The Dynamics of Project Management during Innovation

Master Thesis
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14th August 2024
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rijksuniversiteit groningen

COLOPHON

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Date of submission:	14th of August 2024
Version:	Final
Word count:	22.703 words
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PREFACE

Dear Reader,

Before you is my master's thesis, the finalisation of my studies. This research was conducted as part of the Master's program in Society, Sustainability, and Planning at the University of Groningen. While it marks the end of my academic journey, it also signifies the beginning of a new chapter in my life. The subject of my thesis combines project management and innovation within the context of three infrastructure projects in the Netherlands. The blend of these topics motivated me to delve deeply into this research.

Throughout this process, I gained firsthand experience of what I aspire to pursue in the future. As one of the respondents stated:
"Given the transitions ahead, such as those in mobility, energy, and housing, innovation is indispensable. If you keep doing what you've always done, you'll get what you've always gotten, and we'll remain in perpetual crisis. It is therefore important to innovate and find smart solutions."

- Respondent, public partner

This quote underscores the necessity of innovation. As a project manager, the goal is to maintain timelines, budgets, and costs. My research aligns with this objective, although, like project management and innovation, challenges arose, requiring adaptability to meet targets. Writing this thesis wasn't a perpetual crisis but rather a quest for smart solutions and occasionally taking different steps.

I am grateful to several individuals who supported and contributed to my academic endeavours. First and foremost, I extend my thanks to the policymakers and experts in the field of project management who generously shared their expertise and provided access to their knowledge. Their willingness to participate in interviews and offer insightful perspectives made this research possible.

I am also grateful to my supervisor, Stefan Verweij, for his consistent and constructive feedback, prompt responses to my queries, and invaluable guidance throughout this research process. Despite my busy schedule managing a thesis alongside board duties, sports, a social life, and completing all master's courses in a year, his availability during the summer holiday has significantly enriched this thesis.

Thank you.

Huub Raspe

Groningen, August 2024

ABSTRACT

Infrastructure projects, the lifeblood of modern urban development and innovation, demand the seamless integration of human, material, and financial resources. Public-private partnerships (PPPs) are increasingly instrumental in these projects, and their potential to drive product and process innovations is a reason for optimism. While empirical evidence on the impact of PPPs on such innovations is still in its infancy, this research is of paramount importance as it examines how various PPP models can stimulate innovation in infrastructure projects, with a keen focus on creating conditions for innovation realization.

The theoretical framework integrates innovation theory, emphasizing product and process innovations, with project management theory, which covers process, project, people, and performance. This framework analyses how these elements drive innovation and enhance project outcomes through a comparative analysis.

The study employs a comprehensive case study methodology to explore innovation within PPPs in Dutch infrastructure projects. Through purposeful case selection, semi-structured interviews with public and private partners, and extensive desk research—including reports, theses, and implementation plans—the research offers a understanding of innovative practices across different project management models such as DBFM(O), the two-phase approach, and living labs.

The analysis reveals that living labs fosters radical experimentation and continuous innovation through a flexible, knowledge-sharing environment. The two-phase Approach supports incremental innovations and effective risk management with a structured phase process. Conversely, DBFM(O) relies on established methods, to address specific challenges and meet stringent safety and sustainability targets. However, it may need to be more conducive to radical innovation due to its rigid contractual nature. Each model presents distinct advantages and challenges in promoting innovation.

By leveraging strategic conditions, infrastructure projects in PPP arrangements can significantly enhance innovation, overcome challenges, and achieve goals. Key factors, such as integrating sustainability, project management, knowledge sharing, and strategic leadership, play a crucial role. However, it's the robust monitoring that provides the necessary control and oversight, reassuring the project stakeholders about the progress and quality of the infrastructure projects.

Keywords: Innovation, projectmanagement, public-private partnerships, infrastructure, sustainability

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CHAPTER 1 | INTRODUCTION

1.1 | MOTIVATION AND RELEVANCE

"Projects" stand as pivotal elements shaping the trajectory of modern urban planning and innovation advancements. A project represents a concerted effort to effect transformative change within defined parameters, utilising human, material, and financial resources in a coordinated manner (Turner, 2016). Notably, these projects often take the form of partnerships, frequently structured as public-private partnerships (Verweij, 2023). These partnerships evolve and interact with other organisations in a complex and dynamic organisational landscape (De Groot, Leendertse, and Arts, 2022).
Organisations today face a rapidly changing environment (Aaltola, 2017). Over the last 10 to 15 years, the importance of sustainability has significantly increased (Lundin, 2016). Companies are now under more significant pressure to expand their reporting and accountability from focusing solely on economic performance for shareholders to including sustainability performance for all stakeholders (Visser, 2002). There is growing awareness that a change in mindset is not just necessary, but imperative, both in consumer behaviour and policy-making. This challenge should motivate us to rethink our approaches and strategies.
Grasping the key concepts that underpin collaborative efforts in infrastructure planning is a significant challenge. Spatial analyses and interventions often hinge on a single moment, assuming the intervention will lead to the desired change and result from a specific decision (De Roo, Rauws, and Zuidema, 2020). However, the dynamic nature of infrastructure planning means that these assumptions can be overly simplistic, and the outcomes of interventions are only sometimes predictable. Understanding these concepts is crucial for navigating the complexities of infrastructure planning.

Effective collaboration in infrastructure planning involves several key concepts, including project management, sustainability, and the integration of technology. Stakeholders—government agencies, private firms, community groups, and residents—must work together to identify common goals and address potential conflicts. Sustainable planning ensures that projects meet present needs without compromising future generations' ability to meet theirs. The role of technology and innovation in urban development is crucial. According to Aghion and Tirole (1994), the value of innovation depends on its potential payoff, the likelihood of its implementation, and its development cost. Stakeholders will only be motivated to develop an innovation if they obtain the potential payoff (Himmel & Siemiatycki, 2017). This principle applies to infrastructure planning, where stakeholders must weigh the costs and benefits of new projects and initiatives.

