ‘trust’ is used, but it has two different meanings here. The focus of the research is on trust between people within organisations. This is a personal level of trust and has to be built between multiple people in the different organisations. Before a connection can be made between the people in the organisations to initiate the collaboration, the asset owner organisations have to be convinced about the collaboration and have to trust that it is beneficial for them. Organisations are structured into different levels; organisational, tactical, and strategic. At these different levels, people should be convinced about the collaboration. In case one of the levels in an organisation does not trust that the collaboration is a good plan for them, it will be very difficult for the organisation as a whole to participate in the collaboration. For example, an asset manager, on the operational level, can be very enthusiastic about participating in the collaboration, but when the strategic level, which decides where the money and time are divided to, does not trust that the collaboration is useful for them, there is a minimal chance that the organisation can participate in the collaboration fully and share its resources and data. Similarly, when the strategic level wants to invest time and money in the collaboration but the asset managers strongly oppose this idea, it can cause problems and resistance within the organisation. Therefore, trust in the collaboration has to be built, and the focus should be on all the different levels within an organisation for this to be most efficient.

To give members of the taskforce the opportunity to react to the findings of this research after the presentation, it was sent to them by email with the question if they would read it and send a response in case there were important things missing or they had other comments. From this email, there was a response about the steps for the process description. This participant mentioned that it is essential to indicate, either in an existing step or as an additional step, the importance of starting to work together on small, concrete tasks early in the collaboration. As an example, they mention a knowledge-sharing session that could deliver immediate visible results. They said:

This is somewhat implicated in step 3, but unless we explicitly address these quick wins, they are likely to be overlooked.”

Based on this validation, several points were highlighted to pay extra attention to. These were that collaboration is a necessity, trust in the collaboration also has to be built, and it is important to start early with collaborating on small tasks to deliver visible results.

7

Discussion

Through interviews and literature review, several findings were found regarding the development of an effective collaboration for a renovation and replacement task involving multiple asset owners. In this chapter, the findings will be discussed, and the results from the interviews presented in Chapter 5, will be compared with the theory from the literature review conducted in Chapter 3. After that, in Chapter 7.3, it is explained what is important when developing a collaboration in a province other than Noord-Holland, which is examined in this research.

7.1. Interpretation of the findings

Renewal problem

In Chapter 1, the introduction to this research described the problem. It was explained that the renewal task is increasing, but the ability to handle this task is decreasing due to limited manpower and resources. The suggested solution is for asset owners to collaborate and work on the renewal task together. To develop this collaboration, a model was designed that includes the important steps of collaboration and how to overcome the challenges that come with these steps. From the research, it became clear that collaboration can mitigate several of the issues that complicate the renewal task. For example, by sharing resources, capacity shortages can be mitigated, and by sharing knowledge, the lack of knowledge can be decreased, and asset owners can use the expertise of other asset owners without having to conduct their own research.

However, collaboration developed within the framework will not completely solve the renewal problem, as there are still challenges that can make the renewal task complex. For example, if asset owners do not have their strategic priorities aligned, the collaboration can struggle to gain momentum. For an effective collaboration, it is essential that the asset owners are willing to participate, but also roughly at the same time. Asset owners are unlikely to wait for other organisations to be convinced that the collaboration is beneficial. Additionally, the financial contribution that organisations can make is likely to differ per organisation, which can make collaboration difficult. When it is not clear how an organisation is supposed to contribute to the collaboration financially, this can prevent them from participating in the network. In the literature, there was no clear structure found on who should contribute how much and whether it should be based on certain criteria, such as the amount of assets or the size of the organisation. The interviews explained that such financial contributions are important to make clear to the participants of the collaboration. If there are too many agreements, it could deter the participants.

Time

For the collaboration required for the renovation and replacement of multiple assets managed by different asset owners, several findings were identified that described the difficulty in establishing this collaboration. There are several challenges and barriers defined that can hinder or cause a collaboration to fail. A significant challenge mentioned here was time. Time can be interpreted as a different type of challenge. From the interviews, a significant challenge that came up multiple times was the lack of

time for asset owners to participate in a collaboration or even consider that such a collaboration could be beneficial for them. This lack of time is a significant barrier, as mentioned by a couple of participants, but it was not identified as a major challenge in the literature review. In the literature review, the challenges involving time consisted of the goal to complete the project on time (Moradi and Kähkönen, 2022; Schuh et al., 2014), which is important in a project but not a crucial component when developing a collaboration between asset owners. However, Ansell and Gash (2007) described that it is important for stakeholders to take extra time to rebuild trust in the event of a previous conflict. When this was not possible, they indicated that these stakeholders should not embark on the collaboration. This illustrates the importance of asset owners having sufficient time to consider participating in a collaboration and to actually participate in it. When there is a lack of time, it hinders the efficiency of collaboration because the involved parties are unable to invest the necessary time needed to build relationships and carry out tasks.

Trust and relationships

This continues in the following challenge, which is the lack of a relationship between the asset owners of the infrastructure. In the interviews, it was mentioned that for the province of Noord-Holland, there were asset managers who did not know each other personally, even from neighbouring municipalities. The lack of a relationship makes a collaboration very difficult because there is no trust between the participants, and they do not understand how the other participants work. Additionally, conflicts in a relationship can create barriers to the collaboration process (Lozano et al., 2021), while relationships can also help mitigate conflicts in collaboration (Faris et al., 2022). So, relationships are crucial for a collaboration to be successful. The relationships in renovation and replacement tasks are important, because in a relationship, trust is developed, and for the renovation and replacement task, trust is necessary, for example, to let another organisation renovate someone else's bridge. A lack of a relationship also results in a lack of trust, which has been mentioned multiple times as a significant challenge in collaboration. Especially in voluntary collaboration, which is the collaboration for a renovation and replacement task, trust is described as a crucial coordination mechanism for collaboration (Edelenbos and Klijn, 2007). It reduces conflicts and promotes an effective project process (Chen et al., 2022; Engebø et al., 2020). This was confirmed in the interviews and also mentioned as one of the most important components of the collaboration.

However, there are different levels of trust. For example, in the renovation and replacement task, an organisation can trust that the way another organisation has renovated their bridge was good enough, so they will do it the same way, or an organisation can trust another organisation to renovate their bridge for them. Here, there is a deeper level of trust than in the first case, so it is essential to understand what the level of trust entails. During the validation of the findings, also another type of trust was mentioned, which is trust in the collaboration. Asset owners should trust that collaboration is beneficial to them. This aligns with something mentioned by Patel et al. (2011), which is that trust is a central component to team performance and the involved organisations should trust that the tasks are important and that they are receiving the right structure and guidance to carry out this task. For renovation and replacement projects or the renewal task in general, trust is different because it involves multiple organisations that are required to trust each other, and an existing asset is involved. The focus is not on executing a project together but on the fact that there is a common problem that requires collaboration to be developed in order to tackle it. Aside from the fact that the level of trust differs, it is also a different type of trust because it has to allow for organisations to collectively tackle a shared challenge and pool their resources to address it. This type of trust is missing from the literature but was mentioned in the interviews. One of the participants mentioned the importance of building connections from the start, because the organisations need to know what the others can bring to the table and start building trust. They describe that it is easier to adopt a solution from another organisation when there is a foundation of trust. In a collaboration network for the renewal task, building trust is required between various organisations involving multiple people who have an interest in the renewal of different assets. The trust that needs to be built involves all these different people, which requires organisations to open up their planning and share their resources, so that together they can align and create a plan for the renewal of their infrastructure, rather than focusing on one renovation of a single bridge.

