rijksuniversiteit groningen

faculteit ruimtelijke wetenschappen

Fostering innovation in the Dutch construction industry

A comparative qualitative case study of four Dutch circular construction projects

Master thesis Environmental and Infrastructure Planning

Name: Marlies Rijkeboer

Student number: 3206866

Date: 4th of July, 2022

Supervisor: Dr. S. Verweij

Colofon

Title:	Fostering innovation in the Dutch construction industry
Subtitle:	A comparative qualitative case study of four Dutch circular construction projects
Author:	Marlies Rijkeboer
Student number:	3206866
Contact:	m.l.rijkeboer@student.rug.nl
Master:	MSc Environmental & Infrastructure Planning
University:	Rijksuniversiteit Groningen
Version:	Final version
Date:	4th of July, 2022
Supervisor:	Dr. S. Verweij
Second reader:	Dr. T. Busscher

Preface

Dear reader,

in front of you lies my master thesis, titled ‘Fostering innovation in the Dutch construction industry’ to contribute to the recent call for more sustainable and innovative construction of Dutch infrastructure.

This work marks the completion of my master Environmental & Infrastructure Planning at the University of Groningen. Together with a bachelor's degree in Technische Planologie, I feel that I have gained a lot of insights into the world of spatial planning and look forward to taking this with me towards a professional career. Even more grateful am I for the amazing student life I could combine this with and all the dear friends, colleagues and activities that came with that.

First, I would like to thank my supervisor, Stefan Verweij, for his guidance in the process of writing this thesis. The good suggestions and critical feedback have taught me a lot during the process. But even more prominently, the enthusiasm and the interesting brainstorms have given me motivation. Secondly, I want to thank all the interviewees for their input. The pleasant and interesting conversations have made this thesis possible and have shown me what it is like to work as an expert in the field. I hope to have translated the gathered information into useful insights for both academia and planning practice.

Additionally, I would like to thank my parents, for their love and support during my college years. Also, I would like to thank my dear friends and roommates for their support, and also the encouragement to focus on other things here and there. In specific I want to thank my friend Luna for always wanting to read through chapters, the endless supply of coffee and the fun study moments during the writing process.

Enjoy reading this thesis!

Marlies Rijkeboer

Heerde, July 2022

Abstract

Innovation is a multidimensional, global, dynamic and open activity which increases competitiveness, generates economic benefits, and improves the quality of living standards through the creation and adoption of innovative ideas and technologies. Growing environmental challenges encourage using innovation as a promising tool for transformative sustainable system change. In line with this, the goal for the Dutch economy is to be circular by the year 2050. Key in achieving this, is collaborative governance. Public, private and civic organizations work collectively, to accelerate the transition towards a circular economy. One of the five transition agendas to accomplish this, is assigned to the construction industry.

The Dutch infrastructure construction industry is struggling with its lacking long-term perspective and its focus on individual phase results. The fragmented and linear project nature of construction projects forms a barrier to innovation. This is problematic since the Dutch construction sector accounts for 50% of the raw materials consumption, of which a large proportion is caused by waste from demolition. In combination with pressing environmental challenges, such as the Dutch nitrogen crisis, policymakers agree that the pace of circular innovation has to step up to create a more sustainable living environment. Unfortunately, the transformation from a linear towards a more circular construction sector requires a radical system change, opposing a challenge for policymakers and construction professionals. This challenge is fundamentally grounded in the fact, that a societal and academic knowledge gap exists in how innovative outcomes are developed and implemented in construction projects.

Therefore, the research aim of this study is to explain how and which structural mechanisms in collaborative governance foster innovation. Structural mechanisms are connected and explained by the model of Carbonara & Pellegrino (2019), who developed a conceptual framework of the relationship between innovation and public-private partnerships (PPP), based on main streams of studies on innovation. This study extends current academic knowledge by using this model to explain structural mechanisms for innovation in other types of public-private collaborative governance models. Additionally, the influence of network management activities on the structural mechanisms of the network structure is studied based on the theoretical insights of Busscher et al. (2022), Klijn & Koppenjan (2006) and Warsen et al. (2019).

A qualitative research methodology is applied by collecting data from documents and semi-structured interviews. The research design answers the research question ‘how do different structural mechanisms contribute to innovation in Dutch construction projects?’ through a comparative case study of four successful circular construction projects characterized by four different public-private collaborative governance models. The selected cases are Croeselaan Utrecht, bio-based cycling bridge Ritsumasyl, Circular Viaduct Kampen and InnovA58 Living Lab.

Findings reveal that early private sector involvement, mutual trust among actors and investing in network management activities, such as facilitating interaction and exploring for new ideas, adapted to the projects’ situation are crucial in achieving innovative outcomes. These results provide foundations for future planning practice implications for more sustainable and innovative construction of future infrastructure.

Table of Content

List of Figures and Tables

Chapter 1 – introduction

1.1 The need for innovation in construction

Innovation is a multidimensional, global, dynamic and open activity which increases competitiveness, generates economic benefits, and improves the quality of living standards through the creation and adoption of innovative ideas and technologies (Ozorhon et al. 2010). While one can debate the definition of innovation, academic literature is full of arguments stressing the importance of innovation in improving education, health, safety services and infrastructure successfully (Esteve et al. 2012; Himmel & Siemiatycki, 2017). Over time, different motives behind innovation development have emerged. Recent studies are drawn to innovation as a promising tool for transformative system change to cope with pressing environmental challenges (Schot & Steinmueller, 2018).

Key to innovative development is that achieving it is a collaborative matter. Explaining, implementing and conceiving innovation through collaboration with multiple public and private organizations is seen as a prerequisite for effective and efficient outcomes (Moore & Hartley, 2008). Collaboration, itself, should not be reckoned as innovation. Yet, collaboration functions as a catalyst for innovations that with solely in-house development would be unfeasible or more complicated to achieve (Esteve et al. 2012). More specifically, by involving the resources and skills of private parties in public service provision, public-private governance is considered an important policy instrument in creating more effective, efficient and innovative public services (Steijn et al. 2011). Subsequently, tackling today's pressing climate issues through collaborative governance is seen as a prominent topic on many national educational, organizational and political agendas (Weihe et al., 2011).

One sector that stands out in prioritizing innovation for optimizing global sustainability, is the construction industry (Vanderley, 2011). The construction – referring to the construction of infrastructure - places a considerable amount of pressure on the environment, by being the largest consumer of natural, limited resources and the usage of over a third of the energy produced globally (Munaro et al. 2020; Vanderley, 2011). Planners, engineers, and environmental scientists globally recognize that projects in the construction sector need to become more innovative to develop construction in a more sustainable way (Montgomery et al. 2015). Unfortunately, to date, the construction industry is perceived as one of the less innovative sectors due to its linear project-based and fragmented nature (Ozorhon et al. 2010; Volker, 2019). Clarifying, current construction projects often operate in separate phases, with every actor focusing on optimizing its contribution to the project. However, when the designer designs without considering the construction, or the contractor does not think about the end-users, fragmentation is caused in a process that theoretically should create one final product, which forms a barrier to innovative outcomes (Volker, 2019). Therefore, scholars argue that a system change is needed to step away from the current business of one-to-one dyads to work towards an innovative, network-based system that avoids entering into customized contracts with every partner (Adner, 2017; Volker, 2019).

1.2 The Dutch construction industry and circular ambitions

Especially in combination with increasing concerns about environmental issues, not the least because of the current nitrogen crisis, this system change is just as important for the Netherlands. Unfortunately, transforming towards a system-based construction sector requires a radical change in business operations and thus opposes a challenge for construction professionals and policymakers. Subsequently, the demand for business models and policies that create an environment that stimulates innovative

outcomes is increasing (Roumboutsos, 2015; Tiossi et al. 2019). Important actions that were undertaken in this regard started on the European level in terms of procurement. Exemplifying, member states are stimulated to make use of ´Strategic Public Procurement´ (Hueskes, 2019). Strategic public procurement can be interpreted as using public procurement as a policy tool that focuses on public policy objectives that include the promotion of environmental aspects (green public procurement), adheres to social and ethical standards or promotes innovative goods, services or works (Ibid). Of interest here, is Preamble no. 47 of Directive 2014/24/EU on public procurement which states that "Public authorities should make the best strategic use of public procurement to spur innovation…" in order to achieve 'the best value for public money as well as wider economic, environmental and societal benefits in terms of generating new ideas, translating them into innovative products and services and thus promoting sustainable economic growth" (European Commission, 2014 in Hueskes, 2019). The increased awareness of promoting sustainable economic growth has triggered member states and has led to governments worldwide experimenting with possible solutions. One of these solutions is connected to a current topic of interest, the concept of the Circular Economy (CE).

In the last decade, CE is often coined as an important enabler in the idea of sustainable economic growth (Trevisan et al. 2022). CE builds upon the system approach, working towards systems that are restorative or regenerative by 'intention and design' (Ellen Macarthur Foundation, 2013). CE steps away from linear project processes and instead focuses on creating sustainable use in the form of recycling and demolition (Van Buren et al. 2016; Volker, 2019). Recently, as part of the Green Deal, the European Commission adopted a Circular Action Plan, which encourages member states to reduce pressure on natural resources and promote circular economy processes (European Commission, 2020). In 2016, the Dutch 'Rijksbrede programma Nederland Circulair in 2050' was therefore established, where the cabinet illustrates how the Dutch economy should transform into a fully circular economy in 2050 (Ministerie van Infrastructuur en Waterstaat, 2016). A large part of this document is dedicated to the more efficient and smarter use of raw materials. Additionally, a new 'Grondstoffenakkoord' was signed, to make specific agreements about the raw materials. The effect on the construction industry is tremendous. In the new 'Uitvoeringsprogramma Circulaire Economie 2021 - 2023' it is stated that for build and construction practices, efforts are made to develop mature innovation systems, which primarily affect the construction industry (Ministerie van Infrastructuur en Waterstaat, 2021). And these attempts are slowly becoming visible in the construction landscape. With the ambition of the main road and waterworks agency, Rijkswaterstaat, to become energy neutral in 2030 and circular in 2050 a variety of initiatives can be visited, which mirror attempts and successes in the field of circular innovation. A few successful circular projects have therefore already been completed, of which a few will function as cases for this thesis. These are; the redevelopment of the Croeselaan in Utrecht, the first Dutch Circular Viaduct in Kampen, a bio-based cycling bridge in Ritsumasyl and InnovA58 Living Lab InnovA58 (see Chapter 3).

1.3 Relevance

1.3.1 Construction innovation and societal impact

The construction of infrastructure is important for the functioning of today's economy. Businesses depend on transport systems for efficient movements of goods, local communities are dependent on transportation to health care, education and personal mobility and transportation networks are needed for people's everyday commute (Montgomery et al. 2015). Unfortunately, the construction industry is responsible for a considerable environmental impact through their construction practices, using about 50% of the total raw materials and 36% of the global final energy and together with the continuation of CO2 emissions, pressure on the environment is tremendously (Norouzi et al. 2021). This is also

observable in the Netherlands, where the construction sector accounts for 50% of the raw materials consumption. A large part of this comes from the demolition of infrastructure construction (Rijkswaterstaat, 2019).

In combination with recent environmental circumstances, referring to the Dutch nitrogen crisis, it is no wonder that experts agree that efforts should be made to step up the pace of innovations (Ibid).

Infrastructure systems need to be planned, designed, constructed, and maintained more innovatively so that they better manage the potentially negative environmental and social impacts, and risks while at the same time promoting directly and indirectly related positive impacts or benefits (Montgomery et al. 2015). Research has shown that collaboration is crucial in this (Hueskes, 2019; Rutten & Oerlemans, 2009). This, however, is challenging for policymakers and engineers (Xue et al. 2014). Explaining, the construction industry has a fragmented supply chain and a complex variety of participants collaborating at various levels, including different knowledge, skills and technologies in different organizations, which makes transformative change for sustainable development difficult (Volker, 2019; Xue et al. 2014). Although Dutch ambitions are designed to create an energy-neutral construction sector for 2030, transformative change is seen as drastic and knowledge about the desired practice or collaborations in achieving that, is still more speculation than reality (Rijkswaterstaat, 2020). To respond to this societal knowledge gap, it is crucial that planners and engineers, active in the construction sector, gain insights into how innovation through collaborative governance can foster innovation in Dutch construction projects.

1.3.2 Construction innovation and earlier academic literature

Since construction projects often operate in a public-private partnership, which can be defined as a mode within collaborative governance, most studies have studied such collaborative matters (Brogaard, 2017). In general, these studies focus on contractual arrangements, (financial) performance and the organizational form (Hueskes, 2019; Reynaers, 2014). In terms of innovation, they touch upon the relevance of public procurement delivery methods in combination with innovative solutions (Eaton et al. 2006; Hueskes & Verhoest, 2015; Roumboutsos & Saussier, 2014; Uyarra et al. 2014 in Verweij et al. 2020). Public-private partnerships have been praised for being innovation-friendly and incentivizing sustainability, because of their integration of project phases (DBFMO) and their long-term contracts stimulate life cycle costing perspective, risk transfer and collaboration between actors (e.g. Grimsey & Lewis, 2004; Lenferink et al., 2013; Verweij & Van Meerkerk, 2021). Unfortunately, although studies show interesting results of the influence of collaborative governance on innovation and sustainability, the number of empirical studies that provide evidence is limited.

An academic research gap exists in how and under which conditions these collaborations can enable innovation and sustainability (Himmel & Siemiatycki, 2017; Hueskes, 2019). This thesis, therefore, focuses on studying how innovation is fostered and which mechanisms are needed in the context of collaborative governance in construction projects. Carbonara & Pellegrino (2018) have investigated literature focused on public-private partnerships and innovation and have developed a conceptual framework of ‘structural mechanisms’ - elements in existing public-private collaborations that are connected to for instance the network of a project - which is likely to foster innovation. Studies already show that procurement–related conditions (contract structure) and collaboration–related mechanisms (trust) stimulate innovation. Based on new insights, the model has been further developed (Carbornara & Pellegrino, 2019). This novel framework will be used to explain which structural mechanisms foster innovation. Yet, this thesis then focuses not only on public-private partnerships but more broadly on various public-private collaborative governance models (see also Table 1). to extend empirical evidence

on which and how mechanisms foster innovation through collaborative governance in construction projects.

Furthermore, so far the study of Carbonara & Pellegrino (2019) and for example, Verweij et al. (2020) who also focused on structural have already indicated that structural mechanisms of collaboration-related conditions (such as trust and cooperation between partners) are necessary to foster innovation. Nevertheless, they remain vague as to which management activities, such as network management are necessary (Callens et al. 2022). These activities are however crucial in multi-actor collaboration as they encourage learning processes which result in innovative ideas (Ibid). In general, academics have already studied the role of individuals/entrepreneurs in performing their network management activities in public-private collaborations (Osborne & Brown, 2011; Slappendel, 1996 in Hueskes, 2019). Yet, it is the combination of the structural mechanisms and the way they are managed by managers that should receive more attention to be able to extend current studies on how innovation can be fostered, implemented and managed that requires insights (Klijn & van Twist, 2007). While insights on the micro-level of network management have already been researched this thesis, therefore, responds to this second academic research gap, by gaining an understanding of which network management activities are crucial in achieving innovative outcomes.

1.4 Research aim and research questions

Over the last decade, a rise in collaborative governance initiatives can be observed, since solving today's complex environmental problems requires expertise from both the public and the private spheres (Bianchi et al., 2016). There is a growing interest in the use and applicability of collaborative governance structures for sustainable development, the conditions under which they perform well and the way they can be improved (Hueskes, 2019). To induce transformative sustainable change in the current linear fragmented and environmentally unfriendly project nature of the construction industry, it is necessary to innovate.

Hence, the research aim of this study is to understand how structural mechanisms in collaborative governance foster innovation, to explain which structural mechanisms are more likely to foster innovation than others and to gain insights into how these were managed, by comparing the four Dutch circular construction projects; Croeselaan Utrecht, Circular Viaduct Kampen, Bio-based cycling bridge Ritsumasyl, InnovA58 Living Lab.

To fulfil the aim of this research, I have formulated the following research question:

"How do different structural mechanisms contribute to innovation in Dutch construction projects?"

To provide an answer to the main research question, it is necessary to gain an in-depth understanding of collaborative governance forms and their characteristics. Accordingly, structural mechanisms must be defined and their relationship to innovation explained. Network management activities influence the impact of structural mechanisms and need to be explained.

Consequently, the research design is further shaped by the following sub-research questions:

- How can innovation be defined?
- What types of collaborative governance can we distinguish in construction management and what are their characteristics?
- Which structural mechanisms explain the relationships between innovative outcomes and collaborative governance and which network management activities are used?
- What lessons can we draw for future planning practice?