The concept of sustainability has recently been linked to project management (Gareis et al., 2011; Maltzman & Shirley, 2010). As Lundin (2016) concluded, integrating sustainability requires a shift in the management of projects - from managing time, budget and quality to managing social, environmental and economic impacts. Integrating sustainability in project management is more than adding a new facet or perspective (Gareis et al., 2011). It goes beyond merely adjusting processes and formats within current project management; integrating new perspectives into project considerations complicates matters further (Aaltola, 2017). This increased complexity necessitates a more holistic and less mechanical project management approach. The traditional project management paradigm of controlling time,

budget and quality suggests a level of predictability and control that could be more realistic in complex changes (Lundin, 2016). The integration of sustainability requires a paradigm shift. From an approach to project management that can be characterised by predictability and controllability of both process and deliverables and is focused on eliminating risks to an approach that is characterised by flexibility, complexity and opportunity (Lundin, 2016; Gareis et al., 2011; De Groot et al., 2022).
However, the actual impact of considering sustainability may be about taking responsibility for the more sustainable development of organisations and businesses (Lundin, 2016). This shift in responsibility significantly changes the role of project managers and the profession (Aaltola, 2017; Rijkswaterstaat, 2024). Integrating sustainability requires that project managers not only develop themselves as specialists in sustainable development but also act as partners of and peer stakeholders. Rijkswaterstaat, responsible for all infrastructure projects in the Netherlands, has set clear sustainability goals: "*By 2030, we aim to be climate-neutral and operate in a circular manner. This means we will emit no greenhouse gases or compensate for any emissions we produce. We will generate all the electricity we use. We will minimise the use of primary raw materials and safely and efficiently reuse materials that become available*" (Rijkswaterstaat, 2024a). In this mind shift, the change a project brings about is no longer a given nor an exclusive responsibility of the project sponsor, but also the project manager's responsibility with ethics and transparency as an essential touchstone (Lundin, 2016). Project management is no longer about 'managing' stakeholders but about engaging with stakeholders to realise sustainable development of the organisation and society (ibid).

This research explores the complexity of innovation within infrastructure projects, recognising the inevitability of uncertainty (Verweij, 2023; De Groot et al., 2022). This research connects the push for modernisation in developed economies with the long-term need for projects that promote environmentally friendly development through environmental innovations. By examining innovation and project management within different forms of PPPs - the DBFM (Design-Build-Finance-Maintain) concession model, the two-phase approach and living labs - as contrasting PPP methods for creating innovation within infrastructure projects in the Netherlands. Hodge and Greve (2019) distinguish different dimensions of the concept: PPP can be understood as a specific organisational form or project, but PPP is also seen as a policy instrument, form or style of cooperation, or policy rhetoric. It involves an anchored relationship between at least a public procurer and a private contractor, structured by a contract and a specific organisational form, for developing and managing public infrastructure in the form of a project (Verweij, 2023; Hodge et al., 2010). Analysing the Netherlands through different cases helps to improve best practices, as Pojabi and Stead (2014) stated: "The Dutch system of land use and transport planning is often highly regarded among academics and practitioners". Each PPP model offers unique approaches to managing the complexities of infrastructure projects. By comparing these models within the Dutch context, research can identify the strengths and weaknesses of each approach. This comparative analysis helps understand which elements contribute to successful outcomes and which may need improvement. Moreover, it provides practical examples of how different PPP frameworks can be adapted or combined to enhance the efficiency and effectiveness of infrastructure projects, thereby enlightening the audience on the potential strategies for their own projects.
Given the explorative nature of this research, it should be noted that PPP DBFM contracts have become the standard PPP form in the Netherlands for developing and managing

national public infrastructure (Rijkswaterstaat, 2020). DBFM, while efficient in time and cost, faces challenges of limited innovation and flexibility (Verweij, 2023). In contrast to the traditional DBFM model, the two-phase approach and living labs have emerged as compelling alternatives. Both perspectives share a co-evolutionary view, which is well-suited to understanding complex, interconnected, and continuously changing environments (Abatecola et al., 2020; Breslin, 2015), such as the dynamic organisational landscape in infrastructure planning (De Groot et al., 2022). Further research is needed to understand the impact of different characteristics on innovation within different PPP contracts. Planning has always focused on conscious and structured preparation and the organisation of spatial interventions in socio-spatial systems to maintain or improve the quality of the daily environment (De Roo et al., 2020). These days, there is a shift towards adaptive planning. However, adaptive planning does not differ significantly from traditional planning methods, as it also considers the unpredictability of transitional and emergent processes alongside deliberate and structured interventions within a 'controlled' environment (De Roo et al., 2020).

1.2 | OBJECTIVE AND RESEARCH QUESTION

This research aims to find out if Public-Private Partnerships (PPPs) in the different types of infrastructural contracts can sustainably promote innovation and what is needed to enhance this development in the Netherlands in the future. To gain more insight into this, the following research question is used:

RQ: *How can infrastructural projects optimise innovation within public-private partnership arrangements, while creating some conditions to enhance innovation realisation?*

The main research question gives rise to five additional questions for exploration:

1. How do projects drive innovation in different PPP structures?

The first question aims to explore how innovation is practically applied within PPP structures. It examines what innovation means in this context and provides examples of how it appears within different projects.

2. How do process indicators within different PPP structures create innovation through project management?
3. How do project indicators within different PPP structures create innovation through project management?
4. How do people indicators within different PPP structures create innovation through project management?
5. How do performance indicators within different PPP structures create innovation through project management?

These questions explore how various indicators within PPP structures—specifically process, project-specific, people, and performance metrics—can drive innovation in project management. Due to time constraints, the research will focus on these four areas, creating a comparative framework within different PPP structures.

1.3 | STRUCTURE

This thesis is structured into five chapters. The first chapter introduces innovation and project management within Public-Private Partnerships (PPPs), framing the research problem and its societal relevance. Chapter two explores vital concepts, defining innovation and examining current developments. It also investigates project management dimensions—process, project, people, and performance—establishing an analytical framework. The third chapter outlines the methodology and data collection process, involving a purposeful selection of three infrastructure case studies in the Netherlands. Chapter four presents the results and links the analysis developed in Chapter 2 based on these case studies. Finally, chapter five concludes with a summary of findings, a discussion of their implications, and recommendations for future research.