Building trust is difficult because it is very personal and cannot be simply imposed. The development of trust emerges over time, as discussed outlined in the strategies in Chapter 6.6, where some ideas

on how to build trust were proposed, most of which were identified during the interviews. Trust can be developed by working together on small projects, getting to know each other informally, and continuing to work on building a relationship and trust. These strategies can help to stimulate the development of trust, but there is no certainty that trust will definitely be developed because it is personal and it differs per person how trust can be built and how long this will take.

Stimulating asset owners

Stimulating asset owners to collaborate is an important component in initiating and developing a collaboration. The success factors for this can indicate what would stimulate organisations to participate in the collaboration; however, during the interviews, some other findings were also found to be interesting and useful for stimulating a collaboration. A way to stimulate collaboration is to make it appealing to join and utilise the FOMO principle, which stands for 'Fear Of Missing Out'. This means that organisations not yet part of the collaboration should feel as if they are missing out on something that would be useful and appealing to them. To show the organisations what they are missing out on, it is important to share the successes of the collaboration, even the small ones. Ansell and Gash (2007) described that collaboration is more likely to occur when potential benefits and advantages are clear and small wins can be achieved from the collaboration. The collaboration network can grow as a result, and this often happens organically when organisations join the collaboration because they see successes or when people bring others to meetings to meet other organisations.

Process description for developing collaboration

In Chapter 6.5, a model is provided for the process description of how to develop a collaboration. It consists of five steps that show, step by step, how a collaboration progresses from initiation to actual collaboration. This process description is based on how the collaboration in the SSRV initiative was developed, as well as the components from the literature that corresponded with this development. The steps indicate who is involved in each step, what will happen, what the challenges are and how to overcome these challenges. When comparing the model with the framework of Faris et al. (2022), which distributes the factors of collaboration over the life cycle of a project, some similarities can be observed. The first two steps that define the project and a relationship corresponds mostly with each other. In the model for this research, the focus lies more on how the relationship will be developed, but the identification of roles and responsibilities matches. The later steps involve components that match the model for this research, but the steps do not align. However, the framework of Faris et al. (2022) focuses on a single project, and the model of Chapter 6.5 is designed for a renovation and replacement task that can lead to multiple projects, which makes the process different. The model developed for this research focuses more on how collaboration for a larger task can be initiated and developed and how the asset owners can be involved in this collaboration and stay involved in the process.

Types of collaboration

In Chapter 3.2.1, three types of collaboration were described that seemed to correspond to the renewal task of this research: task-orientated working, inter-organisational collaboration and collaborative governance. By examining the research results and comparing them to the three types of collaboration, it became clearer how each of these types aligns with the renewal task. Task-orientated working is an organisational principle where social tasks are defined and realised in cooperation with external actors (Anderson, 2018). It is a valuable way to develop a collaboration for the renovation and replacement task because this involves multiple external actors for which social tasks can be defined and can be realised together. Inter-organisational collaboration is a collaboration between organisations that are usually separate, which increases public value by working together instead of working separately. This type of collaboration indicates that it is not natural for organisations, such as different municipalities, to work together on a task. In the collaboration for the renovation and replacement task in Noord-Holland, similar challenges and advantages were mentioned, such as sharing resources and the fact that the collaboration is based on trust and openness (Nezami et al., 2022). Collaborative governance is a collaboration between public and private organisations that addresses public policy issues and employs a collective decision-making approach (McNaught, 2023). This means that the decisions are made with all the parties involved, which aligns with the collaboration in the renewal task in Noord-Holland. Additionally, the public policy issues addressed through collaborative governance share the complexity of the renovation and replacement task.

The three types of collaboration are complementary to the renewal task. Task-orientated working is important at the beginning of collaboration development to establish trust and define the problem. The inter-organisational collaboration continues with the exploration of working on a task with separate organisations, and collaborative governance indicates how the decision-making approach can work the most efficiently.

Challenges collaboration in renovation and replacement

The focus of this research lies on the challenge for asset owners to renovate and replace their infrastructure, due to a lack of manpower and knowledge as well as a growing renewal task. In the literature review, several challenges were mentioned for asset owners when planning the renovation or replacement of infrastructure. These challenges included aligning decision areas, defining objectives, managing multiple stakeholders, and considering various infrastructure asset characteristics. By researching how a collaboration can be developed, these challenges also emerged, making it clearer what the challenges consist of and perhaps how to overcome them.

The first challenge, aligning decision areas, means that there are different areas in which decisions must be made: decisions regarding infrastructure objectives, infrastructure situation, and infrastructure intervention. These areas are interrelated, and there is no straightforward alignment between the decisions; this makes prioritization complex (Schraven et al., 2011). The interviews revealed that the alignment of these decision areas is even more complex due to the different levels within an organisation that must be aligned when making decisions. Within the framework developed in this research, the different priorities and interests of the various levels of the involved organisations are intended to be clear; however, there is currently no structured mechanism to connect the decision areas across the organisations. The collaboration developed here can serve as the starting point for exploring such a mechanism, as the interests of the different organisations are intended to be clear on all levels. However, it will continue to be complex because organisations have different ways of working and rules, and define their infrastructure assets differently, so a shared language is necessary. This is also where other challenges arise, such as a lack of trust and fear of losing autonomy. There should be trust between the organisations to put all their interests and priorities on the table, and they may be afraid to lose autonomy when a shared language is being developed.

The next challenge was defining objectives for public agencies. These objectives form the foundation for evaluating the infrastructure's condition and performance, and prioritise renovation and replacement activities. However, public agencies sometimes struggle to define objectives that align with their strategic policy goals (Dekker, 1996; Schraven et al., 2011). In the interviews, it was found that defining these objectives was not a priority for the involved organisations, and there are other transitions that are included in the policy goals of the organisations, which had higher priority, resulting in more resources being allocated to those transitions. For some organisations, the condition of their infrastructure assets was unclear, which could mean that no clear objectives were defined, making it difficult to prioritise renovation and replacement activities. Especially when there are other tasks that might be clearer and therefore have a higher priority. The lack of clear objectives has implications for collaboration, as it makes it more complex to align objectives, which can hinder collaboration. Also, the renovation and replacement could not be a priority, which makes it difficult to develop a collaboration for the renewal task. In the framework, the aim is to define the interests and goals of the involved organisations. For this, it is necessary to define the objectives.

Managing multiple stakeholders in renovation and replacement projects means that the expectations of the different stakeholders involved in renovating a specific asset must be considered in asset management decisions and defining objectives (Schraven et al., 2011). In this research, the multiple stakeholders involved with a single asset are not explicitly addressed, but the focus is more on the complexity of aligning interests between different asset owners and their different organisational levels for the development of a collaboration. The involvement of objectives from other stakeholders who are involved with the infrastructure assets can be added to the framework as part of the early stakeholder engagement. It is essential to address these objectives in the early steps of the model, such as the initiation step or the meeting step. This requires the development of the collaboration to shift from only looking at asset owners to also including external stakeholders, which makes it more complex.

The last challenge mentioned in the literature review was that the characteristics of infrastructure assets

can be defined differently by asset owners, and the norms for defining the benefits or failure of the assets can be difficult to measure. In the interviews, this was also mentioned as asset owners may have their own rules and ways for working on infrastructure assets, based on their organisation's policy. These differences can complicate collaboration, as they make it difficult to align the characteristics. As mentioned in the first challenge regarding the different decision areas, for collaboration, it is required that the objectives are aligned to facilitate decision-making. This is also the case here, as it will be complex when the norms and characteristics of the assets are differently defined and a plan has to be made for how to renew these assets together in collaboration. A shared language would be useful here, but also brings challenges, such as a lack of trust and fear of losing autonomy.