1.5 Reading guide

This thesis comprises five chapters. Chapter 2 will discuss the core concepts and theories from literature. Following the structure of this chapter, chapter 2.1 will provide a more in-depth understanding of innovation in construction projects. Chapter 2.2 will explain different forms of collaborative governance and their characteristics concerning fostering innovation. Chapter 2.3 will introduce structural mechanisms for innovation while incorporating theoretical underpinnings of the influence of network management activities. Chapter 3 illustrates which methodology was used to guide the empirical methods for this study. Chapter 4 presents the results of this thesis. Based on the results, Chapter five will provide an answer to the main research question and will discuss the outcomes in light of existing literature. Additionally, Chapter 5 presents the conclusion, the discussion and suggestions for future research. Chapter 6 provides a reflection on the research process.

Chapter 2 - Theoretical Framework

2.1 Innovation

In Chapter 2.1.1, the concept of innovation will be discussed and historical perspectives on innovation application will be touched upon. The latter is relevant since it introduces the means behind the motive to transform the current linear construction practice. Chapter 2.1.2 will position the concept of innovation in the context of the construction sector. In the construction sector, a specific category of innovations has been of interest in line with the urge to regard construction projects as a system rather than a linear process: circular innovations. Chapter 2.1.3 will, therefore, provide a more in-depth understanding of the concept of the Circular Economy (CE) and its beneficial impact on achieving a more sustainable construction sector.

2.1.1 Defining innovation

Innovation is a complex construct studied by researchers from different backgrounds and several perspectives, which makes forming a unanimous definition for the term difficult (Damanpour & Schneider, 2009). However, to arrive at a definition that illustrates how structural mechanisms more or less facilitate innovation through collaborative governance in construction projects, it is necessary to first arrive at a definition of the term 'innovation' that fits the context of this thesis. When investigating the development of the concept of innovation over time, early literature departs from the point of view of Schumpeter (1939, p. 84) who states that "...any ´doing things differently´ in the realm of economic life are instances of what we shall refer to by the term innovation". Ever since the concept has matured and has received a larger scope. An academic definition that is often utilized and reflects the broader nature of the term, is formulated by Damanpour (1992, p. 556), who describes innovation as "the adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization". This adheres to the most important requirement of innovation; it has to be something new or significantly improved (OECD, 2005). Moore & Hartley (2008) add that innovation is characterized by the fact that it can only be implemented and conceived as innovation when it is constituted by multiple organizations. Explaining, that in order to create innovations inside one's firm, in any circumstance you will need others to accomplish this innovation.

Before diving into different types of innovation (see chapter 2.1.2), it is necessary to visit how innovation can be categorized to understand how innovation is interpreted in light of this thesis. In general, according to Philips (1997), one can distinguish between technological innovations and non - technological innovations. Technological innovation entails the development or significant improvements of new products and processes. Non-technological innovations, also known as organizational and marketing innovations, entail significant changes in management or for instance price strategies (Philips 1997; OECD, 2005). In this regard, I specifically address one important distinction. Explaining, within non-technological innovation, one can encounter 'administrative innovations', which refer to new policies, but also to new organizational forms (Van de Ven, 1986 in Hueskes, 2019). New organizational forms may entail innovative inter-organizational arrangements between public, private and non-profit organizations, created to tackle mutual problems (Mandell & Steelman, 2003). In this regard, innovations can be viewed from two perspectives. First, some forms of collaborative governance (Chapter 2.2), can be seen as the innovation itself (Windrum, 2008). Second, the outcomes arising from these collaborative governance structures can be seen as innovations. This thesis focuses on the latter. Hueskes (2019) who has similarly approached innovation in her work, describes that innovation is something that has been brought into practice, or applied, and is perceived as being new to those

involved in the adoption; therefore, innovation refers to the outcome of a project and does not refer to a single innovation, but to the degree to which innovations have been applied through the efforts made in the design construction, maintenance or operation phase. Departing from this translation of the term innovation, Chapter 2.1.2 will approach important historical perspectives of how innovation in construction can be framed.

2.1.2 Innovation in construction

Achieving innovative outcomes is dependent on how and which choices are made earlier in the collaborative process (Hueskes, 2019). Experiences from policymakers and practitioners who are involved in processes for innovation interpretively connect different views and lead to new analyses and actions. These views can be regarded as 'framings' which represent interpretations of past experiences and imaginations of future potential which create the foundation of new actions and expectations (Taylor, 2003). Since they extend beyond the public policy sphere, they also influence the mobilization and actions of non-governmental organizations and private sector entities (Ibid). Schot & Steinmueller (2018), in their work, distinguish three historical frames. The first frame is connected to the Post-World War II period. In this stage, innovation was connected to the idea that government support for science and research and development would result in growth and would address market failure in the private provision of new knowledge. The second frame emerged in the 1980s and is highly connected to the globalizing world. With a focus on competitiveness, the innovation here is perceived in terms of knowledge creation, commercialization and enabling entrepreneurship by building clusters and networks to stimulate learning (Schot & Steinmueller, 2018). The third frame is linked to contemporary social and environmental challenges and calls for transformative change. This transformative change refers to socio-technical system change. An example of how this is operationalized is the establishment of the Sustainable Development Goals (SDG) of the United Nations, developed to induce sustainability actions in countries. In general, all three frames are important for policymaking, however, it is stated that transformative system innovation should be a priority (Ibid). For construction innovation, the last frame is an important driver for reaching innovative outcomes in the construction sector.

Explaining, as previously mentioned, the construction industry is widely perceived as one of the less innovative sectors. For the Dutch context, this is also observable. An overall lacking long-term perspective and a focus on individual phase results make that innovation stays behind (Rijkswaterstaat, 2019). Studies confirm that the fragmented and project-based nature limits innovative outcomes (Ozorhon et al. 2010). At the moment, every construction project is seen as a separate supply chain. For each phase partners are separately procured, transactions are safeguarded and involved actors have to start afresh after each phase to think about what is desired which forms a barrier to innovation (Volker, 2019). Partnering in the construction supply chain would be beneficial, yet is often seen as complex. Due to the large environmental pressure, the construction sector creates, transformative change is necessary. An increasing number of scholars advocate that viewing construction projects as ecosystems is a very promising idea to redefine relationships in the construction industry (Volker, 2019). Systems are network-based structures rather than one-to-one dyads and avoid the urge to enter into contractual agreements with every partner (Adner, 2017; Volker, 2019). A system environment is created, where a network of actors continuously are coordinated based on the same set of rules and together work towards collective outcomes in bundled phases. System thinking would create a large awareness of innovating collectively to lower transaction costs in later stages (Volker, 2019). A lot of literature is emerging around the concept of the system approach. In light of this thesis, it is important to acknowledge its appearance, yet the scope does not allow for an in-depth study of this concept. Also, it is not widely applied in the Dutch context yet. Since the idea behind such an approach is however interesting to

investigate, this study will slightly touch upon it by including 'bundled phases' as one of the structural mechanisms, to see how the integration of phases contributes to fostering innovation. This will be further discussed an explained in Chapter 2.3.

So far I have discussed relevant categories of innovation and current motives for innovation application. It is now necessary to visit which type of innovations I will consider in this thesis. In general, four types of innovation for the construction industry can be distinguished; product, process, organizational-contractual and financial innovation (Russell et al. 2006, Tawiah & Russell, 2008). Product innovation is mainly focused on developing innovative technologies. This may entail the use of new, more sustainable materials, such as bio-based materials, in the design of a bridge. Process innovation relates to activities such as innovating logistics, and assembling activities for construction to efficiently prepare the construction site (Russell et al. 2006). Third, Russel et al. (2006) address organizational-contractual innovations. These kinds of innovations relate to stakeholder relationships and contractual agreements. Lastly, financial innovations are included in their taxonomy. Financial innovations entail developing new ways of streaming revenues or creating innovative forms of financing and payments. The last two types of innovation also concern off-balance-sheet financing, contractual terms concerning performance-based payment mechanisms and the negotiation of risk assignment, important motives to develop infrastructure projects through PPP structures (Verweij et al. 2019). This thesis focuses mainly on product innovation. To respond to these recent developments, the scope of product innovation will be further narrowed down to circular innovation. The next sub-chapter will provide a more in-depth understanding of the selected type of product innovation, circular innovation and its embeddedness in the concept of Circular Economy.

2.1.3 The construction industry and the Circular Economy

As mentioned in Chapter 1, the interest in the circular economy concept lies in its compatibility with sustainable development. Nevertheless, the relationship between the circular economy in terms of innovation for sustainable development is also sometimes regarded as weak (Velenturf & Purnell, 2021) and needs explaining. Overall, there is an agreement that sustainable development requires improvement of social, economic and environmental outcomes. While economic growth is often associated with environmental degradation Brundtland (WCED, 1987) states that it is economic growth that leads to the improvement of environmental resources. It is this foundation, that found resonance in the concept of CE (Velenturf & Purnell, 2021). Nowadays, the concept of CE aims at not only economic benefits (savings by reducing purchasing primary raw materials), but also at environmental impacts such as impact reduction and social benefits such as job creation (Saidani et al. 2017). CE can be defined as "an industrial system that is restorative or regenerative by intention and design" (Ellen Macarthur Foundation, 2013, p. 7). Circularity is a property of a system, rather than the property of an individual product or service (Adams et al., 2016; Ceschin & Gaziulusoy, 2016; Konietzko et al., 2020). Development, therefore, belongs to the earlier mentioned transformative system change (Trevisan et al. 2022). This is why transforming towards a circular economy in construction projects requires both product innovation as well as system innovation. Both the focus on product innovation, and within product innovation, circular innovations, as viewing construction projects as a system connects with the model used in this thesis (Carbonara & Pellegrino, 2019) which builds upon this.

The current Dutch linear models of production, consumption and waste generation, fundamentally conflict with sustainable development. Namely, CE requires stepping away from a linear project fashion and instead aims to go full circle, to create sustainable use in recycling and demolishing (Van Buren et al. 2016; Volker, 2019). In such a transformation, it is no wonder that industrial actors, non-expert in

CE, are requiring guidance in their shift from a linear to a more circular economy (Saidani et al. 2017). Circularity indicators appear to be relevant in the context of circular economy transition (Ibid). Kircherr et al. (2017), in their work, have investigated 114 applications of the concept of CE and have concluded that in current understandings circular economy is mostly depicted as elements of the 4R model (Reduce, Repair, Reuse, Recycle) which in practice then mainly expresses itself on the combination of three of them, being: reduce, reuse and recycling. Hereby, reduce is interpreted as increasing efficiency in product use of use fewer natural resources or materials, reuse is interpreted as reusing a product that is still in good condition and fulfils its original function and recycling is interpreted as processing materials to obtain the same or lower quality (Potting et al. 2017 in Kircherr et al. 2017). The selection of cases that have included successful innovative circulations is based on these three indicators (See also Chapter 3.2).

2.2 Collaborative governance

In Chapter 2.2.1, collaborative governance will be discussed and defined. This chapter will also explain the relationship between collaborative governance and the idea of systems for innovation. In Chapter 2.2.2 different forms of collaborative governance will be outlined and the motive behind public-private interplay for innovation will be explained.

2.2.1 Defining collaborative governance

Infrastructure construction projects are complex in nature (Pryke et al., 2018), have a significant impact on the environment and require multiple separate actors, encompassed in a network (Hastie et al., 2017). These networks carry important properties, which makes that they could be regarded as functioning systems. Explaining, Leendertse (2015) illustrates that networks are seen as fundamental building blocks of economic activity. Governance, in that regard, is seen as managing the combination of these building blocks. One could argue that networks can be interpreted as systems, cross-linked by various actors (Leendertse, 2015). Important here is that a system is not regarded as statical, but as something that can change and possesses dynamics (Verhees, 2013). Of course, each system of actors acts differently. They can differ from linear systems to circular systems to open network systems (Verhees, 2013). The framework of Carbonara & Pellegrino (2019) was deliberately selected since it adheres to a large range of such systems, as will be further explained in Chapter 2.3. In this thesis, I will further approach these systems in terms of public-private collaborative governance structures.

To date, collaborative governance has become a widely studied term in public administration literature, yet its definition remains broad and its use rather inconsistent (Emerson et al., 2011). Scholars position their opinions around the definition of collaborative governance based on various conditions, such as whether governance is initiated and/or controlled by public actors, whether the collaboration is to be seen as permanent or task-oriented and for instance how the collaboration is perceived by its actors such as objectless collaboration to collaboration for clear public purpose integrated into policy design or decision-making (Ansell & Gash, 2007; Batory & Svensson, 2019). In more practical words, one could state that the concept of collaborative governance fluctuates from ‘narrow’ (restrictive) definitions to more ‘diffused’ definitions. The narrow definition of collaborative governance implies that processes and actions are driven by governmental bodies that involve non-governmental bodies in a specific stage of the policy process, to achieve a predetermined public policy objective (Batory & Svensson, 2019). An example of this can be found in the work of Ansell & Gash (2007, p. 544) who define 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-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets’. This definition implies that the government is the initiative-taking actor, which excludes lobbying efforts by non-state actors. Moreover, it excludes coordination within and among governmental sector actors (Batory & Svensson, 2019). Continuing on this, a more diffuse notion of collaborative governance leaves room for different initiators of the process, other types of participants and varied aims for collaborative actions. An example of this is brought by Emerson et al. (2011, p.2) who state that collaborative governance can be understood as ‘*the processes and structures of public policy decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/or/ the public, private and civic spheres to carry out a public purpose that could not otherwise be accomplished’*. This definition allows for a broader engagement of stakeholders, than solely formal state-initiated arrangements and engagements between governmental and non-governmental stakeholders, as the earlier definition assumed. Explaining, it encompasses ‘multi-partner governance’,

which can include partnerships among the private sector, the state and civil society as well as joined-up government and hybrid arrangements, such as public-private partnerships (Agrawal & Lemos, 2007; Emerson et al. 2011), It is the versatility of this definition that offers the possibility to use this as an umbrella term to be able to incorporate discussing various forms of public-private collaborative governance in this thesis. The next sub-section will explain which trends can be observed in the public-private interplay for innovation and will provide important characteristics for some main forms of collaborative governance, shaping the scope for the cases as well.

2.2.2 Governing for innovation: a public-private interplay

The provision of innovative public service projects requires a balance between the diverging interests of public and private actors. In short, this balance expresses itself in the way the public sector has a responsibility to provide services to inhabitants and ratepayers, while the private sector is entitled to receive compensation for providing and maintaining the infrastructure service, as well as being compensated for allocating private capital in the provision of infrastructure (Mandri-Perrott & Stiggers, 2013). Innovation plays an important role in the private sector, with regard to competitiveness. It is the key success factor, since it triggers improving products, helps to cut out costs and may open new markets (Cankar & Petkovsek, 2013). Innovation is gaining importance in the public sector as well, as it improves the quality of service delivery as well as it reduces costs. (Ibid). The importance of collaboration is increasingly acknowledged, fed by several trends (in Grotenbreg & van Buuren, 2018):

- A gradual dispersal of innovation policy away from national governments towards regional and local authorities, leading to a more multi-level setting (Kuhlmann, 2001)
- More applied, tailor-made governmental support for innovation and increased interaction with industry and universities (Etzkowitz & Klofsten, 2005)
- A focus on collaborative governance and a more coordinating role for governments (Grotenbreg & van Buuren, 2018)

Evidently, the latter trend links with the topic of interest here. First, because a more coordinating role for the public government indicates an increasing reliance on collaboration that goes beyond governmental borders, which corresponds with the definition presented in the previous sub-section. Second, the last trend is fed by motives that are also visible in the innovation aims of the construction sector. Explaining, Klijn & Koppenjan (2015) state that to solve today's complex problems, a collaboration between non-governmental actors, public and private actors should be mobilized. To deal with environmental challenges, the state's capacity for solutions is diminishing and other actors are stepping in (Grotebreg & van Buuren, 2018). Collaborative governance here encourages interaction and cooperation between the institutional spheres (Lundberg, 2013).

Accordingly, now that we have visited the definition of collaborative governance and have arrived at the motives behind the motivation of collaborative governance for achieving innovative outcomes, I will go more in-depth into the various forms of collaborative governance, which also touches upon the different public-private collaborative governance models of the studied cases.

2.2.2.1 Traditional contracts and innovation

To display a spectrum of collaborative governance, the model of Koppenjan (2002) is used. I will explain broadly four types of collaborative governance. For the first two types, Figure 1 is used. For the latter types, section 2.2.2.2 will provide more in-depth information.

As Figure 1 illustrates, there are a few main categories of collaboration that can be distinguished, ranging from the fully public sector (on the left of the figure) to the fully private sector (on the right of the figure). The latter will not be touched upon in this thesis, due to the absence of public involvement (see also Chapter 3.2). The first category that will be discussed describes traditional public contracting forms. An example of traditional public contracting forms is a Design & Construct contract, also used in the renewal of the Croeselaan Utrecht (Case 1). In a D&C contract, the investment responsibility of the public sector is high. In terms of innovation, D&C contracts in general do not encourage the private contractor to develop improved designs, because the private contractor is not responsible for maintenance costs occurring after project completion (Culp, 2011 in Verweij & Van Meerkerk, 2020). Another contract form, the ´Bouwteam' also belongs to this category but focuses mainly on the design phase. A Bouwteam contract can be seen as a collaborative model where the contractor is early involved to share knowledge about the realization costs of the design and its execution, which makes it possible to reduce costs and might also encourage more innovative designs (Chao-Duivis, 2012).