CHAPTER 2 | THEORETICAL FRAMEWORK

Innovation is pivotal in the infrastructure industry, manifesting in four main types: product, process, organisational, and financial (Russel et al., 2006). Product innovations integrate new technologies, designs, and materials into projects. Process innovations improve site preparation, logistics, and construction activities. Organisational innovations involve contractual arrangements and stakeholder relationships, while financial innovations introduce new financing and payment methods. Public-private partnerships (PPPs) have been vital in advancing organisational and financial innovations in transport infrastructure (Eversdijk & Korsten, 2015). These partnerships optimise resource use and foster innovation (Rutte & Samsom, 2012). Despite their potential, empirical evidence on PPPs' ability to stimulate product and process innovation is limited, prompting further investigation (Himmel & Siemiatycki, 2017; Hueskes & Verhoest, 2015; Koenen, 2018).
This research explores how PPPs can drive product and process innovations in infrastructure projects. Product innovations include the development and adoption of advanced construction technologies and materials, while process innovations involve improved methods for construction and service delivery (Russell et al., 2006; Tawiah & Russell, 2008).

This study needs to investigate the concept of innovation; project management theory will be the basis of this theoretical framework. The framework for this study is based on four premises proposed by Turner (2016):

1. **Process**: Effective time management combines clear deadlines with flexible scheduling to adapt to changes and uncertainties, driving innovation and improving project outcomes;
2. **Project**: PPP structures thrive on agility and adaptability, which are essential for innovation. They focus on unique tasks and leverage private sector expertise to balance cost and client satisfaction;
3. **People**: Efficient stakeholder management optimally utilises contributions and addresses diverse needs, fostering an environment that encourages innovation and enhances project outcomes.
4. **Performance**: Emphasising performance measurement and stakeholder management highlights innovation's role in achieving transformational change and improving processes and outcomes through metrics and perceptions.

By examining these elements, this research aims to provide insights into enhancing innovation in infrastructure projects through PPPs, thereby improving project performance and value.

2.1 | INNOVATION

The effectiveness of innovations hinges on their radicalness and diffusion (Jänicke, 2008), which are constrained when confined to niche markets. Understanding diffusion mechanisms is crucial for devising strategies, particularly noting the influence of lead markets for environmental technologies (Beise & Rennings, 2005; Jänicke & Jacob, 2004). These innovations address global challenges, requiring political or societal support due to market failures, and capitalise on global market opportunities driven by resource scarcity and environmental constraints. They offer "win-win" solutions within the capitalist framework, appealing to environmentally intensive industries amidst economic risks and the complexities of global environmental governance (Jänicke, 2008). This study assumes these dynamics are observable in today's construction and project management sectors.

In the industry, Russell, Tawiah, and De Zoysa (2006) identify four main types of innovations: product, process, organisational, and financial. Product innovations in construction involve integrating new technologies into infrastructure projects, introducing novel designs, and utilising new materials. Process innovations pertain to the activities of principal and trade contractors, including site preparation, logistics, and assembly required for construction. Organisational innovations concern the contractual arrangements and relationships among stakeholders responsible for project delivery. Financial innovations involve new forms of financing and payment, potentially unlocking creative revenue streams for infrastructure (Russell et al., 2006).

Organisational, contractual and financial innovations include negotiations on risk assignment, performance-based payment mechanisms, and off-balance-sheet financing (Russell et al., 2006). These have long driven transport infrastructure development through PPPs (Eversdijk & Korsten, 2015). PPPs gained popularity for optimising resource use, promoting entrepreneurship and innovation (Rutte & Samsom, 2012, p. 37), and generating added value (Rijkswaterstaat et al., 2016). However, empirical evidence on PPPs' ability to stimulate innovation remains limited (Himmel & Siemiatycki, 2017; Hueskes & Verhoest, 2015), a concern echoed by policymakers (Koenen, 2018). This research thus examines product and process innovations in infrastructure projects, focusing on how PPPs can encourage such innovations.

Innovations refer to "significant technological improvements" in products and processes (Verweij, 2020). Product innovation involves developing new products and, as the construction industry often adopts rather than develops innovations, utilising new products such as advanced construction equipment, novel product assemblies, designs, concepts, advanced technology for operation and maintenance, and new materials (Russell et al., 2006; Tawiah & Russell, 2008). In PPPs within the Dutch context, the private partner provides both products (e.g., tunnel systems, new roads) and services (e.g., maintenance of tunnels and roads) (Yescombe, 2007). Therefore, product innovation includes product and service innovations (Verweij, 2020). Process innovations involve new or significantly improved methods or skills for constructing products or delivering services (Verweij, 2020). Examples include logistical technologies, site preparation, off-site fabrication, construction methods, assembly technologies, and information technology tools for project design and management (Russell et al., 2006; Tawiah & Russell, 2008).

2.2 | PROJECT MANAGEMENT

Projects play a crucial role in infrastructure planning. The project as a temporary organisation is viewed here as a production function, an agency for assigning resources to manage change within the functional organisation, and an agency for managing uncertainty (Turner et al., 2003). A project can, in short, be considered any series of activities and tasks (Pinto, 2016), including:

- Having a specific objective or result to be completed within certain specifications
- Are customer focussed
- Have defined start and end dates
- Have limited resources
- Consume human and non-human resources
- Are multifunctional i.e. cut across several functional lines

Many of the classical definitions of projects emphasise the role of a project as a production function, emphasising that the project is “an endeavour” (Turner et al., 2003; Söderlund, 2004), connecting projects with the concept of innovation. This study needs to investigate this action; project management theory will be the basis of this theoretical framework. Project management could be defined as coordinating and organising all activities to be carried out

by a plurality of specialised persons or groups in a temporary joint venture, which is aimed at a specified result that is to be achieved within a limited period within the specific condition and with finite resources (PMI, 2021). Researching into projects is thus more a matter of looking and trying to capture the unique, complex and time-limited processes of interaction, organisation and management (Söderlund, 2004). In recent years, project res projects diversified at a rapid pace. Studies done by Geraldi and Söderlund (2018) welcome this, given the impact, magnitude, frequency and diversity of contemporary projects and the many challenges surrounding the numerous projects in our society. But it also hampers the development of a common language (ibid). Historically, project management has been firmly grounded in engineering, construction, and project planning. Over the years, it has increasingly incorporated elements of social science and broader management/organisation studies, addressing a range of issues beyond the traditional scope of project management (Geraldi & Söderlund, 2018).

As the basis of this theoretical framework, we use four premises created by Turner (2016), and from that, we develop an understanding of what we mean by project management.