To summarise these challenges in the implementation of the framework, the objectives of the asset owners must be clearly defined during the development of the collaboration. This will decrease the challenge of aligning the decision-making areas because the objectives and interests will be clear for all involved organisations. What is difficult here is that organisations execute their work differently, and this should be more aligned. This is also the case for the definition of the infrastructure asset characteristics and the definition of objectives. The other challenge, managing multiple stakeholders, is part of the research as the framework develops a collaboration among multiple asset owners. However, the other stakeholders who are more specifically involved in the renovation or replacement of a particular asset are not taken into account here, which is important an important consideration.

7.2. Contribution to literature

Many of the findings in this research confirm the findings from the literature review, as mentioned before in this chapter. However, from the interviews and the case study, several other findings were also discovered that were not included in the literature review. These findings are valuable additions that have been implemented in the framework for developing collaboration and will be explained here.

The FOMO principle

A motivator for collaboration that was mentioned several times during the interviews is the FOMO principle. This means that by showing the successes and processes of the collaboration network, organisations that are not yet participating in the network can be encouraged to join. It is an informal motivator based on the willingness of organisations to be part of something that they can see is beneficial for them to participate in.

Low threshold participation

During the interviews, it was mentioned that for the development of the collaboration, it is important to keep the participation in the network approachable. By having a low threshold for participation, the organisations can feel that it is easy to join the collaboration, without too many obligations, allowing them to explore whether the collaboration is beneficial for them. This is partly in contrast to what was found in the literature, which is that a structured governance framework is important for efficient collaboration. In the SSRV case, the "softer" informal approach was explained as more effective during the earlier stages and valued by the involved organisations.

Knowledge sharing

In the literature, knowledge sharing was described as a benefit of collaboration. During the interviews and looking into the case study, a reason for collaboration was identified as a lack of knowledge, which was partly due to the ageing of staff and people leaving organisations. The collaboration here explained that collaboration is not only beneficial for knowledge sharing but also for preserving knowledge. The organisations can use knowledge from one another, thereby avoiding the need to research this information themselves. Meanwhile this knowledge is distributed to various organisations, ensuring that when someone leaves, the knowledge is not automatically lost, as it is not confined to a single person.

Learning possibilities

Something that contrasts with the previous point is that collaboration is not only used as a means to achieve a project more efficiently, but it is also a learning possibility for the organisations involved. This was also mentioned during the interviews as a motivator for participants to participate in the collaboration network. By collaborating and working together on tasks, asset owners can learn from each other

about how a specific renovation is done or how they tender a particular asset.

Investing energy

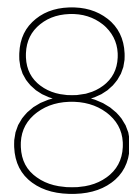
The last important thing discovered from the interviews that was not clear from the literature review is the importance of investing energy in collaboration. There should be energy invested in the collaboration for it to work, but also, the people with the right energy must be utilized to start making connections with others from different organisations. It was mentioned during the interviews that these people do not necessarily have to have the right knowledge, but more extraverted individuals can be more useful in building relationships. After this, they can bring the people with the right knowledge and help build connections.

7.3. Generalisation

The model developed in Chapter 6.5 is based on collaboration in the province of Noord-Holland. To apply this model to other provinces or regions, it is important to keep a few key factors in mind:

1. **Understand the problem in the region.** It is essential to understand how this region perceives the problem and whether there is an urgency that requires collaboration. Here, it is essential to explore whether collaboration is a necessity for the problem.
2. **Understand the actors.** In other provinces, there are other asset owners that manage other infrastructure assets. For example, the province of Noord-Holland has one large city, but if a province has more than one, it could work differently.
3. **Understand what the region needs.** In SSRV, the collaboration is built in a certain way, but this does not necessarily have to work in other provinces as well. It is essential to understand what a region requires, for example, in terms of leadership, agreements, and speed of the process.

Therefore, it is important to keep in mind is that other provinces or regions operate differently and have different regulations. The organisations are also different and can have another relationship with each other. There could already be a collaboration between specific organisations that works, or there are conflicts and organisations do not want to work with specific other organisations. The context for the collaboration must be clear, which includes the problem for which the collaboration is initiated, the actors involved, and clarity on what the region needs and whether a collaboration is required for this.



Conclusion

The objective of this research is to explore how an effective collaboration can be initiated and developed between different asset owners that manage infrastructure assets that need to be renovated or replaced. For this objective, the main research question was formulated as follows.

How can an effective collaboration be initiated and developed between infrastructure asset owners in large-scale renovation and replacement projects?

In this chapter, the main research question will be answered in Chapter 8.2, but first, the six sub-questions that were formulated to help answer the main research question will be answered in Chapter 8.1.

8.1. Sub-questions

SQ 1: What are the characteristics of renovation and replacement infrastructure projects?

During the Second World War, a significant amount of infrastructure was destroyed in many countries, resulting in a large peak of infrastructure building in the 1960s and 1970s. For civil infrastructure, the average lifespan is around 60 to 120 years, which means that in the following decades, the need for renewal of civil infrastructure will be greater than for other types of infrastructure. There is no one-size-fits-all approach for this because the properties are unique, and the infrastructure was built a long time ago, making it more complex than new construction. Additionally, accessibility and dealing with multiple stakeholders make it complicated. Renovation and replacement of an object are required when it reaches its end-of-life, which can occur due to three reasons: technical, economic, or functional end-of-life. Technical end-of-life means that the object is degrading. Economic end-of-life means that maintenance is becoming too expensive, and the renovation or replacement of the object will be more cost-efficient. Functional end-of-life means that the object is no longer functioning properly due to changes in usage, such as heavier and increased traffic. The costs for renewing the civil infrastructure are expected to increase significantly in the following years, with municipalities bearing the majority of these costs.

There are various options for reusing a bridge. The first option is to keep it at the exact location and perform maintenance to keep it functioning; here, a renovation or replacement is not necessary. Next is functional reuse, where the bridge has a similar function but is located in a different place. The bridge can also serve another function, either in the same place or a different one. In addition to this, the bridge's parts can also be used for something else. Lastly, parts of the bridges may be reused as raw materials.

Several challenges in renovation and replacement projects have been identified in the literature. For example, decision areas have to be aligned. There are various decision areas that are interrelated and must be aligned when planning a renovation or replacement project. Next to that, the objectives for the involved parties must be defined, which can be challenging sometimes, as these objectives form the basis for evaluating and assessing the performance state of the infrastructure. These objectives may

sometimes be inconsistent with the organisation's policy. Also, there are often multiple stakeholders involved in renewal projects, for which the expectations are important to consider. Lastly, the norms on how to define the state of the objects differ per asset owner and are sometimes difficult to measure.

SQ 2: What are factors that ensure a successful collaboration in large-scale infrastructure projects involving renovation and replacement?