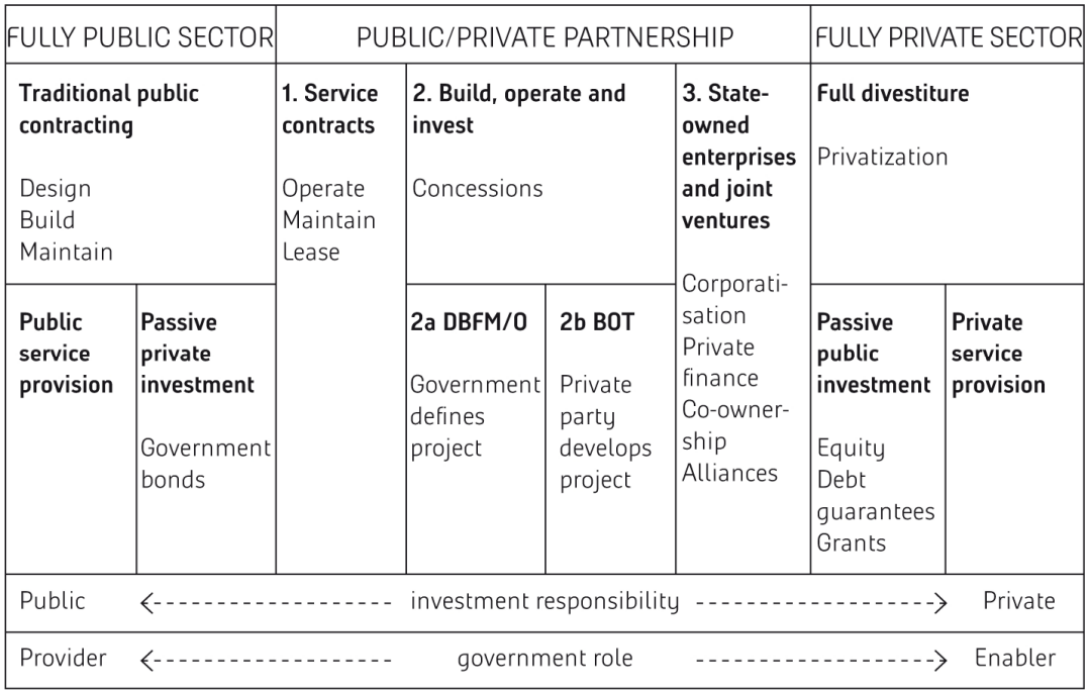

Figure 1: Contract forms from public to private (Koppenjan in Priemus et al. 2008)

In the middle of the figure, public-private partnerships are addressed. PPPs are seen as a mode of collaborative governance (Brogaard, 2017 in Callens et al. 2021). Their long-term engagement and multi-actor collaboration stimulate innovative outcomes because of interaction which creates synergy and learning processes (Callens et al. 2021). Grimsey & Lewis (2004) describe PPPs as '*arrangements whereby private parties participate in or provide support for, the provision of infrastructure, and a PPP project results in a contract for a private entity to deliver public infrastructure-based services*' (Grimsey & Lewis, 2004, p. 2). In literature, it is often stated that two characteristics of PPP are distinctive from other partnerships. First, projects are mid to long-term in duration and second, the partners in the partnership must work together to develop the desired outcome and thus share costs, risks and benefits (Esteve et al. 2012; Klijn & Teisman, 2003). In literature, two main forms of PPP can be distinguished, the concession model and the alliance model (e.g. Klijn et al., 2007., Eversdijk & Korsten, 2009). The concession model is largely based on a contractual arrangement where private parties design, finance and construct and possibly also maintain and exploit a public sector project (Koppenjan, 2005). The most common concession contract used in the Dutch construction industry is DBFM(O), because of its

focus on lowering transaction costs in between different elements of a project (for instance the design and the maintenance phase), also illustrated as 'value for money'. Additionally, added value is seen in the way the private sector can be motivated to integrate innovations, during the partner phase (Koppenjan, 2005). Concessions are characterized by their strict rules, while alliances are focused on soft management, such as mutual trust (Reynaers, 2014; Leendertse 2015; Verhees et al. 2015). The idea that both public and private parties from one team to invest in infrastructure projects have one mutual goal, as is the case in alliances, could potentially lead to more innovation and a more efficient process (Koppenjan & Klijn, 2004).

2.2.2.2 Living laboratories and other public-private governance structures

Another type of public-private governance model that currently can be found in the construction industry is the form of living laboratories (Living Labs). Living Labs can be seen as 'public-private-people' partnerships (Neef et al. 2017). In such partnerships, specifically sustainability, innovation and learning ambitions are integrated and co-creation is being pursued in an organic setting. In general, two general two forms can be distinguished, namely Product Oriented Living Labs (POLs) and Urban Transition Labs (UTLs), which differ in characteristics (Ibid). UTLs work within urban systems to mobilize change, by testing and learning from innovation in real-time to respond to broader societal, economic or environmental issues in a given urban place (Bulkeley et al. 2016). Relevant to this study are the POLs, a form where for example InnovA58 primarily was designed for (Verweij et al. 2018). POLs focus on product innovation in a demarcated area. Lastly, it must be stated that outside of the categories shown in Figure 1, it is not uncommon that the search for the use and applicability of collaborative governance for innovation also induces other forms of collaborative governance, outside of the main categories (Hueskes et al. 2019). An example of this is the Bouwteam agreement used in the bio-based cycling bridge Ritsumasyl, also case 2 that was studied (see Chapter 3.2). Whilst I earlier mentioned that such a contract belongs to the traditional public contracting methods, for this project, the Bouwteam was extended outside the design phase, to keep the continuity of the present knowledge and expertise throughout the process. Therefore, it is that this thesis does not primarily focus on the contract, but rather on the mechanisms that drive innovation within collaborative governance. Which drivers and barriers are most common for construction projects and which structural mechanisms can be crystallized from this, will be explained in the next chapter.

2.3 Structural mechanisms for construction innovation

The previous chapter introduced the concept of collaborative governance and its links to innovation and illustrated different public-private collaborative governance models and their characteristics. In chapter 2.3.1, the connection between public-private collaborative governance models and structural mechanisms that more or less foster innovation in construction projects will be illustrated based on the model of Carbonara & Pellegrino (2019). Furthermore, characteristics of network management and activities that managers can undertake, are discussed.

2.3.1 structural mechanisms

Steering for innovative outcomes can be difficult when the conditions of the system are not clear (Verhees, 2013). Cankar & Petkovsek (2013) describe this complex relationship in a project's network in the form of internal and external drivers. For the private sector, internal factors that influence the openness to innovation are for instance innovation culture across the organization, organizational structure, the attitude of managers towards innovation, goal-setting and financial aspects, while external factors include the economic state of affairs, existing government policies, collaboration with other suppliers and links with academic and research institutions (Cankar & Petkovsek, 2013). For the public sector, internal factors are described as good management, leadership, training for public servants, bureaucracy and organizational structure design, while the external drivers consist of collaboration between the public and private sectors and for instance the presence of rewards for innovative public sector initiatives (Ibid). Another important driver, more political, is dealing with budget reductions or a lack of funding resources, which provide a great incentive for public institutions to be more innovative in their daily tasks. It is no wonder, that in a collaborative setting where both individuals within an organization, as organizations with each other talk in diverging interests, it is rather difficult to filter out what optimal circumstances for fostering innovation are. Academics have tried to crystalize some of these circumstances. For instance, studies show that in particular PPP contracts can be considered to have a positive relationship with the provision of innovative solutions on their risk transfer, long-term commitment, collaborative working and design freedom as earlier mentioned. However, on the contrary, some scholars claim that the benefits of PPP for innovation are limited. Leiringer (2006) for instance, states that governments must be cautious about using PPP as an innovative public procurement method. Furthermore, Klijn & Teisman (2003) state that the idea of co-operating actors who achieve added value together and share risks is too over-promising since partners in public-private collaborations have difficulties with joint decision-making, decision making and tend to lean towards contracting out and separating responsibilities.

It is the lack of existing studies that failed to provide an understanding of the relationship between public-private collaborations and innovation, that has encouraged Carbonara & Pellegrino (2019) to design a conceptual framework, which is shown in Figure 2. First, two statements for the application of this model in this thesis have to be mentioned. First, since their work is based on today's main streams of studies on innovation, it provides a recent overview of mechanisms that currently are expected to have a positive relationship with innovation. Second, since this model is originally focused on PPP and PPP exist in many shapes, dimensions are broad interpret and selected to be applicable to every PPP model (Carbonara & Pellegrino, 2019), which makes that I regard this model suitable for studying other public-private collaborative governance structures as well.

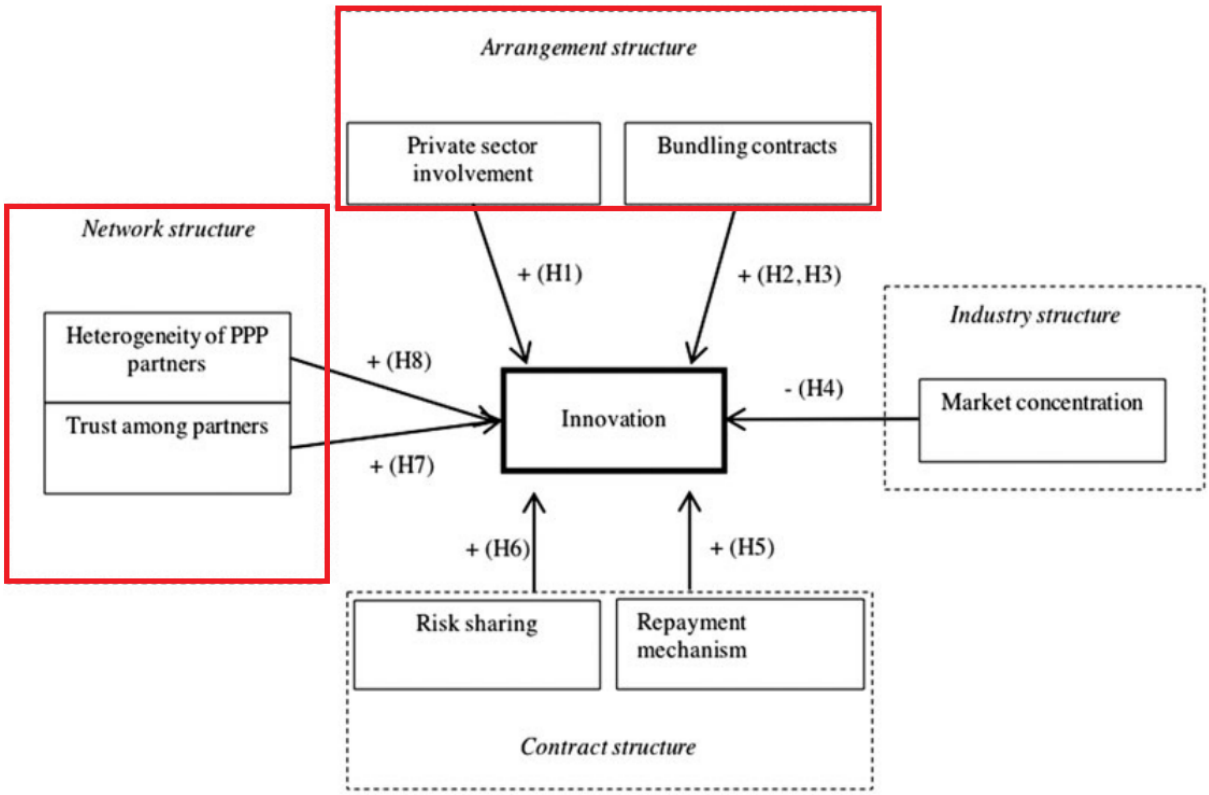

Figure 2: relationships between PPP features and innovation (Carbonara & Pellegrino, 2019)

Every structural mechanism can be traced back to one of the four dimensions; the arrangement structure, the industry structure, the contract structure, and the network structure (Carbonara et al. 2013, Roumboutsos & Saussier 2014, Carbonara and Pellegrino 2018 in Carbonara & Pellegrino, 2019). As earlier stated, many studies have already studied the influence of the contract and thereby focused on risk-sharing and payment mechanisms (see also Chapter 1). Furthermore, the industry structure is difficult to apply since this research focuses on the Dutch industry. Hence, two dimensions will be discussed, the arrangement structure and the network structure, outlined in red in Figure 2. This means that first, for the arrangement structure, (early) private sector involvement and the extent to which phases were bundled in the construction projects, will be studied. Second, for the network structure, trust among partners and heterogeneity will be studied. Additionally, Carbonara & Pellegrino (2019) stress that it is important to elaborate on managerial implications explaining the relationship between innovation and collaborations with this model. In section 2.3.4, the role of network management will be discussed.

2.3.2 Arrangement structure

Multiple factors separate the public from the private sector. A prominent difference lies in the fact that firms have to take risks to survive the market, while public organizations do not directly gain from this. Risk aversion is a key barrier to innovation in the public sector, while the characteristics of the private sector, often profit-seeking behaviour and a reward-like culture towards successful innovation, can help to make projects more innovative than the public sector on its own was able to do (Carbonara & Pellegrino, 2019). Hence, there are important mechanisms connected to how the collaboration for a

construction project is arranged. As Figure 2 illustrates, there are commonly two mechanisms that can influence innovative outcomes when it comes to the arrangement structure.

First, **private sector involvement** is pointed out. An extended scope of private sector involvement in infrastructure projects mostly leads to more cost-saving innovation (Himmel & Siemiathyki, 2017). Studies in business management, point out that the internal characteristics of organizations that influence their innovative performance have concluded that the risk-taking behaviour of the private sector is a key determinant of achieving innovative outcomes (Kline & Rosenberg, 1986; Dosi, 1988; Shapira, 1994; Utterback, 1994 in Carbonara & Pellegrino, 2019). Early private involvement could, thus, provide conceptual creative and innovation opportunities which can strengthen plan development (Verhees, 2013). However, it must be stated that the type of contract does influence this because not in every contract, private sector involvement will be designed in the same way (Kwak et al. 2009). Explaining in a traditional contract this might be more formally arranged than in a living lab environment.

Second, a condition that is highly related to the former condition is **bundled phases**. Many scientists pled for a more ecosystem approach in construction management (e.g. Van Buren et al. 2016; Volker, 2019), where different phases of construction projects are bundled so that knowledge can equally be transferred and is less dependent on fragmented project phases. Within collaborative governance, most PPP structures bundle a few or all of the project life cycle phases, design, build, finance, operate and maintain. Bundling the phases in a contract is beneficial for innovation since it will force mainly the private sector to think ahead when it comes to upcoming efficiency costs. Exemplifying, when the construction phase and the operation phase are bundled, a private partner will try to improve the productive or technical efficiency, in order to gain the benefits from the investments later on (Himmel & Siemiathyki, 2017). Bundling phases this way encourages upfront innovation investments that will contribute to reducing costs over the rest of the project's life cycle (Hart, 2003). In sum, I expect that (early) private sector involvement and bundled phases will contribute to achieving innovative outcomes.

2.3.3 Network structure

A project is embedded in a network, connected by actors who share resources and partake in actions or activities, which as earlier stated, could also be seen as systems (Adami & Verschoore, 2018). Literature on innovation stresses the positive relationship between a project's network and innovative outcomes (Chesbrough, 2003, Barney & Clark, 2007, Wang et al. 2011 in Carbonara & Pellegrino, 2019). As Figure 2 already illustrated, two conditions are especially worthwhile mentioning, when assessing which factors can influence innovative outcomes when it comes to relational governance.

First, **trust among partners** is mentioned to have a positive relationship with achieving innovative outcomes (Carbonara & Pellegrino, 2019). Relational characteristics such as trust are needed, besides contractual relationships, to make collaborations work (Warsen et al. 2019; Hueskes, 2019). Specifically for innovation, Lee et al. (2010) state that this mutual trust in a collaborative relationship is a prerequisite for enabling innovation among organizations. Mutual trust would allow for more open and honest sharing of information, which supports shared understanding, reduces the need to guard against opportunistic behaviour and reduces conflict (Carbonara & Pellegrino, 2019; Warsen et al. 2019). Walker et al. (2003) state that this openness to information sharing leaves more room for actors to be comfortable with joint problem solving, and setting up common goals to meet project objectives. Where developing and adopting innovation processes, trust can also take away uncertainty in partnerships, contributing to a proper basis for a more long-term collaboration (Parker & Vaidya, 2001; Ring & van der Ven,1992 in Klijn et al. 2021). Especially in smaller consortia, the expectation is that involved organizations enjoy a 'collaborative advantage' by building and maintaining close trusting relationships

and synergy is more easily achieved (Huxham & Vangen, 2006). At the same time, it is good to take into account that not every consortium enables the same amount of trust. For instance, 'Bouwteams', where collaboration is constituted early on, might have more room to build trusting relationships than DBFM contracts where projects are more fragmented. Explaining, the rigid structure of some typical collaborative governance models can inhibit free communication and collaboration, particularly between designers and end-users of the project (Barlow and Köberle-Gaiser, 2008). Therefore, some governance literature argues that trust functions as a substitute for formal contracts, which are embedded in social relationships (Hueskes, 2019).