1. **Process**: Effective time management combines clear deadlines with flexible scheduling to adapt to changes and uncertainties, driving innovation and improving project outcomes.
2. **Project**: PPP structures thrive on agility and adaptability, essential for innovation, by focusing on unique tasks and leveraging private sector expertise to balance cost and client satisfaction.
3. **People**: Efficient stakeholder management optimally utilises contributions and addresses diverse needs, fostering an environment that encourages innovation and enhances project outcomes.
4. **Performance**: Emphasising performance measurement and stakeholder management highlights innovation's role in achieving transformational change, improving processes and outcomes through both metrics and perceptions.

Projects utilise resources and perform work to create a new asset, known as the project deliverable or "output." This output represents the change, and its success is evaluated by assessing whether the goals and performance improvements are achieved in the years following the project's completion. Consequently, the **process** is a critical component in project management.
Two main parties evaluate the project's value: the owner and the contractor. The owner pays the contractor a price for the asset (change or output), while the contractor incurs costs to complete the work. When creating an innovative product or process, the **project** complexity is also a determining factor. Hence, performance-based payments and the involvement of private financing encourage the use of proven technologies and techniques (Klijn et al., 2015).
Premise three suggests the existence of a project life-cycle consisting of three inherent steps: defining objectives, determining the means to achieve those objectives, and completing the work while monitoring performance. The focus during the **performance** phase may be on individual or group behaviour ("hard" aspects) or values ("soft" aspects).
Finally, Ralf Müller and Lundin (2007) demonstrated that project managers who consider a broader range of stakeholders achieve better results. Team satisfaction has the most significant impact on project success, followed by user satisfaction and customer satisfaction. The actors who initiate and collaborate comprise another key sub-dimension of innovation as a process (Larsson et al., 2022). Therefore, it is essential to incorporate the people **concept** within every project.

2.2.1 | PROCESS

First, time is crucial. There must be some conceptions of the time horizons and time limits for the temporary organisation. One obvious reason for this is that "temporary" implies

something exists for a limited time and, normally, this time aspect is well known from the beginning (Lundin, 1995). Mainstream organisation theory - i.e., of Western origin - tends to think of time in linear and orderly terms. But processes of change, dynamism and transformation are undeniably interwoven with trajectories in time and thereby emphasise the factor of time (de Roo et al., 2020).
Crucial problems to be handled within the sequence, according to Hassard (1991, p.116), include uncertainty, conflict resolution and the allocation of scarce time resources, which in turn explain the need for time scheduling, synchronisation and the allocation of time (see Moore, 1963). As Turner (1995) puts it, a project is transient: it has a beginning and an end.
Therefore, this research will explore how different PPP structures contribute to innovation through time management, specifically by asking: "*Have these different PPP structures added value in terms of time indicators?*" Loosemore (2015) highlights that participants in construction projects engage in creative, reactive problem-solving daily. These 'hidden' innovations often arise unpredictably in response to resource constraints, evolving requirements, and unforeseen challenges during project execution (Larsson et al., 2022). Consequently, our examination of time management will address the roles of uncertainty, dynamics, and flexibility in fostering innovation within project management.

Time in project management is about scheduling because management is about control, making sure that the system is operating well and moving in the right direction. But as Peter Druker said, we cannot manage it if we cannot measure it (Turner, 2016). Project planning and scheduling provides us with a set of tools, and techniques and a system to develop the needed yardstick to measure and assess the health of the project (Aaltola, 2017). While sometimes planning and scheduling are used synonymously, we believe that planning is about data collection and intelligence gathering and organising our thoughts, and making decisions about how we want to do the project, whereas scheduling is focused on time, resources and costs (Khamooshi and Cioffi, 2013). It is about analysing the feasible scenarios using available data, assumptions and constraints developing a blueprint (baseline) for execution of the project (Aaltola, 2017). One can think of planning to consist of the following steps (Turner, 2016):

- Developing the scope documents
- Developing the work breakdown structure
- Developing the list of activities
- Collecting the network diagram
- Developing all the assumptions and constraints needed for scheduling

Once planning is taken care of and we know what we are going to do, the analysis phase or scheduling could be started (Aaltola, 2017). Scheduling is about fixing the position of each activity on the time axis that is deciding when to start and finish each activity as a result of which the project as a whole is scheduled (Khamooshi and Cioffi, 2013). There are many scenarios a project planner/ scheduler could face. Depending on strategies, aims, objectives, assumptions, constraints, characteristics of the project, availability of resources and many other variables the approach could be varied and quite diverse (Turner, 2016). However, in principle, development of a so called baseline schedule or blueprint for execution of a project could be achieved by taking these steps (Turner, 2016):

- Time only analysis (scheduling the project ignoring resource constraints)
- Resources based schedule analysis
- Cost analysis and budget assessment
- Optimal schedule development (integrates time, cost, quality and scope into the schedule).

The end of this lengthy process is an agreed upon baseline schedule which will be used for monitoring and control of the project and directing the project to successful delivery of the end product and closing the project (Calhoun et al., 2002). It has to be emphasised that

planning and scheduling processes and products are not static but quite flexible and dynamic (Khamooshi and Cioffi, 2013). In what follows we discuss how the dynamism and flexibility must be integrated in the processes and products (plans and schedules). The objective is to design a flexible and dynamic system of scheduling which is capable of dealing with all sorts of uncertainty and potential ongoing change (Turner, 2016).

The review of literature (Turner, 2016; Calhoun et al., 2002; Aaltola, 2017) suggests most of these findings are quite theoretical and they have not been translated into practical solutions and tools for planning and scheduling of large and complex projects in a very volatile and dynamic environment. Practitioners of planning and scheduling for projects are still facing the same hard classic problem of developing a dynamic schedule for a variety of projects, within a rapidly changing and complex setting (Turner, 2016). These problems include single project scheduling, multi-project scheduling, single resource or multi-resource, limited or unlimited resources, limited variables. While all aforementioned models and approaches could be very useful in a particular situation, industry and environment, few of the suggested approaches are generic, widespread and practical enough to be included in an off the shelf project management software (Khamooshi and Cioffi, 2013). It is the responsibility of the project planner and scheduler to take advantage of the finding and fitting and tailoring the model to their needs if possible at all (Aaltola, 2017). In what follows the focus is on more practical and pragmatic recommendations in project planning and scheduling and provide some guidance on how scheduling of projects could be improved, based on Turner's (2016):

- Define your objectives and priorities
- Focus on collecting planning and scheduling data
- Implement the schedule but be ready for change
- Use a systematic approach to develop the schedule
- Input the planning data in project management software of your choice
- Perform schedule risk analysis

An overemphasis on shorter project duration as a primary scheduling objective, coupled with insufficient attention to scheduling risks and the inherent unreliability of estimates, frequently leads to scheduling failures in many projects (Khamooshi & Cioffi, 2013). The reliance on deterministic values for cost and duration estimates during planning and scheduling persists despite widespread recognition that complete reliability could be more attainable (e.g., Lundin, 1995; de Roo et al., 2020). This issue is particularly pronounced in large, complex, innovative projects with significantly amplified uncertainties (Turner, 2016). Appropriate objectives must be set to mitigate these risks, and a flexible and dynamic scheduling approach must be developed (Turner, 2016; Aaltola, 2017).