The main factors for a successful collaboration in renovation and replacement projects regarding infrastructure assets have been identified through the literature review and confirmed during the interviews. The first success factor is having trust and transparency. Without trust, collaboration is challenging to maintain because asset owners are less willing to share data and let others be in charge of their assets. Trust building is crucial for this, which often occurs within the relationship-building process of the collaboration participants. Transparency is essential to avoid conflicts and misunderstandings, fostering an open environment for collaboration where all the participants are clear about their roles and responsibilities. This corresponds with the fact that clear communication is required to avoid misunderstandings and manage expectations. Another key factor in ensuring success is to involve asset owners early in the process. This will give them a feeling that they are being heard, and that there is a genuine interest in their problem. In addition, this helps align goals and expectations for the collaboration. Something that emerged as a success factor in the literature, but was mentioned less in the interviews, was having a shared goal. This helps to unite the participants and have them work towards the same goal, which increases commitment. In the renovation and replacement task, one clear goal is challenging to define; however, within the collaboration, it is useful to define different small goals for the asset owners collaborating on different projects. Another success factor for the collaboration is that energy must be invested in it for the collaboration to work. When there is not enough energy, and the participants wait and see what will happen, the collaboration is less likely to succeed. The last important success factor is that the collaboration should be approachable. This means it must be appealing to join and have a low threshold with an open environment where participants are treated as equals.

SQ 3: What are the key challenges asset owners face when collaborating in large-scale infrastructure projects involving renovation and replacement?

The key challenges in a collaboration between asset owners often correspond with the success factors. When there is a lack of a certain success factor, this will often hinder the collaboration process. For instance, a significant challenge in collaboration is the lack of a relationship and trust between the asset owners of the infrastructure. It was found that in Noord-Holland, some of the neighbouring asset managers did not even know each other, which makes it very difficult to start a collaboration. Another challenge was the limited time of asset managers. Some asset managers in municipalities have multiple roles within their organisation and do not have time to consider participating in a collaboration. For them, it is easier not to be part of the collaboration, while it would be especially useful for them as it would save time in the long term. Another challenge for asset owners in the renovation and replacement task is the fear of losing autonomy. Asset owners have a legal responsibility for their assets and what will happen to them, and cannot just let another organisation be in charge of their assets. It is uncertain what will happen to their autonomy when they participate in a collaboration, and this can be a barrier to joining. Besides this, these organisations also have their own ways of working and rules, and when participating in a collaboration, these ways of working have to be combined, which makes decision-making complicated. Moreover, there are different layers within organisations that need to be convinced that the collaboration is beneficial for them to be part of. The asset manager (operational level) may be willing to join the collaboration, but if they do not receive time or funding from the management of the organisation (strategic level), participation in the collaboration is unlikely to occur.

SQ 4: What are existing frameworks for collaboration?

Through the literature review, four frameworks have been identified that highlight important components for collaboration and align with the collaboration aimed to be developed in this research for the renewal task. The framework of Schuh et al. (2014) divides collaboration into three dimensions: communication, coordination, and cooperation. The success factors for collaboration were included in these three dimensions, which provided an elaborate definition of collaboration. Yang (2016) demonstrated different types of collaborative governance, a type of collaboration explained earlier in Chapter 3.2.1, and explained how these types, combined with the major elements, influence the performance of the

collaboration. This revealed components that could influence the participants' willingness to join a collaboration and is therefore useful for this research. The next framework, proposed by Ansell and Gash (2007), also demonstrates collaborative governance. They included the collaborative process and the components that were important in this process, as well as the starting conditions, institutional design, and facilitative leadership that influence this collaborative process. This provided an in-depth explanation of how a collaboration can be developed and what influences it. Lastly, the framework of Faris et al. (2022) shows how a collaboration is developed for a project's lifecycle. The first steps involve establishing a project vision and building relationships, which are found to be important for developing a collaboration for a larger task as well.

SQ 5: How can the participation of asset owners be stimulated within the collaborative framework for renovation and replacement projects?

In the initiation and development of a collaboration between asset owners, it is important to understand how these asset owners can be stimulated to participate in such a collaboration. A key finding for this was to demonstrate concrete successes during the collaboration, even if they were small. These show to other organisations that the collaboration is valuable and could encourage them to be part of these successes. This matches with one of the success factors mentioned before, which is that the collaboration should be appealing to join. The FOMO principle was used here, which stands for Fear Of Missing Out. Showing what the organisations are missing out on, which could be useful to them, can encourage them to join the collaboration network. Another important aspect is that organisations should be treated as equals in the collaboration, regardless of their size or number of assets. This shows an open environment where the organisations can express their interests and expectations for the collaboration. Sharing knowledge was mentioned as a large benefit of the collaboration, which can be used to encourage organisations to join the network. The collaboration should be approachable and easy to join; this decreases the barrier to participation. Additionally, future contributions should be straightforward so that organisations do not back out due to excessive workload. For example, a template for a policy document can be provided for asset managers to take to their management; this makes it easier for them to contribute to the collaboration. The participation of asset owners can also be stimulated by facilitating relationship-building. A large barrier to collaboration was defined as a lack of relationship, but by organising informal meetings and workshops, these relationships can start to develop. Lastly, it is essential that participation in the collaboration is stimulated, not forced or mandated. The collaboration is voluntary, and the organisations should be encouraged to join the network because the benefits are helpful for them.

SQ 6: How do the roles, interests, and priorities of asset owners influence the collaboration dynamics?

In the collaboration for the renovation and replacement task, there are different asset owners with varying roles, interests, and priorities. This can influence the collaboration dynamics. The priorities of the organisation can affect how they want to collaborate and for what. This can be difficult for the decision-making process. In addition, during the interviews, it became apparent that some smaller organisations were cautious due to the fear of losing control and being dominated by larger organisations. These larger organisations have more resources and could take over the actions and decisions in the collaboration. This influences the collaboration dynamics as it makes the smaller organisations more reluctant to participate. Another challenge regarding the priorities of the asset owners is the planning of the organisations. In the event of a collaboration and something happens in one of the organisations involved that causes problems with the planning, there is uncertainty how that would be handled. Furthermore, something mentioned earlier, the organisations have a legal responsibility for their assets, which makes them cautious about collaborating and influences the dynamics of collaboration as this also makes them reluctant to participate. So, to conclude, the different roles, interests, and priorities of asset owners complicate the collaboration because they require considering and combining more factors to ensure all asset owners are satisfied and fully participate in the collaboration.

8.2. Main research question

By combining the answers to all the sub-questions, the main research question can be answered, which was defined as follows:

How can an effective collaboration be initiated and developed between infrastructure asset owners in large-scale renovation and replacement projects?

To initiate and develop an effective collaboration between infrastructure asset owners for large-scale renovation and replacement projects, a process description has been formulated. This consists of the main components of this collaboration, including building trust and relationships, a voluntary approach, and defining shared goals. The process also includes addressing the challenges that may arise and how to overcome these.

The first step is to initiate the collaboration by exploring whether the problem for which the collaboration is required is shared by the asset owners of the infrastructure. Here, it is essential to establish a shared understanding of the problem and assess the risks if no action is taken. There should be genuine interest in how asset owners perceive the problem, and it should be thoroughly discussed to gain a comprehensive understanding of the problem that is shared by all participants.

The next step is for the asset owners to get to know each other and start building a relationship and trust. Here, the interests and goals of the organisations can be defined, and they can share their knowledge and data with others. These meetings should be informal and voluntary to make them approachable.

The third step is to initiate small actions from the collaboration to demonstrate to others that it is working. Small successes can be shared here, and trust is further developed by continuing with informal meetings and doing small things together. Additionally, some agreements can be formulated regarding the execution of the tasks within the collaboration.

The next step is to explore the possibilities for collaboration. Larger actions can be explored here that involve multiple organisations, and more concrete ideas can be developed, which can be translated into shared goals for the collaboration. The collaboration ideas and successes should be appealing, and there should be open communication about any concerns that the organisations might have.