Second, Carbonara & Pellegrino (2019) point out that the **heterogeneity** of partners is important in influencing innovative outcomes. Many scholars have agreed that the combination of varied and complementary resources generates innovation, induces innovation diffusion and enhances new applications (Owen-Smith and Powell, 2004). The heterogeneity of firms refers to the range of various knowledge, expertise and competencies a project team includes, where the inclusion of so-called heterogeneous knowledge improves the creative potential to develop innovative outcomes (Rodan & Galunic, 2004 in Carbonara & Pellegrino, 2019). A broad range of partners all geared up with different competencies enables constituting more knowledge due to supplemental internal resources with complementary external resources (Ibid). The public sector is very heterogeneous and consists of a complex open system of organizations with various tasks. Decision-making can therefore be slower than in the private sector because of the long chains of command. In particular, different levels of government and different types of output play a large role in measuring innovation. This complex organizational structure often has an impact on innovation.

2.3.4 Network management

Robust cooperation within the network is at the ground of a successful public-private governance model and is based on core elements such as common objectives, sharing risks (Walker et al. 2003) and sharing resources (Adami & Verschoore, 2018). Effective network management - management of the relationships between partners in the network - is therefore crucial for achieving good and successful outcomes (Klijn et al. 2010; McGuire & Agranoff, 2011; Ysa et al., 2014 in Busscher et al. 2022). Network management activities are aimed at strengthening collaboration between actors, facilitating interaction, trying to enhance coordination and aiming to align the interests of partners in the network which contributes to innovative outcomes (Klijn et al., 2021; Klijn & Koppenjan, 2016; Warsen, 2021).

In the literature, a multitude of actions, interventions, and types of process strategies can be found. Therefore, a few characteristics of various network management forms will be presented here, channeled into roles provided in the work of Busscher et al. (2022). The first role can be defined as the 'convener' (Ansell & Gash, 2012 in Busscher et al. 2022). Conveners may be seen as stewards of the process; they facilitate collaboration between stakeholders and try to safeguard the collaboration by ensuring the information flow and compliance with agreements. A second role can be defined as a 'mediator'. Mediators facilitate discussion and debate and aim to stabilize conditions for positive exchange between different stakeholders (Ansell & Gash, 2012 in Busscher et al. 2022). Warsen (2021) adds that dialogue in this one is very important, to prevent misunderstanding and to align expectations. Network managers should therefore be aware of the differences in the team, and should try to foster dialogue to help clear expectations (Ibid). Lastly, the role of a network manager can take the form of a catalyst. Catalysts facilitate collaboration and help to seek opportunities (Busscher et al. 2022). Motivating the network members is regarded as important, in order to raise awareness of everybody's contribution to the process and create collective ownership of the project outcomes.

Ideally, aspects from each role should be incorporated into the network management activities. Again, the structure of the contract might influence the room or capacity for network managers to shape the network.

2.4 conceptual model

In Figure 3 the conceptual model of this thesis is shown. Here, two dimensions of a collaborative governance structure, derived from Carbonara & Pellegrino (2019), are displayed. The arrangement structure, tells something about the way collaboration is arranged in terms of private risk involvement and project phases, and the network structure, tells something about the heterogeneity and trust of actors present in a collaboration. The latter, is influenced by network management, hence the relationship with network management activities. This study investigates which structural mechanisms in collaborative governance (the independent variable) present in the arrangement and network structure of a project, more or less foster innovation (the dependent variable) in construction projects.

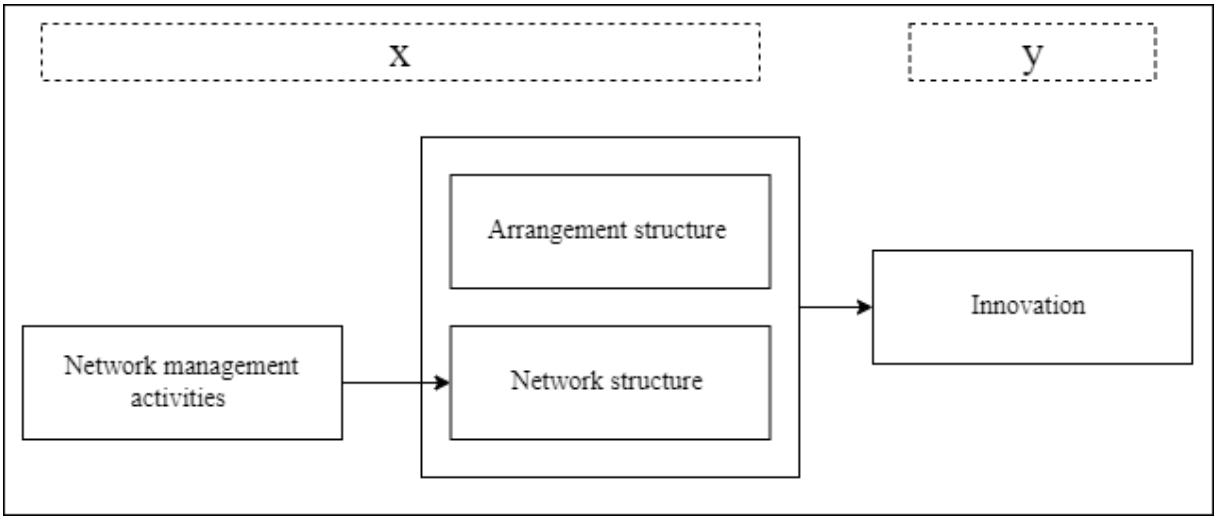

Figure 3: Conceptual model (Author, 2022)

Chapter 3 - Methodology

In this study, a qualitative research methodology is applied by collecting data from documents and semi-structured interviews. The research design answers the research question 'how do different structural mechanisms contribute to innovation in Dutch construction projects?' through a comparative case study of four successful circular construction projects varying in the public-private collaborative governance structure. The cases are Croeselaan Utrecht, bio-based cycling bridge Ritsumasyl, Circular Viaduct Kampen and InnovA58 Living Lab. In this chapter, the motivation behind the choice of research design, data collection and analysis methods, operationalization and ethical considerations will be touched upon.

3.1 Research strategy

To date, it remains unclear how innovative outcomes are developed and implemented (Himmel and Siemiatycki, 2017; Hueskes & Verhoest, 2017 in Verweij & Leendertse, 2018). The main research question of this thesis adheres to the form of a 'how question', resulting in a comprehensive framework of which mechanisms are most suitable for achieving innovative outcomes. Yin (2009) states that the form of a question provides an important clue towards the most relevant research strategy. Accordingly, 'why' and 'how' questions in combination with the desire to explain mechanisms lead to a case study as an appropriate method (Ibid). Following this, adopting a qualitative comparative case study is seen as a suitable research strategy to answer this thesis' research question. Case studies provide the possibility to gather profound and integral knowledge on a specific object or process in practice (Clifford et al., 2016). Translating this method towards the topic of this thesis, conducting a case study will provide a useful frame for comparing the in Chapter 2 assigned necessary topics of interest for achieving innovative outcomes: the network structure, the arrangement structure and network management activities. The case study will compare four Dutch circular construction projects. Comparative case studies allow for theoretical outcomes that are grounded in empirical evidence, which creates more convincing outcomes (Gustafsson, 2017). The core reason why I adopt a qualitative comparative case study for this research is that it allows for obtaining data both per case and comparing data across cases, which lies a profound foundation for discovering promising combinations of structural mechanisms in achieving innovative outcomes. The comparative case study provides an in-depth exploration from multiple perspectives of complex and unique projects or systems (Simons, 2009), in this case, circular construction projects. Which construction projects are considered for this in-depth exploration will be touched upon in the next subsection.

3.2 Case selection

To execute a comparative case study, cases must be selected properly. To provide each case with a similar adherence to the research design, four conditional prerequisites are applied. First, the majority of this thesis addresses Dutch policy and future ambitions concerning innovation in construction and results in a comprehensive framework for which preferred mechanisms foster innovation in Dutch construction projects. Therefore, construction projects that function as cases must be geographically located and executed in the Netherlands. This also means that the industry structure (Carbonara & Pellegrino, 2019), see also Figure 2, is kept constant. Second, this study focuses on the construction of infrastructure, which limits itself to the construction of either water, road or groundworks and excludes for instance the construction of buildings. Third, this study studies the conditions under which innovation can come about as a result of construction projects. Explaining, this thesis has elaborated on a definition of collaborative governance models that are relevant assessing. The most important element concerning this point is that efforts solely executed by a private firm will not be considered, since this thesis aims to study a collaborative matter of achieving innovation and not individual market innovations. Fourth, the cases must have successfully delivered an innovative project outcome. In this thesis, the scope of innovation is narrowed down by directing this at circular innovations.

To gather a broad perspective on how some structural mechanisms embedded in construction projects might provide better innovative outcomes than others, I used the logic of a truth table to select cases. Since innovation and the industry structure remains constant, an in-depth understanding can be reached by establishing a systematic comparison of *varying* collaborative governance models of a few Dutch circular construction cases. The variation of the cases is extra indicated, by the letters A & B. Explaining, the duration of the cases Croeselaan Utrecht & Cycling Bridge Ritsumasyl were long (indicated by letter A), while the duration of the Circular Viaduct Kampen & InnovA58 Living Lab were short (indicated by letter B).

Cases	**Collaborative governance model**	**Involved parties**	**Integrated or separated**	**Public/private**	**Duration**	**Risk**
Croeselaan, Utrecht	Design & Construct	Dura Vermeer, the municipality of Utrecht	Seperated **A**	Public/private **A**	Long **A**	Private party **A**
Circular Viaduct, Kampen	Cooperative agreement	Van Hattum en Blankevoort, Consolis Spanbeton, Rijkswaterstaat	Integrated **B**	Public/private **A**	Short **B**	Shared **B**
Bio-based cycling bridge Ritsumasyl	Bouwteam	Province of Friesland, Sweco/Witteveen +Bos, Reef Infra/Spie and Infra Composites	Separated **A**	Public/Private/ Education **B**	Short **B**	Shared **B**
InnovA58 Living Lab	Living Lab	Several private investors, Rijkswaterstaat, Ministry of Infrastructure and Waterworks	Integrated **B**	Public/Private/ Education/ Research **B**	Long **A**	Public Party **A**

Table 1: Overview of collaborative governance model per case (Author, 2022)

I focus on collaborative governance, as defined in Chapter 2.2. A broader definition was deliberately chosen, to be able to include a broad variation in collaborative governance structures. The selected cases, therefore, include public-private collaborative governance models, ranging from a design & construct to a 'bouwteam', to a 'cooperative agreement' to an experimental living lab construction.

Table 1 displays the four selected cases, out of eight potential cases, that are expected to deliver the most variation. Variation was based on the characteristics of collaborative governance (Chapter 2.2). For example, the partners might differ from purely public-private (case 1 & case 2), or public-private and educational entities (Case 3 & case 4). How the in Chapter 2 defined concepts of innovation, collaborative governance, structural mechanisms and network management activities are operationalized, will be discussed more in-depth in subsection 3.3.

3.3 Operationalization

This thesis investigates which and how structural mechanisms of varying collaborative governance structures more or less influence innovative outcomes in construction projects. Therefore, this thesis adheres to a few definitions and conditions, which are worthwhile dissecting to understand their context in the operationalization of this research.

3.3.1 Innovation

For this research, I have chosen to focus on innovation in terms of sustainable development and have used the scope of the concept of Circular Economy (further: CE) for this. CE is defined as 'an industrial system that is restorative or regenerative by intention and design' (Ellen Macarthur Foundation, 2013, p. 7). Indicators that illustrate whether a project is circular, are defined by the 4 R's: Reuse, Recovering, Reduction and Recycling (of waste, materials and energy) (Heshmati, 2015; Kirchherr et al., 2017; Trevisan et al. 2022). For this thesis, every project has incorporated one or more of these concepts. Finally, to investigate how and which structural mechanisms in these varying collaborative governance structures foster circular innovation and how they are influenced by network management activities, table 2 displays indicators gathered from academic sources that have been linked to the concept variables of each topic to be able to operationalize the different concepts in the further data collection. To guide the connection from theory to analysis when reading through the results in Chapter 4, concept variables with more than two indicators, thus 'Trust' and 'Network management activities' are supported by letters A – E (table 2).

Dimension	Concept variable	Indicators	Data source
Network	**Heterogeneity of actors**	- Number of partners - Variety of partners	Carbonara & Pellegrino (2019)
	Trust among partners	- Open communication (A) - Taking each other's interest into account (B) - Taking risks (C) - Having a connection (D) - Length of contract (E)	Carbonara & Pellegrino (2019) Warsen et al. (2019), Hueskes (2019)
Arrangement	**(Early) private sector involvement**	- Private sector as risk involving partner - Early involvement of the private sector	Carbonara & Pellegrino (2019), Lenferink et al. (2014)
	Bundled phases	- Integrated or segregated project phases	Carbonara & Pellegrino (2019), Hueskes (2019), Volker (2019)
Management	**Network management activities**	- Steering information flows and/or compliance with agreements (A) - Steering for collective aims (B) - Facilitating and initiating interaction processes (C) - Creating network arrangements for exploring new ideas (joint fact finding, joint research) (D) - Managing conflict (E)	Busscher et al. (2022), Klijn & Koppenjan (2006), Warsen et al. (2019)

Table 2: Concept variables and indicators (Author, 2022)

In the left column of table 2 the dimensions, as discussed in Chapter 2, are displayed. The structural mechanisms that are connected to that, see also Chapter 2.2, are shown in the column 'Concept variables'. To be able to empirically indicate whether structural mechanisms are more or less present in the studied cases, indicators are connected to the concept variables. An example is, that trust is felt when

respondents feel that they could openly communicate about issues during the project (See also Chapter 2.3). In the right column, the data source of the presented indicators is shown.

3.4 Ethical considerations

Ethical considerations were taken into account when conducting this research. One ethical aspect is connected to the position of the researcher. In this case, I was not partaking in an internship which made that my position as a researcher was not connected to a specific organization. I did however introduce myself and the motivation behind my research to all respondents before the interview so that it was clear for which aim the study would be conducted. In order to inform each respondent about their rights and privacy, an informed consent form was sent before each interview. In this informed consent, information about the data use and storage was provided, as well as permission was asked for the use of names, organizational functions and the possibility to record the interview (see also Appendix A). All respondents agreed on these terms, meaning that their names are displayed in table 3 with permission. The data gathered, was only accessible to the researcher. During each interview, I introduced myself and the topics that I would address and I repeated the agreed terms, to make sure every respondent was aware and was able to ask questions when necessary. Interviewees were allowed to stop the interview at any time of the interview. Furthermore, they were provided with the option to read and check the transcripts. Four interviewees made use of this. Interviewees were asked about documents, to enrich the document analysis and receive access to relevant project documents. At some point, documents were used that contained confidential information about the cases, such as contracts or tender information. For these documents, I have agreed to only use this as background information, this information, therefore, has not been displayed in my thesis. The information derived from the data collection is not used for any other purpose than is agreed upon beforehand, without permission from the respondents first.

3.5 Data Collection

For this research, different data collection methods are used. A literature review was conducted. For the empirical data, qualitative data is collected through document research and semi-structured interviews. Triangulation is used to strengthen the validity of the research results. This will be executed in the form of data source triangulation, which involves collecting data from different types of people to gain multiple perspectives and validation of data (Carter et al. 2014). Figure 4 illustrates, which empirical data was gathered through which method:

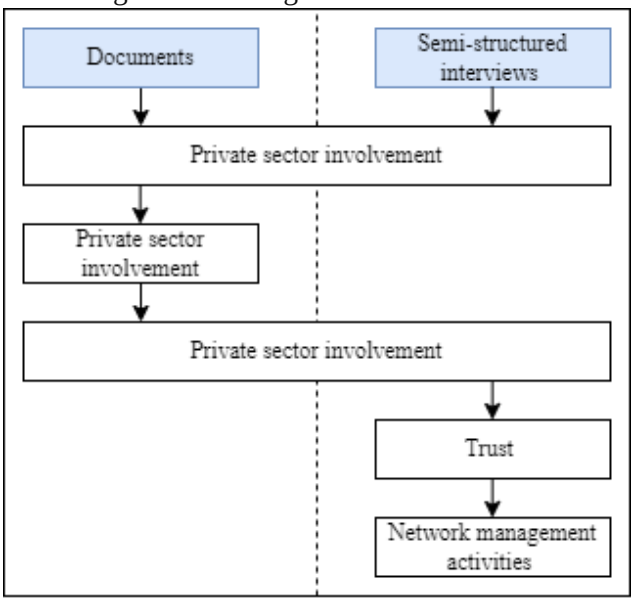

Figure 4: Overview of research methods (Author, 2022)

3.5.1 Semi-structured interviews

Semi-structured interviews are used to gain information and perspectives on the structural mechanisms bound to the network dimension, and the network activities undertaken by the managers of the four circular construction projects. The choice for specifically semi-structured interviews, instead of other types of interviews or for instance a focus group, is because the semi-structured nature allows for freedom of the researcher and the respondent. The topic can be steered by the list of questions created, but it can also switch between questions based on the answers given (Longhurst, 2016). This allows for the interviewee to swerve on some topics more than others. With regards to the effectiveness of the structural mechanisms and the applied network management activities, semi-structured interviews offer the opportunity to crystallize their embeddedness in the varying collaborative governance structures. In general, besides comparing the data gathered from individual experiences of project members per case, a comparison across cases can also take place. That way, qualitative research helps to constitute generalizations from one project to a similar project (Onwuegbuzie & Leech, 2010).