The traditional focus in project management on controlling the environment and stakeholder actions can inadvertently constrain innovation. However, the dynamic nature of projects and stringent time and budget constraints underscore the critical need to foster innovative solutions (Verweij et al., 2019). Public-private partnerships (PPPs), characterised by long-term contracts encompassing facility design, construction, financing, operations, and maintenance, create incentives for early collaboration among firms within bidding consortia (Demirel et al., 2016). This early engagement is crucial for identifying innovations that can enhance technical aspects, reduce overall costs, and optimise design choices for long-term benefits (Roumboutsos & Saussier, 2014).

Rather than merely reacting to contingencies during the post-contract phase, stakeholders increasingly aim to anticipate potential changes during the pre-contract phase, from initial project conception to contract signing (Kodwo & Allotey, 2014). Much of the expanding literature on the pre-contract phases of projects focuses on identifying the causes and effects of changes and developing effective management strategies (Price and Chahal, 2006; Sun & Meng, 2009; Hwang & Low, 2012). This growing body of research suggests that linking innovation to process indicators—such as pre-contract planning, post-contract management, and overall scheduling operations—is essential for optimising project outcomes. These critical variables warrant further practical investigation to understand their impact on fostering innovation and the added value.

2.2.2 | PROJECT

Temporary organisations are pivotal in managing change, often demonstrating greater agility and adaptability than their traditional functional counterparts (Turner et al., 2003). Lundin (1995) highlights the significance of a temporary organisation's tasks or projects, which can be as crucial to them as overarching goals are to permanent organisations. These tasks are typically classified into two categories: unique and repetitive. Unique tasks address one-off, non-recurring situations, while repetitive tasks focus on ongoing or recurrent objectives (Lundin, 1995). Unique tasks are of particular interest when viewed through the lens of innovation, as they aim to bring transformative changes to otherwise repetitive fields.
Therefore, in this research, we pose the question regarding innovation: "*Have these different PPP structures added value in terms of project indicators?*" The innovation potential can sometimes be limited by the lack of incentives for the private-sector partner to innovate in areas not explicitly defined by the output specifications, contract documents, or aspects that are not rewarded (Himmel & Siemiatycki, 2017). However, local planning guidelines—such as zoning codes, building design standards, and environmental requirements—can spur innovative infrastructure solutions (ibid). Consequently, our examination will focus on how indicators like quality and price (balancing client satisfaction with resource utilisation) and clearly defined quality targets contribute to fostering innovation within project management.

In the context of PPPs, the dynamics shift to the private sector assuming roles across infrastructure design, construction, financing, and maintenance. This delegation of responsibilities transfers risks and fosters an environment conducive to innovation (Verweij, 2020). Private consortiums are thus empowered to devise integrated designs, optimise life cycles, and refine processes to deliver superior outcomes (Himmel & Siemiatycki, 2017). In the competitive arena of PPPs, contracts hinge on a dual evaluation of price and quality. There are two elements to price and quality: client satisfaction and resource utilisation (Turner, 2016). Often, these elements can conflict. The level of client satisfaction provided must be affordable to the provider. There is no point in having a happy client if the project management company has run at a loss. On the other hand, if efficient use of resources in cost-saving is the dominant element, customer satisfaction will suffer (Turner, 2016).
From the client's point of view, quality has two levels: a basic level and a higher level (Wysocki & McGary, 2003). Standard definitions, such as 'fitness for purpose', 'getting it right the first time', and 'right thing, right price, right time' apply at the primary level. In project management, this refers to scope, time and budget (Aaltola, 2017). Achieving the scope, keeping to budget and coming in on time are needed to provide essential client satisfaction (Turner, 2016). Scope, time and budget are factual and can be measured.
Nevertheless, for the client to experience a quality project, higher level needs, often intangible and therefore hard to measure, are required. These intangibles are judged by the client's perception or interpretation of what they see and experience during the project. They are often equally important to the client after delivery, service, and support (Turner, 2016). Garvin (1984) developed eight quality dimensions, which Turner (2016) adapted for project management. They are:

- Performance: refers to the efficiency (for example, return on investment) with which the project achieves its intended purpose.
- Features: attributes that supplement the project's primary performance, for example, tinted glass windows in a building
- Reliability: the capability of the project to perform consistently over its life-cycle
- Conformance: meeting the scope of the project, usually defined by numeric values
- Durability: the degree to which a project withstands stress without failure
- Serviceability: the ease of maintenance and repair
- Aesthetics: sensory characteristics such as look, sound, taste and smooth finish
- Perceived quality: based upon client opinion.

The above quality dimensions are not mutually exclusive, although they relate primarily to the quality of the delivered project. Neither is exhaustive. Service quality is more difficult to define than product quality. Parasurman et al. (1985) developed a set of service quality dimensions. The adaptation of Turner (2016) for project management is:

- Tangibles: the physical appearance of facilities and people
- Service reliability: the ability of the project team to perform dependably
- Responsiveness: willingness of the project management to be prompt in delivering the agreed timetable
- Assurance: the ability of the project team to inspire trust and confidence
- Empathy: the ability of project staff to demonstrate care and to understand client concerns
- Availability: the ability to provide service at the right time and place
- Professionalism: encompasses the impartial and ethical characteristics of the project management team
- Timeliness: delivery of the project within the agreed lead time
- Completeness: delivery of the project in full
- Pleasantness: good manners and politeness of the project team.