The last step is to execute the actions that were formulated in the previous step. These results should be shared with the other organisations to show what the collaboration can achieve. It is essential to continue investing in the relationship, building trust, and regularly communicating about the possibilities of the collaboration.

Several strategies have been defined for initiating and developing the collaboration between asset owners, which can be beneficial for the renovation and replacement task. It is essential that the reason for the collaboration is clear to all participants joining the network. This gives clarity to everyone and reduces uncertainties. The collaboration should start small, and once it is working, it can be progressively increased based on what the organisations want and can handle. Formulating goals for the collaboration unites the network's participants and motivates them to participate actively. These goals can be small projects within the larger renewal task. Additionally, building relationships and trust is crucial when working with various asset owners, as without this they are unlikely to participate in the collaboration and will instead attempt to renew their infrastructure independently. Lastly, in developing a collaboration, it is essential that there is transparency regarding the different roles and responsibilities of the involved parties and their expectations regarding the collaboration. This can prevent misunderstandings and conflicts.

Recommendations and limitations

In this final chapter of the research report, the recommendations and limitations of the research will be described. First, practical recommendations for developing a collaboration for the renewal task will be described in Chapter 9.1. Following this, recommendations for future research are presented in Chapter 9.2. Lastly, the limitations of the research are discussed in Chapter 9.3.

9.1. Practical recommendations

Following the findings of this research, several recommendations can be made for initiating and developing collaboration between asset owners in practice. These recommendations will be explained first. After that, recommendations will be provided for the SSRV initiative.

9.1.1. Recommendations for developing a collaboration

The first recommendation for initiating and developing collaboration for the renewal task is to start small and work on building a relationship between the involved organisations first. By building a relationship, the parties involved in the collaboration can start to develop trust in each other. By starting to build trust at the beginning of the collaboration, it can grow throughout the process of developing the collaboration. This makes it easier to collaborate on actions later in the process. Without trust, organisations can be more reluctant to collaborate.

Secondly, during the development of the collaboration, it is essential to highlight small successes and utilise quick wins to demonstrate the collaboration's effectiveness. This encourages other organisations to participate in the collaboration, and it unites the involved organisations as they can celebrate their successes together.

Another recommendation is to make the collaboration appealing and easy to join. When the collaboration is approachable, there is a low threshold for organisations to join and explore whether collaboration would be useful for them. Additionally, collaboration should be voluntary, and participation should be encouraged rather than mandated to be part of the collaboration network. Furthermore, the organisations must be treated as equals; larger organisations should not dominate the smaller ones.

Fourthly, it is essential to thoroughly explore the problem with the involved asset owners as the first step in developing a collaboration. The problem and the interests and needs of the involved organisations should be clear to all parties involved and this should be a shared problem. However, to explore this problem, it is important to listen to how the asset owners perceive the problem and whether they even see it as a problem. After this is established and clear, the next steps of the process can be continued.

The last recommendation is to ensure the actions from the collaboration correspond to the ability of the organisations handling the actions. When an organisation cannot handle a particular action because it lacks sufficient time or resources, it is very likely to back out of the collaboration. The actions should be adapted to what an organisation can handle and be facilitated by an external organisation to help.

9.1.2. Recommendations for SSRV

Based on the results of this research, a couple of recommendations can also be made on how the SSRV initiative can continue and be further developed. First, the relationships should be continued to work on. During the process of developing the collaboration, there must still be informal moments for asset owners to get to know each other better and meet new people in the collaboration network. People in organisations are changing rapidly, which makes it challenging to build strong connections. By continuing to organise informal meetings, the people involved can meet others more easily in an approachable way, and stronger connections can be made, which is beneficial for building trust.

Another recommendation is to make the collaboration easy. As mentioned before, the actions from the collaboration should correspond to the ability of the organisations. This can be, for example, by facilitating a template for a proposal for the board, or a method for researching the state of an asset.

Thirdly, the asset owners must be informed about every step in the collaboration. The governance structure of SSRV already includes a number of representatives from municipalities and other organisations, but there are also organisations that are not part of these groups. These organisations should also be informed, which could be done through a monthly newsletter or by informing them after a meeting. This makes the process more transparent, and all the organisations are aware of what is going on and what can be expected of them in the future.

Lastly, it could be useful to define small concrete goals. This can unite the involved organisations and motivate them to work together more efficiently. These goals do not have to involve all the organisations, but different smaller goals can be helpful to explore how this works and whether the collaboration is effective in this way. For organisations, this is also a way to build a relationship and trust when they are doing something together.

9.2. Recommendations for future research

Following this research, several recommendations can be made for future research. The first recommendation is to examine collaborations that have been established in another region or province. The focus of this research was on the collaboration in Noord-Holland but in other provinces, the renewal task is also becoming a problem, and collaborative practices are emerging there, such as ZeBra and Zuid-Holland Bereikbaar, as explained in Chapter 3.3. It can be interesting to compare these collaboration approaches and identify differences that could influence the collaboration. Additionally, the success factors and challenges can be compared, which can be interesting to see how much they depend on a specific region.

Secondly, the role of the market organisations has been left out of the scope of this research. However, the market parties play a significant role in this collaboration, for example, when multiple asset owners combine their assets for the same tender. In future research, the influence of these market parties can be investigated, as well as their potential involvement in the collaboration process or even the network. It would be interesting to understand how market parties and the collaboration process interact with each other.

Another recommendation for future research is to measure the impact of the collaboration. It was stated multiple times that collaboration for the renewal task was required, not just a luxury. However, it is interesting to investigate what the added value of collaboration is compared to when there would be no collaboration.

Trust is repeatedly mentioned as an important component in collaboration. For future research, it would be interesting to investigate the evolution of trust over time. Here, it can be researched what is helpful in building trust and how trust between people or organisations can grow stronger.

The last recommendation for future research is to validate the findings with individuals working in collaboration for the renewal task or who need to renovate or replace their assets but are not involved with the SSRV initiative. These individuals can view the findings from an external perspective and validate whether they believe these findings are valid or if there are important components missing.

These recommendations for developing a collaboration and for the SSRV initiative give direction on how to continue with the development of collaboration, in general and in Noord-Holland. There are some

key points to take into account here. The most important element, which is mentioned many times, is the building and maintaining of trust between organisations in a collaboration. Without trust, even if the collaboration is set up with a clear structure and goals, it is likely to be unsuccessful. Especially in the voluntary collaboration that is developed for Noord-Holland with SSRV. This recommendation is challenging because trust is personal and cannot be imposed on people, so the development of trust should take time and depend on the individuals and organisations involved. Collaboration is about the organisations and people involved so a lot should depend on them. Also, the actions from the collaboration have to correspond with the ability of the organisations. It is important to keep communicating with each other about how the collaboration is progressing, what is working and how it can be improved. By communicating, challenges in building trust and unrealistic actions can be discussed and mitigated.

Finally, the aim of this research was to explore how effective collaboration can be structured between asset owners of infrastructure that requires renovation or replacement. The challenge in the Netherlands is the large renewal task, which is increasing, and the decrease in ability to handle the task because of limited resources and manpower to handle the task. Collaboration is suggested as a solution to this challenge, which is why in this research collaboration between various asset owners was researched. A recommendation for the problem of this research is that it is important to understand the problem and the organisations involved. It is crucial to know why the organisations would want to participate in the collaboration and in what way they can contribute, for example, in terms of resources and knowledge. When that is clear, collaboration can begin to develop.