Because of the focus of this thesis, I selected respondents who were involved in the management team, from both public and private sector entities. I did not necessarily ask the question in the order listed, but let the interviewee here and there lead the discussion to be able to explore the issues they experienced as important. I spoke to project leaders since it is most likely that these participants have actively engaged in both the structural mechanisms as they have practised network management activities. In order to have a comfortable, spontaneous conversation with each project member, interview questions are not provided beforehand. However, since some of the projects were constructed more than two years ago, more information about the project and the topics that I will address was sent before the interview, to give the interviewee a general idea of the information desired. Since no physical presence was necessary for this thesis and projects were spread over the country, I have based the option for digital or physical interviews on the preference of the respondents. Often this preference was expressed in digital interviews. Table 3 shows the interviews that were conducted per case. Snowballing technique was used, in order to be able to contact all relevant project members.

Case	Respondent & reference in thesis	Organization	Project role	Date	Duration (in minutes)	Location
Croeselaan Utrecht	(RPU1)	Municipality of Utrecht (Public)	Project leader	31-05-2022	55	Microsoft Teams
Croeselaan Utrecht	(RPR2)	Dura Vermeer (Private)	Project leader	24-05-2022	49	Microsoft Teams
Circular Viaduct Kampen	(RPR3)	Van Hattum en Blankevoort (Private)	Project leader	17-05-2022	47	Microsoft Teams
Circular Viaduct Kampen	(RPU4)	Rijkswaterstaat (Public)	Project leader	17–05-2022	46	Microsoft Teams
Circular Viaduct Kampen	(RPR5)	Consolis Spanbeton (Private)	Project leader	31-05-2022	45	Microsoft Teams
Cycling Bridge Ritsumasyl	(RPR6)	Witteveen + Bos (Private)	Project leader Witteveen + Bos	25-05-2022	55	Heerenveen, Friesland
Cycling Bridge Ritsumasyl	(RPU7)	Province of Friesland (Public)	Project leader	21-06-2022	60	Microsoft Teams
Cycling Bridge Ritsumasyl	(RPU8)	Province of Friesland (Public)	Programme leader	14-06-2022	45	Ritsumasyl, Friesland
InnovA58	(RPR9)	Twynstra Gudde - The Bridge Business innovators (Private)	Innovation manager	07-06-2022	52	Utrecht, Utrecht
InnovA58	(RPU10)	Rijkswaterstaat (Public)	Innovation manager, circular, Advisor Circular Economy circular advisor RWS	10-06-2022	65	Microsoft Teams

Table 3: Information selected interviewees (Author, 2022)

3.5.2 Document research

For the document research, policy documents and other non-scientific documents have been gathered. For some cases, information from scientific case studies was used. Most documents were found on the official websites of the different cases. When in doubt, I asked the respondents during the interview if more documents were available. This snowballing technique has enriched the number of documents. The selected documents can be found in Table 4.

Case	Title	Reference	Document type	Data source
Croeselaan, utrecht	Omgevingsvisie Beurskwartier en Lombokplein	D1	Policy document	Gemeente Utrecht (2017)
Croeselaan, Utrecht	Meerjarenperspectief Stedelijke Ontwikkeling 2017	D2	Policy document	Gemeente Utrecht (2017)
Croeselaan, Utrecht	Presentatie Realisatie Duurzame Croeselaan: van tender tot realisatie	D3	Internal project document	Dura Vermeer (2018)
Circular Viaduct, Kampen	Learning History	D4	Report	Rijkswaterstaat (2019)
Circular Viaduct, Kampen	Prototype Circulair Viaduct	D5	Internal project document	R. Valk, Rijkswaterstaat, Consolis Spanbeton, Van Hattum en Blankevoort (2019)
Circular Viaduct, Kampen	Introducing Circular Innovation in the Construction Industry: The Case of the Circular Viaduct.	D6	Scientific case study	Coenen et al. (2021)
Cycling bridge, Ritsumasyl	Managing risks in the development and implementation of product innovations in construction projects: The case of a movable bio-based composite bridge deck	D7	Scientific case study	Lenferink et al. (2019)
Cycling bridge, Ritsumasyl	Circulair ontwerpscan bio-composiet Fietsbrug Ritsumasyl	D8	Internal project document	Provincie Fryslân, combinatie Sweco/Witteveen+Bos, combinatie Strukton/Spie, Delft Infra Composites (2019)
Cycling bridge, Ritsumasyl	D.R.I.V.E - ervaringen met het bouwteam	D9	Report	Bouwteam 'D.R.I.V.E' (2019)
InnovA58 Living Lab Oirschot	Bidbook Bereikbaarheid Zuid-Nederland	D10	Bidbook	E. Herzog (2019)
InnovA58 Living Lab Oirschot	Eindrapport Verkenning Innovaties	D11	Report	The Bridge, Stichting A58 Rijkswaterstaat, PWC, provincie Brabant (2015)
InnovA58 Living Lab Oirschot	Basisdocument Circulair Ontwerp InnovA58	D12	Report	Hendriksen, Kerkhofs, Leendertse, MieM, Rijkswaterstaat (2017)
InnovA58 Living Lab Oirschot	Learning History InnovA58	D13	Report	Rijkswaterstaat (2021)
InnovA58 Living Lab Oirschot	Living Lab Circulair Ontwerp InnovA58: Observaties en Reflecties	D14	Scientific case study	Verweij et al. (2018)

Table 4:Selected documents (Author, 2022)

The data conducted from the documents was used to enrich and reflect upon the data gathered through the semi-structured interviews (see also Figure 4). Working like that supports thorough research (Bowen, 2009).

3.4 Data analysis

3.4.1 Structuring data

Each interview was transcribed shortly after the conversation took place. During the interview, minor notes have been taken in order to help transcribe afterwards, however, this has been kept to a mere minimum to make sure the participant was given full attention. After transcription, the data was coded. Codes are used to collect and categorize data that are similar in meaning so that segments that relate to each other can easily be found and clustered (Stuckey, 2015). The then categorized, assembled and sorted data provides an organized platform (Williams & Moser, 2019). In this thesis, the analysis of this data will lead to an understanding of which structural mechanisms and which network management activities more or less lead to innovation in construction projects. The codes were selected deductively. The deductive approach draws codes from existing literature on the main topics or what is known about the phenomenon aided by the research aim and research questions (Azungah, 2018; Thomas, 2006). The code tree can be found in Appendix C.

3.4.2 Logics of data comparison

In order to gain an in depth-understanding of the structural mechanisms and network management activities of each case, the following data comparison logic is used. First, data conducted from documents and semi-structured interviews per case is compared. Then, in order to conduct a *comparative* case study, the data is segregated per case and then compared. An example of the logic of this comparison is shown in figure 5. This logic is also implemented in the order of Chapter 4, results.

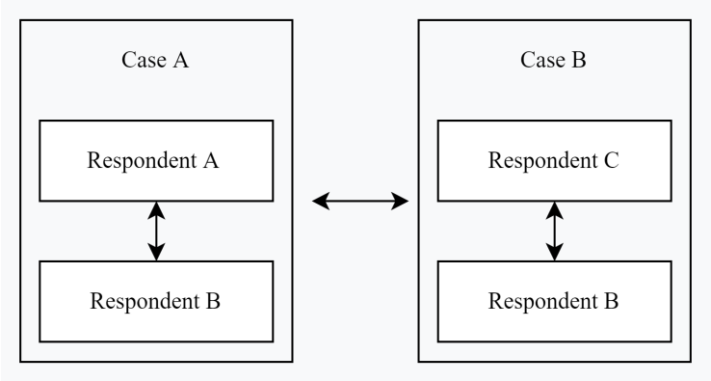

Figure 5: Visualization data comparison logic (Author, 2022)

Chapter 4 Results

In this chapter, the results are shown. First, the results per case—respondents and documents—will be displayed. At the end of each sub section, section 4.1 until 4.4, a table summarizes the results. Following on, section 4.5 shows the segregated data of each case for the comparative case analysis. Each section will follow the structure of the theoretical framework, starting with the link to innovation, the arrangement structure, the network structure and accordingly, the network management activities.

4.1 Innovation in the Croeselaan Utrecht

The municipality of Utrecht is renovating its station area. This initiative came up since the construction of Hoog Catharijne has put pressure on the historical inner city by an increasing number of inhabitants, cyclists and motorists. As one of the main access roads to the station area, a renovation of the Croeselaan was necessary for 2018 (D1&D2). The project has received promising sustainability awards and nominations (RPU1), and has included innovations, where in terms of circularity reduce, reuse, repair and recycle, have been integrated (D3). Important innovative outcomes have been the extensive reuse of material and raw materials from the original Croeselaan and its surroundings (D3). Exemplifying, the foundation and paving material were reused and mixed with compost to offer ground for trees that were replaced. Furthermore, the cycle path is made of Ramac, a replacement of concrete, which emits less CO2 (D3 & RPR2). (RPU1) was project leader of the municipality of Utrecht. (RPR2) was project leader of Dura Vermeer.

4.1.1 Arrangement structure

The municipality of Utrecht has initiated the renovation of the Croeselaan, asking for 'The most sustainable road of the Netherlands' via a Design & Construct contract (D1, D2). In order to arrange this, market parties, experts in innovative solutions, were selected (D3). Based on EMVI criteria, Dura Vermeer was selected as the contractor to design and construct the project. The choice of a Design & Construct contract, which can be seen as a traditional public contract (Verhees et al. 2015), where Dura Vermeer as a contractor was responsible for the project outcomes and risk carrier of both phases. This **private sector involvement** indicates where the risk was located. When it comes to the circular outcomes, most of them were stated in the contract (D3). There was no early involvement of the private sector included.

This project does not incorporate **bundled phases** (D3). In general, bundled, integrated project phases, allow for important knowledge transfer between phases and actors, which is an important mechanism for innovation (Carbonara & Pellegrino, 2019; Volker, 2019). Both respondents agree that working in such a contract, whilst admitting that they were challenged for innovative outcomes, was at times difficult. As an example, a barrier in the transfer between the construction and the maintenance phase was mentioned. Dura Vermeer had suggested some alterations in the material list in order to extend the sustainable lifespan (RPU1). Yet, for the maintenance team of the municipality, it was difficult to agree on raw materials that were never worked with before (RPU1, RPR2). Interestingly, it was mentioned that a project with bundled project phases would have possibly optimized circular outcomes even further, because of the synergy of knowledge that could be gained throughout the project and increased awareness of the total project's life cycle might be stressed (RPR2).

4.1.2 Network structure

The network of this project consisted of the municipality of Utrecht and Dura Vermeer as previously mentioned (RPU1, RPR2, D3). The number of actors was limited. Little to no external extra expertise was involved, which makes the variety in heterogeneity, as operationalized in chapter 2.3, low. However, while the municipality only worked with one party, due to the contract, the municipality had actively searched for opportunities to make sure that there was enough knowledge and expertise specifically on circular innovation present in the network (RPU1). This was done via the selection requirements prior to the tendering process, Dura Vermeer hereby was already one of the pre-selected parties and possessed the necessary knowledge (RPU1). During the project, there was at one point external input for circular solutions. In order to expand the knowledge available for innovative outcomes, the team was willing to incorporate other solutions:

"When you want to innovate, it is important to constantly look around. When another contractor develops a new and better circular product for the market, who are we not to not apply that in order to achieve the best collective results?" Project leader Dura Vermeer (RPR2)

When it comes to **trust**, both respondents agree that there was trust present in the collaboration. Both mainly experienced trust through the feeling of being able to openly communicate about the project. Exemplifying, at some points, there were better product options than originally expected. Dura Vermeer communicated about these possibilities and offered alternatives. Also, Dura Vermeer shared every step of the process transparently in the form of open budgets, so the municipality of Utrecht could exactly check where the money was spent (RPR2). Also, there was room to openly communicate about conflicts. For instance, as earlier mentioned Dura Vermeer had suggested some material changes that were unfamiliar to the municipality of Utrecht. Internally, this caused some conflict in the public sector entity that was openly discussed with Dura Vermeer (RPU1). As a response, an idea came up to invite the maintenance team to the laboratory of Dura Vermeer, where the circular materials were made, to provide some indication of how and why the process was beneficial for the project (RPR2). The respondents differ in their opinion when it comes to the influence of trust on innovative outcomes. On the one hand, open communication has led to open discussions about the integration of innovation in design and circular alternatives (RPR2). On the other hand, the relationship between Dura Vermeer and Utrecht could largely still be regarded as a purely contractual one (RPU1). According to the public project leader, trust was important, but not of extra added value for the innovative outcome of the project:

"Yes, trust is important, but that was more embedded in the preliminary stage. In the end, the innovation proceeds from the tender requirements and the offer that they (Dura Vermeer) submitted."- Project leader Utrecht (RPU1)

4.1.3 Network management activities

When it comes to network management, the following activities have been undertaken that influence or have contributed to the network structure.

First, mainly 'Steering information flow and/or compliance to agreements' was mentioned as necessary (RPU1). Room was made for this, during the contact moments that occurred every two weeks (RPU1). For the public project leader, providing information flows was one of the most important activities to undertake to steer the network. This had to do with the fact that some steps in the process were new to the municipal organization, which required regularly passing through information.
Second, 'steering for collective aims', was mentioned as one of the most important activities (RPU1, RPR2). Both project leaders actively tried to make sure that everybody in the network vouched for a

good innovative end result (RPR2). An important accelerator to propagate a collective circular vision was used by stressing the motivation of the city council:

"The fact that the city council has pronounced that they want to transform the Croeselaan into the most sustainable road in the Netherlands, resulted in us wanting to be associated with such ambition, it was the core motive for this collaborative process' - Project leader Utrecht (RPU1)

Third, 'managing conflict' was mentioned, while both project leaders agreed that this was often not needed. Exemplifying, the circular renewal of the Croeselaan, took place in a dense area of the city of Utrecht. At a certain point, too limited attention was given to the enormous logistic operation that the project would induce and the impact it would have on the direct environment (RPU1). Accordingly, a specialized firm was drawn into the project, to provide daily contact with the surrounding area to avoid conflict. Another example is the cycling path which was an innovative effort, with material that is low in CO2 emission and could be recycled completely (RPR2). It took a while to get the material through the material list, because it would require different maintenance than the familiar materials. When the material was accepted, the cycling path was implemented. Unfortunately, it did not last in quality. Dura Vermeer decided to repair the cycling path completely and directly took full responsibility and the costs for the matter (RPU1, RPR2).

	Arrangement structure		**Network structure**		**Network Management**
	Private sector involvement	**Bundled Phases**	**Heterogeneity**	**Trust**	**Network management activities**
Project leader Utrecht: (RPU1)	Dura Vermeer carried risk	No	Low	Open communication (A)	Mainly focused on steering information flows and compliance to agreements (A) and, steering for collective aims (B) and managing conflict (E)
Project leader Dura Vermeer: (RPR2)	Dura Vermeer carried risk	No	Low	Open communication (A)	Mainly focused on steering information flows and compliance to agreements (A) steering for collective aims (B) and managing conflict (E)
Documents	Dura Vermeer carried risk (D3)	No (D3)	-	-	-

Table 5: Overview results interviewees & documents case 1 (Author, 2022)

4.2 Innovation in Viaduct Kampen

Circular Viaduct Kampen is Netherlands´ first completely circular concrete viaduct (D6) The viaduct was designed, built and disassembled again in the beginning of 2019 by contractor van Hattum en Blankevoort and prefab-builder Consolis Spanbeton in collaboration with Rijkswaterstaat (D5). The first Dutch circular viaduct in Kampen can be considered as a project transcending investment that was demolished after being successfully used over a period of time and has received the Dutch Concrete prize for it (D6). The circularity principles used in this project are as follows. Upfront circular principles were integrated into the design of the viaduct. By performing that, the result is a product that can completely be recycled with concrete elements that can be reused (D5). This way, the viaduct can be produced, built, and used but also demolished and used again (D5), by using a 'lego' construction (R5). Respondents for this case are a project leader of van Hattum en Blankevoort (RPR3), a project leader of Rijkswaterstaat (RPU4) and a project leader of Consolis Spanbeton (RPR5).