The two dimensions are widely cited and respected (Turner, 2016). Drawing from Wild (2002), we add that the quality of a project is the degree to which its client requirements are met and is influenced by:

- Design quality: the degree to which the scope of the project satisfies requirements
- Process quality: the degree to which the project, when delivered, conforms to scope

An essential dimension of quality that is not visible in the above models is the organisation's quality (Basu & Wright, 2003). When a project organisation develops and defines its quality strategy, all project team members, including contractors and sub-contractors, must share a common definition of quality to work towards the same quality objective (Aaltola, 2017). Project quality should contain defined attributes of numeric specifications and perceived intangible dimensions per the list above derived from Parasuraman et al. (1985). Basu and Wright (2003) add that when an organisation changes its approach to a holistic culture, emphasising a single set of numbers based on transparent measurement with senior management commitment, the 'organisational quality' germinates crucial organisation quality dimensions.

The responsibility thus falls on innovations to deliver heightened or equivalent quality at reduced costs, providing tendering consortia with a distinctive competitive advantage (Verweij, 2020). However, quantifying success is more complicated; while technical innovations offer tangible metrics, intangible elements such as aesthetic appeal or community integration pose challenges within the PPP framework (Himmel & Siemiatycki, 2017). Assessing the value proposition of PPPs becomes crucial, where quality and value-for-money serve as critical metrics. Petersen (2019) elaborates on the delicate balance between cost and quality, while Verweij (2023) further scrutinises quality dimensions like traffic flow management, highway safety, and sustainability. Despite these advancements, questions linger about the tangible benefits PPPs confer, especially concerning service availability and genuine value addition. Van den Hurk (2018) delves into the governmental perspective, shedding light on strategies to harness PPPs for societal benefits. Despite government's championing PPPs as Value for Money (VfM) instruments, promising enhanced quality at diminished costs (van den Hurk, 2018), a glaring disparity exists in formulating and executing PPP policies at the central government level. This void is particularly alarming given the intricate political landscape influencing PPP decisions (Teisman & Klijn, 2002; Hodge & Greve, 2010; Himmel & Siemiatycki, 2017).

Project managers must coordinate several complex issues, including human, social, environmental, technological and financial inputs, which are only sometimes identified during

project review meetings (Aaltola, 2017). Therefore, it is a good practice to carry out periodic 'health fitness checks' covering all aspects of the project, including the softer issues related to human resource management (Turner, 2016). Project management is said to be good at 'harder' management issues such as cost and time but relatively weak on human resource management's 'softer' issues (Turner et al., 1996). An example is FIT Sigma, a robust learning and cultural feature which can be adapted to project management to address this gap (Turner, 2016). Good human resource management includes open communication, transparency and trust (Kaplan & Norton, 2004; Wright & Race, 2004). Without a doubt, project management has to be flexible to meet changing needs during the various stages of a project. Being fit for purpose and maintaining fitness do not mean rigid conformance to standards; they require an open mind and willingness to listen and adapt (Turner, 2016).
Innovations realised through PPPs tend to emphasise only partially new technologies or construction methods (Himmel and Siemiatycki, 2017). Instead, they are better characterised as ingenuities, defined as clever or inventive ways of doing things. This includes

- creatively meeting the performance specifications at a lower cost by shrinking the building footprint,
- substituting expensive materials,
- improving energy efficiency or
- developing inventive construction approaches that reduce the building timeline or lower risk.

This growing body of research suggests that linking innovation to project indicators—such as quality and price (balancing client satisfaction with resource utilisation) and clearly defined quality targets—is essential for optimising project outcomes. Such connections are crucial for optimising project outcomes. Furthermore, the role of project managers during innovation as essential human resource managers cannot be overstated, especially in maintaining flexibility throughout the various stages of a project (this will be further explored in subchapter 2.2.3). These critical variables warrant further practical investigation to understand their impact on fostering innovation and added value.

2.2.3 | PEOPLE

Every project needs financial and non-financial contributions from persons, groups, and entities to be accomplished and to create value. The non-financial contributions may be approvals from decision-makers, work efforts from project team members, deliveries of the right quality from suppliers and inputs on expectations from end users (Aaltola, 2017). At the same time, each project will affect persons, groups and entities, for example, positively by creating future income and learning opportunities and negatively by creating side effects like pollution and stressful working conditions (ibid). All persons, groups and entities able to affect or in a position of being affected by the project are called project stakeholders (Turner, 2016). Even though stakeholder management has been a core activity within project management for many years, numerous unsuccessful projects related to unsatisfied stakeholders have been reported (Turner, 2016; Aaltola, 2017). It may, for example, be that the project outcomes do not meet the stakeholders' needs (e.g. Ackermann and Eden, 2011; Wheeler and Sillanpaa, 1998), or the project process is not carried out as expected by the stakeholders (e.g. Ackermann and Eden, 2011). For this research, we will define project stakeholders as "*individuals or organisations that are actively involved in the project or whose interests may be positively or negatively affected due to project execution or completion. They may also influence the project and its result*" (PMI, 2021). The extent to which we take our professional neighbours and citizen neighbours into account is decisive for their support for the project and the image as a project organisation (Lundin, 2016). It is an essential condition in the Netherlands for the construction project's success (Rijkswaterstaat, 2019). Therefore, in this research, we pose the question regarding

innovation: *"Have the different PPP structures achieved added value through people indicators?"* Consequently, our examination will focus on how indicators like leadership, dealing with conflicts and the concept of dare contribute to fostering innovation within project management. This is because public-private collaboration can improve the quality and operational efficiency of public projects implemented in complex environments, such as in the case of the delivery of public infrastructure projects (Kwak et al., 2009). This can be achieved by joining efforts to solve issues that a single organisation could find difficulty in resolving by itself (Satheesh et al., 2023). Public management literature suggests, however, that barriers to developing good collaboration between public and private partners can arise from conflicting perceptions between the actors involved (ibid).

Project stakeholder management aims to increase the likelihood of project success by procuring contributions needed by the project and by enhancing that (critical) project stakeholders perceive the project as a success (Lundin, 2016). Building on Eskerod and Jepsen (2013), Lundin's perception (2016) defines stakeholder management as: *"all purposeful stakeholder-related activities carried out in order to enhance project success"*. Project stakeholder management consists of two main types of activities:

1. Doing stakeholder analysis
2. Interacting with the stakeholders in purposeful ways.

The stakeholder analysis must provide information about the (key) stakeholders' requirements, wishes and concerns related to the project, their success criteria, and their potential to help or harm the project (Aaltola, 2017). The purposeful interactions concern engaging and disengaging the stakeholders based on information from the stakeholder analysis (Ackermann & Eden, 2011). The two types of activities are intertwined as engaging with the stakeholders is typically necessary to provide the information needed for a proper stakeholder analysis, and engaging with the stakeholders during the project course calls for new stakeholder analysis (Lundin, 2016).