9.3. Research limitations

There are also some limitations to this research, which will be discussed in this subchapter. The first limitation is that it was a single-case study, which means that the research focused only on the collaboration being developed in Noord-Holland. This limits the ability to generalise it to other regions because different regions can work in different ways or have different types of assets.

Another limitation is that the collaboration that was researched here is still in development. The SSRV initiative is an ongoing process in which collaboration is still being developed. Although there have been some achievements and the process started a couple of years ago, it was not possible to explore the long-term outcomes of the collaboration and the significant accomplishments.

A third limitation is that the interview did not include participants from the management or strategic level of the organisations. This ensured that it was not possible to obtain information about their perception of the collaboration and whether they thought it would be useful to invest time and funding into the collaboration so their asset managers could collaborate with other organisations and take on the renewal task together.

A fourth limitation is that the research primarily focused on the perspectives of public infrastructure asset owners, such as municipalities. External private organisations were not included in this research, so the perceptions of contractors or other market organisations were not included. These organisations play an essential role in executing projects that can arise from the collaboration for the renewal task and offer insights into how the collaboration works during the implementation phase.

The last limitation is that the interviewees were individuals already part of the SSRV collaboration network. This could lead to bias in their perception of how the collaboration is currently progressing and their feelings about it. Also, not all municipalities in the province of Noord-Holland were represented as participants in the interviews, but only a select few were included in the interviews for this research. This prevented that the opinions of all the organisations in the province of Noord-Holland were included in this research.

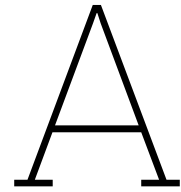
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Interview questions

A.1. Questions initiators

1. Wat is uw functie? Wat is uw rol in het opzetten van (de samenwerking voor) SSRV?
2. Wat was in eerste instantie de reactie van de beheerders op de samenwerking toen deze werd geïnitieerd?
3. Welke type partijen reageren sneller op een samenwerking? Waarom?
4. Is de samenwerking belangrijk? En op wat voor manier?
5. Hoe zit het op dit moment met de samenwerking tussen de beheerders?
6. Wat voor middelen of strategieën worden er gebruikt om beheerders van infrastructuur te stimuleren om mee te doen aan de samenwerking?
7. Wat zijn de grootste knelpunten die u ziet bij het motiveren van beheerders om mee te doen?
 - Kunt u een voorbeeld geven hiervan?
 - Waarom is dit een knelpunt?
8. Zijn er regels/bepaalde voorwaarden om aan de samenwerking mee te doen? Waarom wel/niet?
9. Hoe wordt er omgegaan met verschillende belangen van betrokken partijen?
10. Kunt u een situatie beschrijven waarin de samenwerking tussen beheerders ingewikkeld of stroef verliep?
 - Wat speelde er toen?
 - Welke belangen, overtuigingen of externe factoren speelden mee?
 - Hoe is hiermee omgegaan?
11. Wat zijn tot nu toe leerpunten in het stimuleren van beheerders om samen te werken?
12. Hoe kan vertrouwen worden opgebouwd?
13. Wat zijn vervolgstappen voor het initiatief?
14. Wat is volgens u de sleutel om samenwerking voor de renovatie en vervangingsopgave op gang te brengen?

A.2. Questions asset owners

1. Wat is uw functie? Wat is uw rol in het beheer van infrastructuur?
2. Hoe heeft u te maken met de samenwerking met andere beheerders van infrastructuur? (Bijv. met SSRV)
3. Hoeveel infrastructuur is er in bezit/wat is de orde van grootte t.o.v. andere beheerders?
4. Risico's
 - Wat ziet u als risico met betrekking tot het delen van kennis voor de renovatie en vervangingsopgave?
 - Wat ziet u als risico met betrekking tot het samen aanpakken van de renovatie van een asset/brug/object?
 - Wat ziet u als risico met betrekking tot het loslaten van autonomie?
5. Is er al eerder sprake geweest voor uw organisatie/voor u van een samenwerking met externe partijen?
 - Kunt u een voorbeeld geven wat momenten waarop dit goed ging en waarop dit juist niet goed ging?
6. Wat is voor u cruciaal voor de samenwerking in de renovatie en vervangingsopgave?
7. Wat is voor u de meerwaarde om de renovatie en vervanging van de infrastructuur samen aan te pakken?
8. Heeft u het idee dat er vrijheid zit in de samenwerking?
9. Hoe kan vertrouwen worden opgebouwd?
10. Heeft u een voorbeeld van een moment dat de samenwerking niet optimaal ging?
 - Waar kwam dit door?
 - Hoe kon de samenwerking anders volgens u?
11. Waar ligt voor u de prioriteit bij de renovatie en vervangingsopgave?
12. Wat is voor u belangrijk in de renovatie en vervangingsopgave?
 - Hoe kunnen deze belangen invloed hebben op de keuze om mee te doen aan een samenwerking met andere beheerders?
13. Wat is volgens u de sleutel om samenwerking voor de renovatie en vervangingsopgave op gang te brengen?

B

Consent form

Delft University of Technology
HUMAN RESEARCH ETHICS
INFORMED CONSENT TEMPLATES AND GUIDE
(English Version: January 2022)

The following templates have been developed by the Human Research Ethics Committee (HREC) to assist you in the design of your Informed Consent materials for non-medical research involving human Research Subjects. **It is important to adapt this template to the outline and requirements of your particular study, using the notes and suggestions provided.**

For additional information or specific expertise on preparing your Informed Consent materials you can consult the following:

- The TU Delft [Research Ethics webpages](#),
- Your faculty Data Steward, the TU Delft Privacy Team
- Our brief guide on Completing the HREC checklist
- Our [Risk-Planning tool, Managing Risk in Human Research](#)

If you have any questions about applying for HREC approval which are not dealt with on the [Research Ethics webpages](#), please contact HREC@tudelft.nl

You can find **Dutch versions** of the Informed Consent templates in the Informed Consent section of the [Research Ethics webpages](#).

Informed Consent as a legal and ethical agreement

The key function of the Informed Consent (IC) process is that this is where you (the Responsible Researcher) come to an agreement with your participants about what they will do for your research and what you will do, both legally and ethically, to ensure their physical, emotional and reputational security. It is key that they know exactly what – and particularly what potential risks – they are agreeing to, and that this is clear in your agreement, and executed in practice.

Two types of Informed Consent

“Informed Consent” covers two distinct, if overlapping, elements of a participant’s agreement to participate in scientific research. These are essentially: consent to participate in the research and consent to the way in which any personal data will be processed and managed.

- **Research Participation** – obtaining a participant’s consent to participate is essential for any research involving human “subjects”. It requires researchers to flag the potential physical, emotional or other risks they might be exposed to by virtue of the research process or its findings.
- **Data Processing and Privacy** – at the same time, under the European General Data Protection Regulation (2016) Informed Consent is the most common (but not only) legal basis for collecting Personal Data (including both Personally Identifiable Information and/or Personally Identifiable Research Data) from “human subjects”. Within the context of scientific research specifically it is important that research participants (“human subjects”) understand what potential risks they might face as a consequence of the collection of any Personal Data, as well as what steps will be taken to mitigate those risks. The development and execution of a robust **Data Management Plan** constitutes one of those mitigating steps.

Structure and content of your Informed Consent materials

Your Informed Consent materials can be considered as a legal and ethical contract between you and the people who will be providing you with your research data. In most cases this agreement will comprise of Participant Information and Explicit Consent points. The Participant Information is normally a short, clear summary that informs your participant of anything that might affect their willingness to participate in your research. The specific Explicit Consent points list specific points with which your participants can choose to agree or disagree. Bear in mind, when you are giving participants particular choices, that you will need to execute these agreements with precision.