4.2.1 Arrangement structure

The initiative for the project came up after the announcement of the new concrete agreement in response to the Paris agreement (R5). The project started with early **private sector involvement** by van Hattum en Blankevoort initiating the idea to brainstorm about a completely modular circular viaduct and presenting the ideas to the board of van Hattum en Blankevoort. For the board, this meant a new type of project, but they agreed based on their desire to become circular (D4). Shortly after that, a support base within van Hattum en Blankevoort was set up, (D4, RPR3 & RPU4) and partner Consolis Spanbeton joined the process not much later (RPU4 & RPR5). Both private parties had already invested time and energy in possible design ideas and presented them to Rijkswaterstaat to find adherence to their circular policy ambitions. Connecting RWS turned out to be a challenge. The desire to become more circular was there, but in practice, only little was happening at that moment (D4, RPR5). It, therefore, took some time for RWS to set up a project team and connect to the process. Although RWS has a large team working on innovations, it was difficult to find somebody who got the project off the ground (RPU4). This is also reflected by the public project leader:

"Looking back, the engagement of RWS in the orientation phase was on the low side. The private sector entities have stimulated this circular design, while it was a better idea to integrate RWS earlier to share some design ideas to see how RWS would look at it. On the other hand, this might also have influenced the creative process. It is possible that some design ideas then would not have been executed."(Project leader RWS, RPU4*).*

It was however mentioned, that integrating RWS would have helped to find a support base for the finances more easily (RPR3 & RPR5). While RWS agreed to finance most of the project, the public sector entities and private sector entities agreed to make a shared costs pot. This gave every party the freedom to invest in their circular ambitions. Of course, when something happened along the way that was entirely for the risk of one of the private parties, all parties also agreed to take this upon themselves (RPR3).

The contract that was made up, was a kind of cooperation agreement, including only the real necessary formal points in the form of **bundled phases** (RPR3). For this project, the contract was deliberately kept easy and open, to avoid unnecessary ballast in achieving the circular targets or collaboration (RPU4). Also, no tender was set up. The team deliberately was not interested in a 'traditional contractor-client relationship' and made choices together (D4). In return, an agreement was made that every innovation

and learning lesson was written down in an open-source environment. This later resulted in 'The learning History'(D4, RPR3, RPU4, RPR5).

4.2.2 Network structure

The network of this project consisted of the public sector entity, Rijkswaterstaat, and the contractor van Hattum en Blankevoort and prefab builder Consolis Spanbeton (RPR3, RPU4, RPR5). In terms of **heterogeneity**, the number of actors was limited. As for the knowledge and expertise available in the team, the respondents agreed that the available expertise and knowledge were useful and necessary enablers for the innovative outcomes of the project. When the design was made, parties who were able to execute it were selected (RPR3). However, it was stated that technical knowledge of RWS lacked behind a bit (RPU4). This resulted in the fact that technical input originated from the private sector entities mainly.

For all participants it was emphasized that **trust** was present and needed:

"When you look at an innovation process like this one, you never know what is going to happen. If you don't have trust, it is very difficult to go on an adventure together" (Public project leader RWS, RPU4)

Also, it was mentioned that the market parties were willing to take a risk. Exemplifying, this was translated in the fact that for some elements the market parties already had started their work when RWS had not covered the costs for the activities yet. This was really something that stood out, compared to other less innovative projects (RPU4). Besides that, the respondents also mention that they felt that they had a connection together, which helped to make the project a success:

"Trust is one of the most important factors of the success of the project. "...through mutual trust and respect, we have finished this project. That is far more effective than only having a contractual relationship"(Public project leader Hattum en Blankevoort, RPR3).

4.3.3 Network management activities

When it comes to network management, the following activities have been undertaken that influence or have contributed to the network structure.

First, 'Steering information flows' was mentioned as necessary for the network (RPR3, RPU4, RPR5), mainly because of the innovative character of the project. Collectively, it was decided to create 'Circulaire dinsdag', a contact moment for the network where important updates or ideas were shared (D4, R3, R4, R5). Around these moments, information was steered to each of the organizations.

Second, 'steering for collective aims' was regarded as important. This was extra emphasized by the opening of the project by the former minister of Infrastructure and Waterworks (RPR5). The hard deadline made working collectively towards innovative outcomes in a dynamic innovative fashion even more important. Nonetheless, it was not always easy to make sure everybody was working on the collective aims. For RWS, the technical experts had busy schedules or were not eager to make room for such a project (RPU4). Interestingly, a reversed effect was occurring on the private side of the collaboration. Here, the project leaders were so enthusiastic about the project that they wanted the most experienced people in the project to make it a national success (RPR5). However, this resulted in the fact that their 'best' employees were now full-time working on a relatively small innovation project in

organizations where continuity is very important (RPR5). They noticed that it was important to learn the network where the priorities lie and who had to be included in this process (RPU4, RPR5, D4).

Third, 'facilitating interaction processes' was mentioned. An important effect of this was that the progress in the network was kept high (RPR3). Illustrating, decisions were made faster and feedback was also provided earlier. Still, the respondents admitted that they didn't always feel comfortable or familiar to work in such an interactive, collaborative environment (RPR3, RPU4, RPR5). Sometimes, staying in a more traditional role was comfortable, especially when innovation led to more costs or risks (RPR3). Nevertheless, Rijkswaterstaat steered for an environment where these kinds of decisions or dilemmas were solved collectively. Looking at it collectively made the decision-making process easier (RPR5).
'Exploring for new ideas' was also an important factor that was integrated into these contact moments. Continuous looks at the design were regarded as necessary. Exploring new ideas as a network together, especially since the project was highly innovative and at times uncertain, was necessary to gather all expertise from the network (RPR5).

Fifth, 'managing conflict' was regarded as important. When at some point the construction had started, van Hattum en Blankevoort was invited to view the first concrete blocks. However, during the visit, the blocks didn't come out of the mall:

"Normally, you wouldn't want to drag your client into your (Consolis Spanbeton) problems. Of course, after it is fixed you can be open and transparent about it, but you will try to fix it first. However, for this project, we decided to be open and transparent. So Dick and I included Denis in the problem. With the help of some experts of RWS, it turned out that the installation was not right, and fixing it took a long time. They (RWS) said we know you, you will fix it. Keep us informed and share what you learned. "...sharing the issue, in the end, saved a lot of time." (Project leader Consolis Spanbeton, RPR5)

	Arrangement		**Network**		**Management**
	Private sector involvement	**Bundled Phases**	**Heterogeneity**	**Trust**	**Network management activities**
***Project leader van Hattum en Blankevoort* (RPR3)**	Early involvement private partner, shared risks	Yes	Low	Open communication (A), keeping each other's interest in mind (B), taking a risk (C), having a connection (D)	Steering for information flows (A), Steering for collective aims (B), facilitating interaction processes (C) Exploring for new ideas (D), managing conflict (E)
***Project leader RWS* (RPU4)**	Early involvement private partner, shared risks	Yes	Low	Open communication (A), keeping each other's interest in mind (B) having a connection (D)	Steering for information flows (A), Steering for collective aims (B), facilitating interaction processes (C), managing conflict (E)

***Project leader Consolis Spanbeton* (RPR5)**	Early involvement private partner, shared risks	Yes	Low	Open communication (A), keeping each other's interest in mind (B), taking a risk (C), having a connection (D)	Steering for information flows (A), Steering for collective aims (B), facilitating interaction processes (C) Exploring for new ideas (D), managing conflict (E)
Documents	Early involvement private partner, shared risks due to shared cost pot (D4)	Yes (D4, D5)	Low (D4)	Open communication, having a connection, keeping each other's interest in mind, investing in informal moments (D4)	Facilitating interaction processes (D4)

Table 6: Overview results interviewees & documents case 2 (Author, 2022)

4.3 Innovation in bio-based cycling bridge Ritsumasyl

As part of the program Vrijbaan, the bio-based cycling bridge in the village of Ritsumasyl, was designed in 2019 (D7). The initiative for the project lay with the province of Friesland which wanted to add this last project as a unique circular project to a decade-long program, consisting of almost forty smaller and bigger projects (RPU8). In line with their ambitions on sustainability and innovation, the bridge was developed accordingly to the following aims; to realize a cycling bridge with a movable bridge deck of bio-based composite material, to collaborate with private organizations and educational organizations in this and to generate and disseminate knowledge on the sustainable application of bio-based composite material (D7; D8). Important circular design choices that are integrated into this bridge's design include the recycling of materials where primary raw materials are avoided as much as possible and replaced with bio-composite flax fibre and the recycling of materials from the old bridge (D8). Respondents for this case were (RPR6) involved as a private project manager from Witteveen+Bos and (RPU7) was involved as a public project manager. (RPU8) was involved as a public programme manager of the province of Friesland

4.3.1 Arrangement structure

The province of Friesland, as a public sector entity, has initiated the idea to develop and construct a bio-based cycling bridge in the village of Ritsumasyl (RPU8). Officially, the project was the capstone of a large programme called 'Vrijbaan', which ran from 2008 until 2018. Specifically for the design phase of the project, a Bouwteam contract was applied, to maximize the application of innovative bio-based materials in the construction phase. Prior to the formation of the bouwteam, two separate tenders were organized, for the contractor and the producer of the bridge deck. For the contractor, a pre-selection took place and for the producer of the bridge deck, an open European tender process took place (D7). When the design phase via the Bouwteam was finished, the team decided to continue with the Bouwteam in order to safeguard the continuity of expertise for the rest of the process. When it comes to the **private sector involvement,** the risk would traditionally be allocated to the public sector entity. However, in this case, risks were shared (RPU7).

The contract was carefully chosen by the province of Friesland, to create an optimal climate for innovation (RPR6; RPU7; D9). For this case, one could state that the phases were **bundled phases.** The actors who were involved with the initial phases of the process and the design were also included in the 'bouwteam' when the implementation of the bridge took place (RPU8). It was stated that by bundling the phases important decisions could be made which had an impact on the circular bridge design (D9; RPU7):

> *"By collectively looking for optimizations of the project outcomes, it was possible to implement a narrowing of the canal, which replaced traditional heavy inhibition work. This did not only save money but also induced a reduction in the use of steel, which benefited the circularity of the entire construction" (Experiences with the project team - D9).*

4.3.2 Network structure

The network of this project consisted of Sweco/Witteveen+Bos, the province of Friesland, Reef Infra/Spie and Infra Composites (RPR6, RPU7, RPR8). These parties were all present in the Bouwteam, called 'D.R.I.V.E. Connected to this Bouwteam, was a large group of organizations, such as the educational institutions the university of Delft and NHL Stenden (RPU7). The large number of actors who were involved in the project resulted in a high **heterogeneity** for this project. While everybody was

working on their own part and contribution to the project, respondents claim that synergy among the project members was present. One of the respondents claimed that the heterogeneity of the project was definitely a requirement for the successful innovative outcome of the project:

"It was clear, that it was not about what everybody traditionally claims for their own organization, we were aware of each other's qualities and worked on how we could collectively organize efficient project outcomes"((Public project leader, RPU7).

When it comes to **trust**, all respondents claim that it was present in the Bouwteam. Also, all agreed that it was of added value for the innovative outcome of the project (RPR6, RPU7, RPU8). Additionally, the value of the contract was also mentioned. It was a comfortable feeling that, on the rare occasion that conflicts would occur, there was a certainty to fall back on (RPU8). Trust was mainly felt in the fact that everybody felt that they were able to communicate openly and transparently (RPRU7). The respondents mention, that there was also a feeling of a connection between the project members (RPR6, RPU7). An example of this was when the project was nominated for the Circular Award Public and the whole team prioritized working on it together to support each other. Furthermore, trust was felt in the way the members did the best they could to achieve the best project results:

"If the trust among us as project members was not there, this would have negatively influenced the commitment for the project. Now, we had a collective ambition, and have even adjusted our targets upwards for the bridge" (Private project leader, RPR6)

In this context, the respondent referred to the fact that the ambition of the province was surpassed by multiple meters compared to the original agreement about the bridge length, which enlarged the circular foundation of the cycling bridge tremendously.

4.3.3 Network management activities

When it comes to network management, there are a few activities that influence or have contributed to the network in this case.

First, 'steering information flows' was argued to be crucial, closely linked to a second activity, 'steering for collective aims'. Explaining, communicating clearly and providing everybody in the network with the information on time, also towards the higher management circles, was key to gaining interest and understanding for every step that was made in the process (RPU7; RPU8). For the programme leader, steering information flows was the most important network activity (RPU8). To make sure that everybody was in for a project that took a lot of time and energy, without really knowing what to expect from the outcome, it was deemed necessary that the ambitions of the project were announced clearly regularly (RPR6; RPU7). Two of the project leaders mentioned that the strong ambition of the council of Friesland, helped in carrying the priority of this project out:

"Through the clear communication lines, we were able to clearly explain what the goal of the project was. The freedom and trust we gained from the municipality, made that we were able to pioneer like this" (Public project manager, RPU8)

Third, 'facilitating interaction processes' was mentioned. In the regular Bouwteam meetings, everybody updated each other. This was stated as an important factor to get to know each other's motivations behind the project and collect everyone's opinion on what they wanted to learn from it. Also, it then became

more clear which forms of expertise were available in the network (RPR6). It was regarded as important because it is a fairly new way of working. This made that the meetings were also, fourthly, used to explore ideas. The bouwteam construction invited to design a bridge based on the circular ambitions, which led to a lot of design freedom in the team (RPU8)

Fifth, although this almost wasn't necessary, 'managing conflict' was needed. An example of this was when project groups did not keep each other posted every time, a certain divide existed between the 'Monday group' and the 'Wednesday group' (RPU7). Since project groups sometimes did not meet on the same day, it was a challenge to keep everybody near to the project, which was something that perhaps could be organized better (RPU7).

An example of this was when the contractor during the design phase of the Bouwteam already invited another contractor to think along to get the best result out of the design and reduce costs. However, when the realization phase took off, there was a problem in the construction. When the conflict was mentioned the public project manager decided that the private parties should come up with a plan for the risk. They suggested splitting the costs in three, which was special in this case, because traditionally the public sector entity was responsible for the risk (RPU7).

	Arrangement		**Network**		**Management**
	Private sector involvement	**Bundled Phases**	**Heterogeneity**	**Trust**	**Network management activities**
Project leader Witteveen + Bos: (RPR6)	Public sector carried primarily risk, sometimes shared	Yes	High	Open communication (A), keeping each other's interest in mind (C), having a connection (D)	Steering information flows (A), steering for collective aims (B), facilitating interaction processes (C), exploring for new ideas (D), managing conflict (E)
Public project manager province of Friesland: (RPU7)	Public sector carried primarily risk, sometimes shared	Yes	High	Open communication (A), keeping each other's interest in mind (C), having a connection (D)	Steering information flows (A), steering for collective aims (B), facilitating interaction processes (C), managing conflict (E)
Programme manager province of Friesland: (RPU8)	Public sector carried primarily risk, sometimes shared	Yes	High	Open communication (A)	Steering information flows (A), steering for collective aims (B), managing conflict (E)

Documents	Public sector carried primarily risk, sometimes shared (D9)	Yes (D9)	High (D7)	Open communication (B), taking a risk (E) (D9)	Steering information flows (A), steering for collective aims (B), facilitating interaction processes (C), exploring for new ideas (D) (D9)

Table 7: Overview results interviewees & documents case 3

4.4 Innovation in InnovA58

InnovA58 is the first Dutch project that combines road widening, of the A58 Eindhoven - Tilburg, as a catalyst for experimenting with ideas and concepts for more circular road construction (D11). Unique in this project, is a tight collaboration between private sector entities, knowledge institutes, public sector entities and interest groups united in the program Smartwayz (D10). InnovA58 is one of the eight projects constituted in this programme, and an important element of InnovA58 was the constitution of a Living Lab to test innovations (Verweij et al. 2018). One of the desired types of innovations are circular innovations (D9), designing decision-making into actions that reduce the use of primary raw materials and waste (D8, D10). More specifically, the outcome should contain a more circular lifecycle approach and the use of circular materials in both the road design as well as the direct environment (D8, D11, RPR9).In order to achieve this, the Living Lab produced an 'Innovatiestrook' near Kessel, where a road is constructed based on new, circular materials. (RPR9) was closely involved in the exploration phase as innovation manager in the IBM Team. (RPU10) was involved as a circular advisor and later as innovation manager of the Innovation Team. Later helped to create the Living Lab for InnovA58.

4.4.1 Arrangement structure

The initiative for the project reaches back to 2010 when InnovA58 did not get priority in the available national budgets (D11, RPR9). Regional parties, private and public, were dissatisfied with the decision and pleaded for a creative solution. Then, 'Stichting A58', a cooperation between various market parties, created their 'bid book', where they illustrated how they think about investments for the region, among which the plans around A58 (D8, RPR9). With this early **private sector involvement,** the goal was to really collaborate in a less traditional way, aiming specifically at two goals. First, the idea was to get InnovA58 earlier on the political agenda (RPR9). Second, the idea was to create 'the highway of the future' (D11). The involvement of the private sector involvement was seen as very valuable for the outcome of the project:

"The market parties that have initiated this project, have put the project on the map in a certain way, one that was crucial in the exploration phase but also was very important for the outcome."
(Innovation Manager, RPR9)

The collaboration in this project was also charmed by the ministry, which stated that due to this project, the project had to produce other, more innovative results (D11). For this first part, the private sector entities carried risk and time and energy (D8) however, during the Living Lab, RWS covered the risks (RPU10).