Several challenges when doing project management exist (Lundin, 2016):

- First, it is difficult to identify the (key) stakeholders - as many persons, groups and entities may affect or be affected by the project.
- Secondly, it may not be easy to obtain proper knowledge about the stakeholders' requirements, wishes, concerns, and success criteria as the stakeholders may not be sufficiently conscious of them or able to express them. Further, each stakeholder may be in conflict, or they may change over the project's course.
- Thirdly, the various stakeholders may have conflicting requirements, wishes, concerns, and success criteria, implying that negotiations and trade-offs acceptable to them must be made.
- Fourthly, the project organisation's members need more resources to conduct stakeholder analyses and interact with the stakeholders. To enhance project success, they must figure out how to efficiently spend their scarce resources on stakeholder management.

It is vital to note that project stakeholder management has both a strategic and an operative side and that persons in different roles may take care of them (Ackermann & Eden, 2011). The strategic project stakeholder management concerns overall decisions on how to relate to each stakeholder, that is, whether the stakeholder should be engaged in the project by

giving him or her a formal project role in the project organisation or by inviting the stakeholder to project events or be on a distribution list for a project newsletter (Aaltola, 2017). The operative project stakeholder is concerned with continuous interactions with the project stakeholder regardless of whether it is planned within the strategic considerations or emerging due to upcoming needs initiated by the project or the stakeholder (Aaltola, 2017).
A management for-stakeholders approach implies that a comprehensive understanding of the project stakeholders' needs, interests, and expectations should be developed, and those continuous interactions should take place to sustain the understanding and take care of eventual changes (Lundin, 2016). It may be a good idea to involve several project roles in strategic and operative project stakeholder management, like the project manager, the project owner, project team members and project workers (Ackermann & Eden, 2011; Aaltola, 2017). In big infrastructure projects in the Netherlands, the stakeholders' interests are even more in focus as the law says that a specific project stakeholder manager must be appointed (Rijkswaterstaat, 2020). Thus, the challenge lies in coordinating the tasks and the consistency of the behaviour of the different roles involved in stakeholder management on a project to provide a coherent message to a particular stakeholder (Lundin, 2016).

In developing the theoretical framework for this thesis, the research conducted by Lehtinen et al. (2020) and Aaltonen et al. (2016) provides substantial contributions to project stakeholder management, particularly in the context of inter-organisational projects.
Lehtinen et al. (2020) offer a comprehensive framework that identifies and details organising solutions for external stakeholder engagement. This framework is built around four key components:

1. **Organising Solutions and Propositions:** It consolidates previously scattered insights into a cohesive set of organising solutions and propositions, thereby addressing gaps in existing literature.
2. **Governance-Based Solutions:** The framework suggests redefining roles and responsibilities to extend beyond organisational boundaries. This is particularly evident in alliance contractual models incorporating cross-organisational communication teams, which facilitate more integrated and effective stakeholder engagement.
3. **Value-Based Solutions**: It highlights the importance of shared engagement values and practices, such as co-locational working spaces, which support a management-for-stakeholders approach. This fosters extended stakeholder engagement by aligning shared values across different organisations.
4. **Dynamism-Based Solutions**: The framework emphasises the necessity of flexible roles and responsibilities to manage stakeholders' inherent dynamics and changing concerns in inter-organisational projects. This adaptability is crucial for responding swiftly and effectively to stakeholder needs.

These contributions collectively enhance the understanding and practice of stakeholder management, offering practical and empirically supported methods for organising external stakeholder engagement in complex project environments.
Complementing this, Aaltonen et al. (2016) present a crucial stakeholder theory framework, which provides tools for identifying, classifying, and categorising stakeholders. This framework is essential for understanding stakeholder motivations and behaviours, helping managers balance diverse claims to avoid compromising project objectives. Central to this framework is the stakeholder salience model by Mitchell et al. (1997), which prioritises stakeholder claims based on three attributes:

- Power: The ability to influence project outcomes through material, financial, symbolic, or physical resources.
- Legitimacy is the perceived appropriateness of a stakeholder's actions within a socially constructed system of norms, values, and beliefs.
- Urgency: There is a need for immediate attention to stakeholder claims based on time sensitivity and criticality.

The salience model, as indicated by figure 1, suggests that stakeholders with higher levels of these attributes are more salient and, therefore, receive greater attention from managers. Despite the challenges in operationalising and measuring these attributes, the framework provides a robust basis for understanding and managing stakeholder priorities in project management.

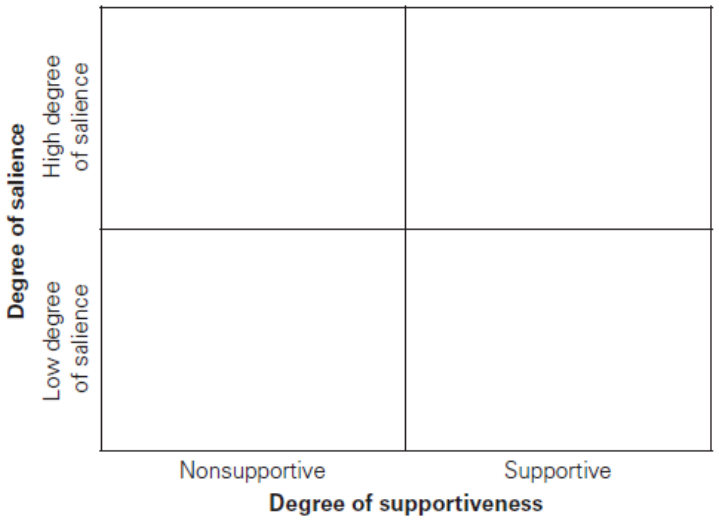

Figure 1: Salience/position–matrix (Aaltonen et al., 2008)

To further explore the industry's external landscape, the number of firms in a consortium can positively impact innovation by combining diverse and complementary resources (Himmel & Siemiatycki, 2017). Meaningful partnerships between public and private sector actors foster a networked project governance model, enhancing trust and facilitating innovative ideas (Roberts & Siemiatycki, 2015). Public-private partnership (PPP) agencies, like Rijkswaterstaat, play a crucial role in incentivising innovation and ensuring the distribution of financial benefits (Hoppe & Schmitz, 2013). Additionally, policymakers are crucial in promoting innovation at every stage of policy design and implementation (Caloffi et al., 2017).