Standard structure of Informed Consent materials

Participant Information	<ul style="list-style-type: none">• Your Participant Information should clearly summarise what your research aims to do, what participants are asked to do, what risks might arise – including identification – and what steps you will take to mitigate them. Remember to include not just the personally identifiable research data (PIRD) you collect, but also how you will store the Informed Consent forms and any personally identifiable information (PII) therein.• See TEMPLATE 1
Explicit Consent points	<ul style="list-style-type: none">• In addition to the Participant Information it is best practice (and sometimes a legal requirement) to include a list of specific Consent Points with which your participants can agree or disagree.• Bear in mind that where your participants disagree, you will need to have practical plans in place to comply with these specific points.• See TEMPLATE 2

Alternative approaches to Informed Consent

Depending on your research methods and goals, the standard approach outlined above may not be appropriate or possible. For example, if you are gathering your research data using an anonymous online survey, the option of removing specific datasets may not be possible – and so this is not something you can offer in your Informed Consent process. In such cases, the Participant Information and Explicit Consent points are replaced by an **Opening Statement** with which participants demonstrate their agreement by clicking the link to the survey (see [TEMPLATE 1](#)).

Alternative Informed Consent materials

Opening Statement	<ul style="list-style-type: none">• Where your participants are asked to, for example, complete an anonymous online survey, a signed Informed Consent form is not an option. Instead, the Participant Information and Explicit Consent points might be replaced by an Opening Statement. In this case a participant's agreement with the terms and conditions of your research can be signified by clicking through to the survey.• Your Opening Statement should ensure that your participants are aware of what your research is about, and what is expected of them before they click through to the survey.• Make sure that your participants can leave the survey or skip questions in line with your Opening Statement – and that your Opening Statement is clear on this.• Make it clear that by clicking through to the survey participants are agreeing to conditions.
Verbal Consent	<ul style="list-style-type: none">• In some circumstances it might be necessary to use other Informed Consent approaches – such as verbal consent and/or consent of a Gatekeeper.
Debriefing Information	<ul style="list-style-type: none">• Where deception is required for your research, Informed Consent has technically not been given. In such cases you are advised to debrief your participants, explaining why they were deceived and how, and seek Informed Consent again after the debrief.

Where it is not possible to seek Informed Consent at all – e.g.: because your method involves covert observation, relies on existing datasets, or is collected from the public domain – steps to ensure the safety of your participants are nevertheless required. For example, you can make sure that the party or parties providing your data are permitted to do so, collect information on the original informed consent process, or demonstrate that you understand how combining multiple datasets might lead to unintended consequences and the steps you will take to avoid this.

Please contact your Faculty Data Steward or the TU Delft Privacy Team, or consult our Guidance Notes on [completing the HREC checklist](#) for more information.

Executing Informed Consent agreements

Like any contract between parties, your Informed Consent agreement needs to be managed and executed in perpetuity, so make sure that you have plans in place to honour the agreements you have made – including what happens if you or another member of the research team moves

elsewhere. Bear in mind also what is and is not executable in practical terms. For example, if you are seeking approval to use personal names with quotes in any publications, then it is unlikely that you can assure anonymity of stored data. Equally, if you agree with participants to use actual names in any kind of publication, it is best practice to obtain additional, specific approval from named participants prior to publication.

It is critical here that the risks and mitigating steps you identify in your HREC checklist and Data Management Plan are consistent with the agreement you make with your participants. It is your job as the (Responsible) Researcher to ensure that your participants are made aware of any potential risks which they may not themselves foresee. In relation to any Personal Data you may be gathering for administrative purposes and/or as research data, it's equally important that this agreement is in line with how you will manage your data in practice.

To this end, you must make sure that the information across your HREC application documents is consistent and aligned.

TEMPLATE 1: Participant Information/Opening Statement

Opening statement
<p>You are being invited to participate in a research study titled <i>Designing an effective collaboration between infrastructure asset managers</i>. This study is being done by Fien de Mol van Otterloo from the TU Delft and APPM. APPM is used for the recruitment of the participants from their contacts. The interview transcripts will be saved on the APPM OneDrive but anonymized and deleted after the research is completed.</p> <p>The purpose of this research study is to develop a framework for an effective collaboration between different asset managers that involve large-scale infrastructure projects involving renovation and replacement. The main factors and challenges in collaboration are included in the framework to see how a collaboration can be designed and stimulated between different asset managers, and will take you approximately 60 minutes to complete. The data will be used for a research for a master thesis. We will be asking you to explain the challenges that were experienced in a previous collaboration and what stimulates you to participate in a collaboration and specifically in the renovation and replacement of infrastructure.</p> <p>As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by anonymizing the data and saving it in a safe environment where only authorized people have access to.</p> <p>Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions. The anonymized data will be saved at in a safe environment for 10 years.</p> <p>For any further question, you can ask:</p> <p>Fien de Mol van Otterloo Researcher</p> <p>Erik-Jan Houwing Supervisor TU Delft</p>

TEMPLATE 2: Explicit Consent points

Please make sure that you select (and amend as necessary) any Explicit Consent points which are relevant to your study and exclude those which do not apply. You should also add further points and necessary to address your specific research situation.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [DD/MM/YYYY], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	<input type="checkbox"/>	<input type="checkbox"/>
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	<input type="checkbox"/>	<input type="checkbox"/>
3. I understand that taking part in the study involves: [see points below]	<input type="checkbox"/>	<input type="checkbox"/>
The purpose of this research study is to develop a framework for an effective collaboration between different asset managers that involve large-scale infrastructure projects involving renovation and replacement. The main factors and challenges in collaboration are included in the framework to see how a collaboration can be designed and stimulated between different asset managers, and will take you approximately 60 minutes to complete. The data will be used for a research for a master thesis. We will be asking you to explain the challenges that were experienced in a previous collaboration and what stimulates you to participate in a collaboration and specifically in the renovation and replacement of infrastructure. The interview will be recorded with audio or video recording (dependent on if the interview will take place online or face-to-face) and transcribed and made anonymous.		
5. I understand that the study will end august 2025	<input type="checkbox"/>	<input type="checkbox"/>
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
9. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach by anonymizing the transcribed interviews	<input type="checkbox"/>	<input type="checkbox"/>
10. I understand that personal information collected about me that can identify me, such as name and job title, will not be shared beyond the study team.	<input type="checkbox"/>	<input type="checkbox"/>
11. I understand that the (identifiable) personal data I provide will be destroyed after the research for the master thesis	<input type="checkbox"/>	<input type="checkbox"/>
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
12. I understand that after the research study the de-identified information I provide will be used for the report for the master thesis	<input type="checkbox"/>	<input type="checkbox"/>
13. I agree that my responses, views or other input can be quoted anonymously in research outputs	<input type="checkbox"/>	<input type="checkbox"/>
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
16. I give permission for the de-identified transcribed interviews that I provide to be archived in APPM OneDrive and TU Delft repository so it can be used for future research and learning.	<input type="checkbox"/>	<input type="checkbox"/>
17. I understand that access to this repository is restricted to the thesis team	<input type="checkbox"/>	<input type="checkbox"/>

Signatures

Name of participant [printed]

Signature

Date

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

Researcher name [printed]

Signature

Date

Study contact details for further information: *[Name, phone number, email address]*

[Back to text](#)

C

Data Management Plan

Plan Overview

A Data Management Plan created using DMPonline

Title: Master thesis - Designing an effective collaboration between infrastructure asset managers

Creator: Fien de Mol van Otterloo

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2025)

Project abstract:

This research will explore the collaboration in renovation and replacement projects where there are different asset managers of the infrastructure. The infrastructure in Noord Holland needs to be renovated and replaced, but the asset managers are different and it would be beneficial for them to work together to use the resources and manpower the most efficiently. The province of Noord Holland came up with an initiative that wants the asset managers to collaborate. Right now, it is not clear why the asset managers would want to participate in this initiative and how they can be stimulated to collaborate in the projects that can come out of the initiative.