For **bundled phases,** it is difficult to dissect whether InnovA58 can be seen as a project with bundled phases since the project was part of a bigger programme (RPU10). The living lab however was constituted of three different elements, among which the 'Innovatiestrook'. This innovatiestrook was a result of the larger programme InnovA58, but the living lab itself is a continuous test environment, while at the same time other projects are enriched with the findings (R11, RPU10). Living labs can fulfill various targets, among which the creation of product innovations and the improvement of sustainability (Neef et al., 2017). In this case, the Living Lab of Innova58 has designed and developed several product innovations (D11) and one could state that these innovations were initiated as well as they were outcomes of the living lab by the same larger group, the Circular Infra Community of which later on information will be provided, as well as the involved contractors and product designers, which mirrors a trajectory of bundled phases.

4.4.2 Network structure

The network of this project contained many public and private sector entities. Looking at the **heterogeneity**, the number of actors was high and their contributions varied. Meaning, that the expertise and knowledge of each actor could uniquely be used for the project. Illustrating, already before the exploration phase many varying market parties in the area who didn't have a direct link with construction, examples are Philips and Heijmans, were involved and provided contributions for circular ideas (RPR9). This enriched the creativity of the solutions (D11, RPR9, RPR10). Also within smaller teams, efforts were made to create rich project results (D11). Illustrating, the ministry of Infrastructure and Waterworks, had deliberately chosen to add a sixth role into their traditional project roles IPM model, such as the project manager and contract manager, and added an innovation manager (RPU10). The contribution came together in Strijp-S in Eindhoven where each team, among which, the innovation team had their project meetings. The variety of the project team was seen as crucial for the process:

"Each member of the innovation team has delivered important and effective ideas or products, you need them both, dreamers and business-minded people, to get there" (Learning History InnovA58, D11).

Yet, it is important to mention that during the startup phase of InnovA58, definitions or interpretations of the concept of the circular economy were still very new and unknown (D11, RPR9, RPU10).

For **trust,** both respondents mentioned that they deemed this as important to reach innovative outcomes (RPR9, RPU10). However, the process of 'control and dominate' towards 'let go and trust' has proven not to be an easy one in a highly uncertain innovation environment (RPR9, D11). Based on the results it becomes clear that trust was very dependent on the situation. Both innovation managers felt that trust = was present in the form of open communication. Also, within the teams, it was stated that there was a feeling of trust that everybody contributed to the collective outcomes of the team and could depend on each other in a formal, professional sense (RPR9). Sometimes trust, in the form of making a connection, was actively looked for and achieved by sometimes stepping out of the formal process and staying a few days with the project team at a different location such as the heath, just to align the collective story and bond during the process (RPR9). Nevertheless, in the collaboration with the rest of the project, trust was not really experienced:

"Looking back, I do think there was trust in the innovation team. However, in the IPM team, I experienced this less. Endlessly, we had to combat our ideas, our steps". "This while, for me, working towards a circular economy is all about trust and collaborating."(Project leader RWS, RPU10)

While the idea was to communicate about issues collectively and go for a real partnership, the project, in general, lacked trust, while that is stated to be important for collaborations like InnovA58 (D13).

4.4.3 Network management activities

When it comes to network management, there are a few activities that influence or have contributed to the network in this case. Both network activities were also connected or solutions in terms of 'managing conflict'.

First, 'steering information flows' was important. Both respondents felt that due to the highly innovative and rather unknown environment, it was needed to actively steer the information in the network (RPR9, RPR10). This was sometimes visualized, to make it comprehensible. For example a figure was drawn

ranging from easy, predictable innovations to largely unknown innovations. The latter mainly delivered possible input for the living lab (RPR9).

Second, 'exploring for new ideas', was crucial, fitting in the aim of the living lab. At some point, the team discovered that the widening of the A58 needed too many raw materials (D10, D11). It was suggested that more attention should be given to circular solutions, which was the foundation of the constitution for the Circular Infra Community, a diverse group that came up with all kinds of ideas for the living lab (RPU10). In the project teams, because of the large number of different types of innovations, high heterogeneity was needed to cope with all innovations and then be able to communicate them again to the 'higher' management teams. Third, also here, 'managing conflict' was important. Especially, since sometimes the ambitions of the innovation team were more ambitious than the rest of the programme (RPU10). This made it at times difficult to emphasize why certain innovations were needed (RPR9, RPR10) and required that the network was managed to avoid conflict (RPU10).

	Arrangement		**Network**		**Management**
	Private sector involvement	**Bundled Phases**	**Heterogeneity**	**Trust**	**Network management activities**
Innovation manager Twynstra Gudde	RWS carried risk	Yes	High	Open communication (A)	Steering information flows (A), managing conflict (E)
Innovation manager (RWS)	RWS carried risk	Yes	High	Open communication (A)	Steering information flows (A), exploring for new ideas (D) managing conflict (E)
Documents	RWS carried risk (D10, D11)	Yes (D13)	High (D10, D11, D13)	Open communication (A) (D13)	Steering for information flows (A), steering for collective aims (B), managing conflict (E) (D13)

Table 8: Overview results interviewees & documents case 4 (Author, 2022)

4.5 Structural mechanisms for innovation

In the previous sub-chapters, Chapter 4.1 until Chapter 4.4, four construction projects with circular outcomes, have been discussed. Per case, this illustrates the gathered data of two or three involved project members, and related documents. Yet, while I have selected already on proven circular innovative outcomes, the way in which they achieved circular outcomes in terms of the discussed structural mechanisms and network management activities, differs. To be able to discover patterns throughout the cases, Table 9 has aggregated all cases, compared to the structural mechanisms and network management activities.

Dimension	Concept variable	Case 1 Croeselaan, Utrecht	Case 2 Circular Viaduct Kampen	Case 3 Cycling Bridge Ritsumasyl	Case 4 InnovA58 Living Lab
Arrangement structure	Private sector involvement	Private sector carried risk	Shared risks, early private involvement	Public sector carried most of the risk, sometimes shared, early private involvement	Public sector carried risk, early private involvement
	Bundled phases	No	Yes	Yes	Yes
Network structure	Heterogeneity among partners	Low	Low	High	High
	Trust	Open communication (A)	Open communication (A), keeping each other's interest in mind (B), taking risks (C), having a connection (D)	Open communication (A), keeping each other's interest in mind (B), taking risks (C), having a connection (D)	Open communication (A)
Network management	Network management activities	Steering information flows and compliance to agreements (A), steering for collective aims (B), managing conflict (E)	Steering information flows and compliance to agreements (A), Steering for collective aims (B), facilitating interaction processes (C) exploring new ideas (D), managing conflict (E)	Steering information flows and compliance to agreements (A), Steering for collective aims (B), facilitating interaction processes (C) exploring new ideas (D), managing conflict (E)	Steering information flows and compliance to agreements (A), exploring new ideas (D), managing conflict (E)

Table 9: Segregated case data (Author, 2022)

4.5.1 Arrangement structure

The first pattern that can be observed is that early private sector involvement is key in projects with bundled phases.
Explaining, looking at the first row of table 9 it can be observed that for three out of the four public-private collaborative governance structures namely, case 2, case 3 and case 4, private sector parties were early involved in the process. Connected to this, it can be observed that for the same cases, phases are bundled. In general, it is stated that most innovation is gained by bundling project phases (Volker, 2019). For cases 2, 3 and 4, the phases are bundled phases.

The second pattern that can be observed is that when phases are not bundled, the best position of risk might be in the corner of the private party.
Explaining, looking at table 9, only for case 1 counts that the risk was carried by the private sector. For the rest of the cases, the risk was carried by the public sector or was shared in terms of a shared cost pot. For this shared cost pot agreements were made, if the costs were clearly in the corner of the private sector entity, the risk would be theirs (RPR3). Naturally, the structure of the contract influences how the risk is divided (Kwak et al. 2009). In case 1, the more traditional contract, one can observe that the private sector entity carries the risk. Based on this case comparison, when phases are not bundled, the private sector might be in the best position to carry risks. Case 1 includes a more traditional procurement method. Here, the public sector purchases certain assets from one agent and will then use that asset to contract out service provision (Carbonara & Pellegrino, 2019).

4.5.2 Network structure

The first pattern that can be observed from the segregated case data, was that heterogeneity was high in projects where the public sector most or completely covered the risks of the project. Looking at table 9, cases 3 and 4 are high in terms of heterogeneity. In these cases, the number of partners and the variety of partners were high. Comparing this to the earlier mentioned case characteristics, the structure of the contract have partly influenced this. In case 1, for example, a tender took place, meaning that due to these contractual agreements only a small number of partners were involved. Yet, for case 2, this didn´t play a role. (Ibid). For case 2, it was deliberately decided that the project would be run with two private sector parties and Rijkswaterstaat (RPR3). In return, the lessons gained from working towards innovative outcomes would be shared in an open-source environment (RPU4). Both cases 3 and 4 were projects, embedded or highly connected to a large program.

The second pattern that can be observed, is ‘that ‘open communication’, based on the case comparison, was key in reaching innovative outcomes.

Trust in general has played a key role in all cases. Prior research confirms that trust consist is important for innovative project performance (Carbonara & Pellegrino, 2019; Warsen, 2019; Hueskes, 2019). Looking at table 9, it strikes out, that trust in the form of ‘open communication’ has been present in each case. This indicates, that this form of trust is key for innovation. Both for cases 2 and 3, more forms of trust are observed. These were linked to keeping each other’s interest, having a connection and taking a risk. It is interesting to see, that both case 1 and case 4 entail the same presence of trust, whilst their public-private collaborative governance characteristics are quite different. This hints, that for the presence of trust in the form of ‘open communication’ the form of contract does not per se has an impact on this. Open communication for innovation can be found in projects that are rather traditionally bound

to contractual agreements, but its presence is also mentioned in projects where contractual agreements to a large extent have not been drawn up.

5.4.3 Network management activities in relation to the network structure

Lastly, a few patterns concerning the network management activities and the combination of network management activities and the network structure can be observed.

The first pattern that can be observed, is that in all cases, 'managing conflict' was a key activity to steer for innovative outcomes. Connected to the network structure, managing conflict seems to correlate with the presence of open communication. Also 'steering for innovation flows' was a key activity in each case.
When comparing the cases, managing conflict is the activity that was experienced as important to all project managers. In combination with the network structure, one can observe that managing conflict also seems to co-relate with the presence of open communication. This then, also correlates with the steering information.

The second pattern that can be observed, is that in cases where many network management activities were undertaken, many forms of trust were experienced.
Case 2 & case 3, show similar forms of trust. These were open communication, taking each other's interest in mind, taking a risk and having a connection. For the same cases, most network activities, among the studied cases, were undertaken. These were steering for collective aims, facilitating interaction, exploring new ideas and managing conflict. Efforts in undertaking many network management activities might, thus, encourage and enable a larger variety of forms of trust among project groups.

The third pattern that could be observed, is that in projects where network management activities were also focused on exploring for new ideas, phases were bundled. Additionally, in these cases, private sector parties were early involved.

In cases 2,3 and 4, phases were bundled as earlier discussed. In these cases, the project managers mentioned that they emphasized on exploring new ideas. Volker (2019) states that bundled phases, increase the innovative outcomes of the project by, among other factors, continuous knowledge transfer. Bundled phases might, based on table 9, create room for exploring new ideas. The other way around might also be possible. In projects with bundled phases, project managers may tend to be more drawn to stimulate the exploring of new ideas throughout the process. Additionally, the early private sector involvement, as earlier addressed, might also have induced or accelerated the search for innovative new ideas.

Chapter 5 Conclusion, discussion & suggestions for further research

5.1 Conclusion

In Chapter 5.1, the conclusions for this study are drawn. First, Chapter 5.1.1 will provide an answer to the sub-research questions, each tackled per paragraph. Chapter 5.1.2 will provide an answer to the primary research question.

5.1.1 Answer to sub-research questions

5.1.1.1 'How can innovation be defined?'

Based on the literature review, innovation can best be defined as "the adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization" (Damanpour, 1992). Emphasize should lie on that innovation is new to the adopting organization and that innovation is constituted by multiple organizations. Innovation can be categorized into technological and non-technological innovations. Among technological innovation, one can categorize product and process innovation. Among non-technological innovation, one can categorize organizational or marketing innovation. For any innovation category counts, that the application of innovation and its reach for innovative outcomes is dependent on how and which choices are made earlier in the process. The motives behind ideas for innovation implementation can be clustered over the last decades, resulting in three characteristic trends (see Chapter 2.1.2). The most recent, thus third frame, calls for transformative socio-technical system change in relation to increasing environmental challenges, for the Netherlands this relates to the nitrogen crisis (see Chapter 1.3). Observing innovation embedded in this particular context studied from the construction industry lens this thesis departs from, innovation is seen as something that has been applied, is new to those involved in the adoption, refers to the outcome of a project and does not refer to a single innovation but to the degree to which innovations have been applied through efforts made in all project phases (Hueskes, 2019).

5.1.1.2 'What types of collaborative governance can we distinguish in construction management and what are their characteristics?'

Collaborative governance can best be seen as an umbrella term and is defined as processes and structures of public policy decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/or/the public, private and civic spheres in order to carry out a public purpose that could otherwise not be accomplished. Based on this definition, collaborative governance engages a broad segment of stakeholders comprising state, private sector and civil society, as well hybrid arrangements, such as public - private partnerships. Collaborative governance has become significantly more addressed in the last decade due to increased awareness solving today's complex problems, especially environmental challenges, collectively. Empirical data has shown that public-private collaborative governance structures can broadly be categorized based on possession of certain characteristics that distinguishes one collaborative model from another.

First, some models are characterized mainly by formal, contractual agreements, where risk is carried by the private sector party, such as the D&C contract in the case of the Croeselaan in Utrecht. In general, structural mechanisms for innovation such as trust are present, but these will likely be narrowly connected and or influenced by the agreed contractual agreements.

Second, nowadays, public-private partnerships are one of the most commonly used contract forms. In these contracts, such as a DBFM (O) contract, design, build, finance, and maintenance are integrated. In these contracts, the client is responsible for each phase. Literature emphasizes the benefits of DBFM (O), mostly in terms of significantly better cost performance

Third, other collaborative governance models may still be bound to contractual agreements, but these agreements might be collectively decided upon, just as the risk allocation is collectively organized. In these contracts, it is common that private sector parties are early involved to think along with the design, which is likely to positively influence innovative outcomes. An example of this is the first phase of the case of the bio-based cycling bridge Ritsumasyl.

Fourth, some collaborative governance models, are less built upon contractual agreements, but rather build upon experimenting with ideas and collectively establishing goals. An example of this is InnovA58 Living Lab. These collaborative governance models tend to early involve private sector parties, are likely to allocate risk in the corner of the public sector party and are distinctive in the open, experimental environment that may trigger innovation and novel ideas.

In general, one could state that collaborative governance models can exist of rather traditional public contracting models, public-private-partnership models and experimental living laboratory models. Nonetheless, it is relevant mentioning that hybrid public-private collaborative governance has been established based on the context in which the project for innovative outcomes is embedded in. An example is a cooperative agreement that was found in the case of the Circular Viaduct, yet also the second phase of the cycling bridge Ritsumasyl shows that variations on common governance models are likely to occur (see also Chapter 4).

5.1.1.3: 'Which structural mechanisms explain the relationships between innovative outcomes and collaborative governance and which network management activities can be observed?

When explaining the relationship between innovative outcomes and collaborative governance certain structural mechanisms – elements in existing public-private collaborations that are connected to for instance the network of a project – are likely to foster innovation (Carbonara & Pellegrino, 2019). These are connected to the arrangement, the network, the industry, and the contract structure of a project. From the perspective of this thesis, four structural mechanisms explain the relationship between innovative outcomes and collaborative governance. The first two are embedded in the arrangement structure of the project. First, private early private sector involvement is expected to lead to more (cost-saving) innovative outcomes, due to the risk-taking behaviour of the private sector. Second, bundled phases contribute to innovation since bundling encourages up-front innovation that will contribute to cost reduction of the infrastructure asset's life cycle. Bundled phases are also increasingly considered in terms of their sustainable innovative character, acting less as linear fragmented project phases and more as a system for innovation. Two characteristics are connected to the network of a project. First, through heterogeneity among partners. The range of knowledge, expertise, and competencies in a project's collaboration, improves the creative potential for innovative outcomes. Trust allows for more open and honest sharing of information, increases the will to keep each other's interest in mind and reduces conflict, elements that are favourable in highly dynamic and uncertain innovative processes. Connected to the network structure is network management. Managing relationships between partners in the network is crucial for achieving successful innovative outcomes, such as steering information and compliance to agreements, facilitating interaction processes and exploring for new ideas and managing conflict. A combination of these activities, should be encouraged.