The research will be executed by doing a literature study, case study and by conducting interviews. The interviews and case study will look into the current initiative that is already exploring the way the renovation and replacement project can be executed the most efficiently. By interviewing the asset managers, it can become clear what challenges have already come up and how the asset managers could be stimulated in the collaboration. The literature review will explore the characteristics of renovation and replacement projects and the collaboration between asset managers in infrastructure projects.

ID: 171215

Start date: 17-02-2025

End date: 04-08-2025

Last modified: 28-02-2025

Master thesis - Designing an effective collaboration between infrastructure asset managers

0. Administrative questions

1. Provide the name of the data management support staff consulted during the preparation of this plan and the date of consultation. Please also mention if you consulted any other support staff.

Xinyan Fan, Data Steward at the Faculty of Civil Engineering and Geosciences, has reviewed this DMP on 26-02-2025.

2. Is TU Delft the lead institution for this project?

- Yes, leading the collaboration – please provide details of the type of collaboration and the involved parties below

The graduation project will be executed at APPM and they will help provide the contacts for the interviews and documents for the case study. A graduation agreement has been established to support this partnership.

1. Data/code description and collection or re-use

3. Provide a general description of the types of data/code you will be working with, including any re-used data/code.

Type of data/code	File format(s)	How will data/code be collected/generated? <i>For re-used data/code: what are the sources and terms of use?</i>	Purpose of processing	Storage location	Who will have access to the data/code?
Interview recording	MP4	Face to face or interviews by using Microsoft Teams	Understanding real life challenges in renovation and replacement projects and how asset managers can be stimulated	APPM OneDrive	Myself
Transcribed interviews	docx	Semi-structured interviews	Understanding real life challenges in renovation and replacement projects and how asset managers can be stimulated	APPM OneDrive	Myself
Anonymized transcribed interviews	.docx	Remove personal data from the transcribed interviews	Understanding real life challenges in renovation and replacement projects and how asset managers can be stimulated. Here without the personal data so it can be shared with the rest of the project team	APPM OneDrive	Thesis team & APPM
Signed informed consent form	PDF	Informed consent form signed digitally	To obtain and document informed consent	APPM OneDrive	Myself
Contact information participants	Excel	APPM and personal network	To contact participants	APPM OneDrive	APPM and myself
Personally identifiable research data, employer, job title, professional experience	.csv	During the interview	To validate the participants.	APPM OneDrive	Thesis team & APPM
Documents case study	.docx / .pdf	These documents are received from APPM about the initiative that is already being explored. These are confidential and can be used for the research as an example for a renovation and replacement projects with different asset managers without using the personal data of the asset managers	Understanding the initiative for renovation and replacement projects and the asset managers that are involved.	APPM OneDrive	APPM and myself

II. Storage and backup during the research process

4. How much data/code storage will you require during the project lifetime?

- < 250 GB

5. Where will the data/code be stored and backed-up during the project lifetime? (Select all that apply.)

- Another storage system – please explain below, including provided security measures

APPM OneDrive

III. Data/code documentation

6. What documentation will accompany data/code? (Select all that apply.)

- Data – Methodology of data collection

A summary of the interviews will be provided in the appendix of the thesis

IV. Legal and ethical requirements, code of conducts

7. Does your research involve human subjects or third-party datasets collected from human participants?

If you are working with a human subject(s), you will need to obtain the HREC approval for your research project.

- Yes – please provide details in the additional information box below

I intend to apply for ethical approval from the Human Research Ethics Committee, but have not yet done so.

8. Will you work with personal data? (This is information about an identified or identifiable natural person, either for research or project administration purposes.)

- Yes

9. Will you work with any other types of confidential or classified data or code as listed below? (Select all that apply and provide additional details below.)

*If you are not sure which option to select, ask your **Faculty Data Steward** for advice.*

- Yes, I work with other types of confidential or classified data/code – please explain below

I will work with documents from the initiative that are not all publically available and I will use information from the interviews about the preferences of the asset managers and their infrastructure

10. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your [Faculty Contract Manager](#) when answering this question

The intellectual property rights are framed by a graduation agreement between Delft University of Technology, myself and APPM.

11. Which personal data or data from human participants do you work with? (Select all that apply.)

- Video materials
- Proof of consent (such as signed consent materials which contain name and signature)
- Other types of personal data or other data from human participants – please provide details below
- Audio recordings
- Telephone number, email addresses and/or other addresses as contact details for administrative purposes
- Names as contact details for administrative purposes

Personally identifiable research data, employer, job title, job description, professional experience

12. Please list the categories of data subjects and their geographical location.

The interview participants are asset managers of infrastructure in the province of Noord Holland, such as Rijkswaterstaat, municipalities and ProRail

13. Will you be receiving personal data from or transferring personal data to third parties (groups of individuals or organisations)?

- No

16. What are the legal grounds for personal data processing?

- Informed consent

17. Please describe the informed consent procedure you will follow below.

The researcher will inform the potential participants about the goals and procedures of the research project. The researcher will also inform them about the personal data that are being processed and for what purpose. This information will be sent to the participant before the interviews, when these have been planned. All participants will be asked for their consent for taking part in the study and for data processing by signing a digital informed consent form before the start of the interview/experiment.

18. Where will you store the physical/digital signed consent forms or other types of proof of consent (such as recording of verbal consent)?

The consent form will be deleted after the personal data is no longer available in the interview data

19. Does the processing of the personal data result in a high risk to the data subjects? (Select all that apply.)

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data in your research project.

If any category applies, please provide additional information in the box below. Likewise, if you collect other type of potentially sensitive data, or if you have any additional comments, include these in the box below.

If one or more options listed below apply, your project might need a DPIA. Please get in touch with the Privacy team (privacy-tud@tudelft.nl) to get advice as to whether DPIA is necessary.

- None of the above apply

23. What will happen with the personal data used in the research after the end of the research project?

- Other – please explain below

Personal data will be deleted at the end of the research project

24. For how long will personal research data (including pseudonymised data) be stored?

- Personal data will be deleted at the end of the research project

25. How will your study participants be asked for their consent for data sharing?

- In the informed consent form: participants are informed that their personal data will be anonymised and that the anonymised dataset is shared publicly

V. Data sharing and long term preservation

27. Apart from personal data mentioned in question 23, will any other data be publicly shared?

Please provide a list of data/code you are going to share under 'Additional Information'.

- No other data/code can be publicly shared – please explain below why data/code cannot be publicly shared

It is included in the appendix

VI. Data management responsibilities and resources

33. If you leave TU Delft (or are unavailable), who is going to be responsible for the data/code resulting from this project?

My supervisor Erik-Jan Houwing, CITG, Integral Design & Management

34. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

No resources required

35. Which faculty do you belong to?

- Faculty of Civil Engineering and Geosciences (CEG)

*