5.1.2 Answer to the primary research question

The primary research question was as follows: 'How do different structural mechanisms contribute to innovation in Dutch construction projects?'

Currently, the lacking long-term perspective and focus on individual project phase results make that innovation in the Dutch industry sector is hampered. Environmental challenges, such as the nitrogen crisis, increase the urge to create a more sustainable construction industry sector through public-private collaborative governance. From the empirical results, a few main conclusions can be drawn.

First, for the arrangement structure of projects, this study has shown that early private sector involvement is key to innovative outcomes. Especially in projects where phases are bundled, early private sector involvement seems to accelerate and or trigger the ambition for innovative outcomes. When phases are not bundled, risk can best be carried by the private-sector party. Second, trust is key to innovative outcomes, independent of the form of the public-private collaborative governance model. Trust should be present in the form of open communication. Heterogeneity does not seem to have a direct contribution to innovative outcomes. Third, network management activities are crucial for innovative outcomes. Connected to the network structure, efforts in network management activities seem to also result in a broader experience of trust in projects. In projects where is actively steered at facilitating interaction processes, more often a connection is felt among the project members. Nevertheless, as networks act as systems, it is important to adapt network management activities, to each situation. To contribute to innovation in Dutch construction projects, in each public-private collaborative governance, active attempts should be made concerning the mentioned main conclusions, in order to foster innovation.

5.2 Discussion

This chapter presents the strengths of this thesis and its contribution to existing academic literature. Accordingly, similarities and differences in relation to the literature will be discussed. Then implications for planning practice and recommendations for future research will be presented.

This thesis has provided an understanding of how and which structural mechanisms in collaborative governance foster innovation in Dutch construction, by comparing four successful Dutch circular construction projects via a qualitative comparative case study. This research contributes to the existing field of knowledge, by using the model of Carbonara & Pellegrino (2019). This model had so far only been applied to public-private partnerships. Yet this thesis explains instead, how structural mechanisms in a variance of four public-private collaborative governance models, more or less foster innovation in Dutch circular construction projects. Additionally, this thesis has gone beyond the scope of the earlier studied micro-level, by including the influence of network management activities and their impact on the network structure of a project.

5.2.1 Methodological limitations and suggestions for future research

First, a more in-depth study of (eco) system innovation in the construction sector has not been touched upon. Another possibly interesting concept might be 'Infra as a service', where the private sector remains the risk carrier of the infrastructural asset. However, this is rather new and has not been applied to a large extent yet. Since I limited my research on finished projects that successfully incorporated innovation, this was outside the scope of my research.

Second, I am currently focused on the context of the Netherlands. However, the model of Carbonara & Pellegrino (2019) and their industry dimension, also encourages international comparative research, which allows for comparing different industries. An example to focus on might be to continue on the topic of circular innovations, to respond to today's urgency to step away from linear industry practices. Research shows that in Europe a ´two–speed Europe' can be observed, which states that countries most advanced include Germany, Belgium, France and the Netherlands, while countries in Eastern and South Europe are lacking behind in pursuing operations according to CE principles (Mazur-Wierzbicka, 2021). A suitable methodology for this might entail pursuing a QCA analysis, which enables analyzing multiple cases and helps to explain why some countries are successful in achieving circular outcomes whilst others are less successful.

5.2.2 Theoretical limitations

A few similarities and differences, when compared to literature, can be observed.

First, the added value of early private sector involvement in projects that were bundled is in line with the literature. Studies and this thesis' results show that the early involvement of private stakeholders might accelerate the innovative character of the project (Carbonara & Pellegrino, 2019; Himmel & Siemiathyki, 2017). Second, the results do not exactly show that the involvement of the private sector as a risk-taking partner fosters innovation in infrastructure construction (Kline & Rosenberg, 1986; Dosi, 1988;Shapira, 1994; Utterback, 1994 in Carbonara & Pellegrino, 2019). What the results do show, is that when a project is not bundled, the risk was for the private sector as illustrated by the case of the Croeselaan. Normally, in a traditional contract, involved partners would only be responsible for a part of the project's outcome, which hampers synergy and innovation (Volker, 2019). In this case, it might have been different, because of the tendering process. This was designed such, that only parties that had expertise in sustainable solutions could join.

It might not always be able to include extra input in a project. First, while it is stated that risk transfer to the private sector might increase innovative outcomes (Carbonara & Pellegrino, 2019), results show that this is not necessarily the case. A possible explanation could be bound to the fact that this study does not really address construction projects that integrate all project phases including the maintenance phase. Volker (2019) states that when the private sector entity is also responsible for the maintenance of a project, more attention is given to being as innovative as possible in the earlier project phases to reduce life cycle costs after. The earlier mentioned 'Infra as a service' contract, might therefore be an interesting form to investigate.

The results did not show a direct link between heterogeneity among partners and innovative outcomes. This was not in line with the literature. Literature states that the heterogeneity of partners refers to a variety of competencies, expertise and know-how. Exposure to this kind of knowledge would improve the creative potential to develop innovation (Carbonara & Pellegrino, 2019). A possible explanation might also be connected to the operationalization. Heterogeneity in this thesis was operationalized in the form of a number of partners and a variety in actors (Carbonara & Pellegrino, 2019). Several other sources however suggest that 'stakeholder involvement' will generate more knowledge. Often, knowledge of network actors is dispersed (Verweij et al. 2013). Involving other stakeholders can enlarge problem-solving capacity if values knowledge and resources are shared (Koppenjan & Klijn, 2004; Verweij et al. 2013). Such operationalization may show different results and might be interesting for future research.

This study was in line with the literature in terms of the relationship between trust and collaborative governance. Trust is key in achieving innovative outcomes (Warsen, 2021). Open communication was essential in each circumstance. Some cases mentioned more indicators for trust than others. For the case of the Croeselaan and the case of InnovA58 Living Lab, trust was similar observed. This is interesting since the contractual structure was quite different. Solely contractual, or solely relational aspects are not beneficial for the innovative project outcomes (Warsen et al. 2019). When trust is lacking, one falls back on the contract. This was for instance the case in the Croeselaan Utrecht, where trust was more experienced as an enabler in reaching contractual agreements. As earlier mentioned, some consortia enable a different amount of trust than others. Of course, it is difficult to determine 'a degree of trust'. Yet, looking at the different forms of trust that were mentioned by the respondents, one could state that the contractual agreements of the bouwteam and the circular viaduct were allowing more interaction and opportunities to build relationships than the design of the case of the Croeselaan allowed. Yet, it is interesting that the Living Lab was also limited in forms of trust. A possible explanation for this could be that, for innovA58, the focus was on loose contractual agreements (Neef et al. 2017). This made it at times difficult to explain why innovations were necessary. As Warsen et al. (2019) state, it is important to balance both contractual and relational aspects to create effective outcomes.

The influence of network management activities on the network structure is in line with the literature (Buscher et al 2022, Klijn & Koppenjan, 2006; Warsen et al. 2019). The ability to steer a network however is rather closely related to the contract structure and the room it provides for intensive network management activities. What is confirmed here, is the idea of networks functioning as systems, discussed in Chapter 2.2 (Leendertse, 2015). Network managers steer in different ways, yet different situations also ask for different actions. Steering information flows and compliance to contractual agremeents is a rather straight forward network management activity to pursue, even in dynamic environments. However, one can still observe that this is needed both in a D&C construction as well as it is needed in a living lab construction.

5.2.3 Implications for planning practice

Three implications for planning practice are drawn from this research:

- It is recommended to include private sector parties early in the process. Possibly, this is even something to take into account in the choice of contract. Early private sector involvement in collaborative governance processes can trigger innovative ideas. It provides the opportunity to increase conceptual creativity, which can strengthen innovative plan development in a later stage.
- It is recommended to invest in an environment that enables mutual trust between partners. Similar to the previous recommendation, this might also be connected to the design of the contract. Open communication is key to innovation. Stimulating being open about project issues and being transparent about finances can trigger such an environment.
- It is recommended to take a close look at network management activities in relation to the network structure. It is worthwhile, to invest in facilitating interaction processes and exploring for new ideas. Network managers should be trained to cope with various situations. From the results of this study, many network management activities are concerned with achieving innovative outcomes. Since networks act as systems, network managers should be continuously aware of varying situations. Steering information and compliance with contractual agreements may work in any situation, nevertheless, exploring for new ideas and facilitating interaction, are just as important to take into account.

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Chapter 6 – Reflection

In this chapter, I will reflect on the research process and the steps I have undertaken to complete this thesis.

For the theoretical framework, I have brought together various academic concepts. I have done this, to create a rich understanding of how different concepts are connected to one another. In doing so, I have tried to funnel each concept. An example can be found in Chapter 2.1, where I started with the concept of innovation, and then illustrated different categories resulting in product innovation which was then connected to circular innovation. Reflecting upon this, the funnelling might have started off too broad or might be too difficult to follow. Nevertheless, the concept of the circular economy is a rather new one, and to be able to connect this concept with other theories and ideas, such as the idea of 'systems' I have deliberately used this funnelling to guide the reader as much as possible.

The comparative qualitative case study offered a suitable method for answering the research questions. The selection of cases in terms of circular innovation was not difficult, since the cases studied for this were among the most successful and therefore known circular projects. The cases varied in the public-private governance model. Nevertheless, it is not always possible to visit all the detailed information about the governance structures of cases. Therefore, in some cases, it turned out to be that the contract was designed a bit different than previously expected. This influenced the variance. Nevertheless, this research has investigated a range of to a large extent varying collaborative governance structures, which extend academic knowledge of the earlier studies that often focused on public-private partnerships. I also hope to have created some insights, on other types of collaborative governance that might be interesting for planning implications as well. For the fourth case initially, another case was selected. Unfortunately, this case was not finished after all, which made it not suitable for this thesis. With some help for a new case, this allowed me to immerse myself in the case of InnovA58, a living lab that actually enriched the case comparison. In terms of collaborative governance, while of course the case selection was done based on different types of collaborative governance, I mainly gathered empirical results from public and private sector managers. Since I chose to focus on a broad range of collaborative governance, it may have been an idea to also interview for example participants of educational or knowledge facilities. Nevertheless, since my focus also extended to network management activities, the choice for public-private sector management was also more practical.

In general, the collected data, both through the literature review as the empirical methods, provided me with sufficient insights to answer the research questions. Here and there, given the relevance of the desire for a more circular economy, I would, if I could do this research again, incorporate this a little more also in the operationalization of this thesis. Nevertheless, I am convinced that the research conducted may trigger planners and policymakers to at least closely examine suitable structural mechanisms and the accompanied network management effort, in order to respond to the national ambitions for a more innovative GWW sector.

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Appendices

Appendix A

Toestemming deelname aan interview

Hartelijk dank dat u meedoet aan mijn afstudeeronderzoek voor de master Environmental & Infrastructure Planning (EIP) aan de Faculteit Ruimtelijke Wetenschappen (Rijksuniversiteit Groningen). Het doel van dit onderzoek is om inzicht te verkrijgen in hoe innovatie binnen collaboratieve samenwerkingen tot stand komt in Nederlandse constructieprojecten. Het interview duurt 60 minuten en zal worden opgenomen met een audiorecorder.

Belangrijk:

- Meedoen aan dit onderzoek is vrijwillig, u heeft het recht om ten allen tijden te stoppen met het interview, tot aan het moment dat dit onderzoek wordt gepubliceerd.

- U heeft het recht om te besluiten bepaalde vragen niet te beantwoorden.

- Uw participatie aan dit onderzoek is vertrouwelijk. De antwoorden die u geeft, worden slechts gebruikt binnen dit onderzoek. Zonder uw toestemming wordt data die kan herleiden tot u persoonlijk, niet gebruikt in rapporten die worden genereerd vanuit dit onderzoek.

- Dit interview zal worden opgenomen. De geluidsopname wordt gebruikt om de verkregen data te transcriberen. De geluidsopname zal niet worden beluisterd door anderen, anders dan de interviewer.

Wilt u de volgende vragen beantwoorden:

Ik ga akkoord met het feit dat dit onderzoek wordt opgenomen	JA / NEE
Mijn functie/organisatie mag worden genoemd binnen dit onderzoek	JA / NEE
Mijn naam mag gebruikt worden binnen dit onderzoek	JA / NEE

Ondergetekende verklaart het document gelezen, begrepen en ingevuld te hebben;

Handtekening deelnemer : _____Datum: _____

Handtekening onderzoeker: _____Datum: _____

Voor vragen kunt u contact opnemen met:

Student: Marlies Rijkeboer: m.l.rijkeboer@student.rug.nl

Begeleider: Dr. S (Stefan) Verweij: s.verweij@rug.nl

Appendix B
Interview Guide

Introductie

- Kennismaken
- Deelnemer bedanken voor het meewerken aan dit interview
- Deelnemer wijzen op rechten & privacy
- Doel en duur (60 minuten) van het interview herhalen
- Uitleggen hoe de data binnen dit onderzoek wordt gebruikt en wat er met de data gebeurt
- Uitleggen thema's en kort de volgorde van het interview toelichten
- Vaststellen of er nog vragen zijn

Thema 0 - Betrokkenheid bij project & rol

- Kunt u uzelf introduceren?
    - Rol/organisatie
- Kunt u mij vertellen hoe u betrokken bent geraakt bij dit project en wat binnen het project uw rol was?
- Wat maakt volgens u, dit project innovatief (en in dit geval circulair)?
- Welke factoren hebben hier volgens u aan bijgedragen?

Thema 1 – Taken & netwerk management activiteiten

- Hoe heeft u ervoor gezorgd, dat alle actoren werden betrokken bij het proces?
- Op welke manier is de communicatie tussen alle actoren verlopen? Kunt u daar een voorbeeld en frequentie van noemen?
- Hoe heeft u ervoor gezorgd dat alle betrokkenen zich richtten op de collectieve belangen (met name innovatie) van het project?
- Wat voor acties ondernam u, als er zich conflicten of problemen voordeden? Kunt u hier een voorbeeld van noemen?
- Kunt u mij vertellen, welke netwerkactiviteiten volgens u van meerwaarde zijn geweest voor de totstandkoming van de innovatieve doelstellingen van dit project?

Thema 2 – Arrangement structure

- Bij wie is het initiatief voor dit project ontstaan?
- Kunt u mij vertellen wanneer welke partijen bij dit project zijn ingeschakeld?
    - Wel/niet early involvement private partij
- Waren de samenwerking en de verantwoordelijkheden van iedere partij vastgelegd in een contract? Zo ja, wat voor soort contract?
- Hoe zijn de verantwoordelijkheden per fase van het project verdeeld tussen de verschillende actoren?
- Acht u de samenstelling van partijen van meerwaarde voor de totstandkoming van de innovatieve doelstellingen van dit project? Waarom wel/niet? Kunt u een voorbeeld noemen van wanneer dit van meerwaarde is gebleken?
- Acht u de timing van de betrokkenheid van de private partijen, van meerwaarde voor de totstandkoming van de innovatieve doelstellingen van dit project? Waarom wel/niet?

- Wanneer fases waren gebundeld: acht u de bundeling van de fases van meerwaarde voor de totstandkoming van de innovatieve doelstellingen van dit project? Waarom wel/niet?

Thema 3 – Network structure

- Hoe ziet het netwerk van dit project er uit?
    - Aantal partijen, welke partijen
- Hoe heeft u de samenwerking gedurende het traject ervaren?
- Had u het gevoel dat er vertrouwen was tussen de betrokken actoren? Zo ja, hoe merkte u dit, kunt u daar een voorbeeld/situatie van noemen?
    - Mogelijk doorvragen/toelichten aspecten vertrouwen
- Had u het idee dat iedere partij op zijn eigen manier een unieke bijdrage kon leveren aan het project en er op die manier heterogeniteit was onder de partners? Zo ja, hoe merkte u dit?
    - Mogelijk toelichten aspecten heterogeniteit
        - Soorten organisaties
        - Soorten rollen
        - Soorten kennis
- Acht u op basis van bovenstaande thema's het onderlinge vertrouwen van meerwaarde voor de totstandkoming van de innovatieve doelstellingen van dit project? Waarom wel/niet?
- Acht u, indien aanwezig, de heterogeniteit tussen actoren van meerwaarde voor het behalen van de circulaire doelstellingen van dit project? Waarom wel/niet?

Thema 3 - Reflectie op uitkomst

- Is dit project met het oog op die doelstellingen wat u betreft geslaagd?
- Zijn er binnen deze thema's met het oog op het streven naar innovatie, aspecten die u achteraf anders had willen aanpakken als u het project opnieuw mocht doorlopen?

Afsluitend

- Wilt u verder nog iets kwijt over dit project met betrekking tot het onderwerp innovatie?
- Herhalen afspraken
- De geïnterviewde vragen naar andere potentiële deelnemers voor dit onderzoek.

Appendix C
Code Tree