As described by Satheesh et al. (2023), boundary spanners are pivotal in cultivating collaboration between public and private sector partners in public infrastructure projects. Different strategic choices can lead to varied outcomes in innovation and development (Kort et al., 2016). Embracing collaborative frameworks requires new policy tools, a strategic shift, and a reevaluation of traditional approaches (Caloffi et al., 2017). However, ambiguity in defining innovation and the inherent constraints of each construction project often limit the scope of innovation, typically resulting in incremental changes focused on cost and risk reduction (Caloffi et al., 2017). Gori, Lattarulo, and Mariani (2017) emphasise the importance of buyers' characteristics, particularly the expertise of local governments, in ensuring the timely delivery of public infrastructure, challenging the traditional focus on auction formats (Caloffi et al., 2017).

This research suggests that linking innovation to people indicators—such as leadership, conflict management, and the concept of "dare"—is vital for optimising project outcomes. However, the management of public infrastructure projects in the Netherlands tends to be a team effort with clearly defined roles, limiting the opportunity for individualised, project-tailored management approaches (Satheesh et al., 2023), which can stifle innovation. These factors warrant further investigation to fully understand their impact on fostering innovation and creating added value in project management.

2.2.4 | PERFORMANCE

Aspirations and accomplishments concerned with some sort of transition are of crucial importance to the temporary organisation (Lundin, 1995). An action orientation implies that something has to be transformed or changed as a consequence of the existence of the temporary organisation and that these changes are to be achieved before the organisation is terminated (Turner, 2016). Either transition can refer to the actual transformation in terms of the distinctive change between "before" and "after", or it can refer to possible (or desirable) perceptions of the transformation or change among project participants, including the project manager, and their ideas about the way the project task could be brought to completion (Crawford et al., 2008). The second meaning of transition is more important to the inner functioning of project work. This is where the notions about how to run a project come into the picture as well as ideas about the cause-effect relationships that are obtained in the field of the particular project, these perceptions or cognitions are multifaceted (Turner, 2016). In other words, the focus for transition may be on either individual and/or group behaviour ("hard" aspects) or on individual and/or group values ("soft" aspects) (Lundin, 1995). Therefore, in this research, we pose the question regarding innovation: *"Have the different PPP structures achieved added value through performance indicators?"* Consequently, our examination will focus on how indicators like innovation on sustainability, complexity and strategies between project phases contribute to fostering innovation within project management. Innovation performance underscores the notion that achieving market success is reliant on the efforts of other innovators in one's environment (Robertson, Caruana and Ferreira, 2023). This, in turn, reflects the systems view of innovation, highlighting that it is an interactive process that requires a cooperative network (Radicic et al., 2020). For innovation to be useful, literature is increasingly asserting that it must involve the sharing and application of knowledge (Robertson, Caruana and Ferreira, 2023).

Performance measurement is the selection and use of quantitative or qualitative data to provide information about the quality and performance of activities, systems, individuals, groups and organisations and to determine progress towards and achievement of objectives (Turner, 2016). For projects, financial measures and other hard or objective criteria such as time and cost, remain central to the measurement of performance but the need for a wider and more contextually sensitive set of assessment criteria has been increasingly recognized (Crawford et al., 2008). Before deciding on the specific criteria or measures for assessment of performance in the project context we need to consider the purpose of the assessment, the units to be measured and how measurements will be made (Turner, 2016). There are many dimensions to consider.

When measuring performance we need to be very clear about the terms we use and what we are assessing in order to avoid confusion and ensure effectiveness of the assessment process (Crawford et al., 2008). Although the term 'measuring performance' is widely used it is actually open to a wide range of meanings and interpretations (Turner, 2016; Verweij 2023). Terms such as performance and success are often interchangeable but different people at different times may interpret them in different ways (Crawford et al., 2008). It is now generally accepted that success is in the eye of the beholder and may be a matter of timing. The distinction between project management success, concerned with internal measures of project performance such as time, cost and quality and product or project

success, measured against the overall objectives of the project (Jugdev and Müller, 2005), is useful, although success remains an ambiguous concept that may be judged differently from different stakeholder perspectives over time (Crawford et al., 2008). Nevertheless, for practical purposes the definition provided by Baker, Murphy and Fisher (1988) in their landmark study reflects a generally accepted understanding of the concept. They concluded that success is a matter of perception but that a project will be most likely to be perceived as an 'overall success' if:

"The project meets the technical performance specification and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people on the project team, and key users or clientele of the project effort."

Further, although it is generally agreed that time and budget performance alone are inadequate as measures of project success, they are still important components of the overall construct (Turner, 2016). Project managers' success can therefore be seen as a component of project success. In examining the literature on project success, Patanakul, Iewwongcharoen and Milosevic (2010) proposed that dimensions for judging success could be categorised into internal or project related criteria (time, cost and performance), customer related criteria (satisfaction, actual utilisation and benefits) and organisation related criteria (financial, market and benefits).
When thinking about assessment metrics it is useful to distinguish between success measures which relate to the achievement of objectives or outcomes and performance measures which relate to the process and practice used to deliver the outcomes (Crawford et al., 2008). In terms of timing, performance measures relating to processes and practices are most likely to be used during the course of a project or program while success measures relating to the achievement of outcomes are most likely to apply at closure (Patanakul, Iewwongcharoen and Milosevic, 2010; Aaltola, 2017). Customer related criteria such as actual utilisation and benefits are most often measured some time, generally three to 12 months, after project or program completion and handover (Patanakul, Iewwongcharoen and Milosevic, 2010).

The expectation of policymakers that PPP would lead to more innovative solutions is undiminished (Ministerie van Infrastructuur en Waterstaat, 2023b). However, only practice, on the contrary, shows at the same time that few innovations take place in the design and construction of public transport infrastructure (Rijkswaterstaat, 2019). Innovation can be an important way to achieve efficiency gains, but it is not an intrinsic feature of for example DBFM projects (Lewis, 2021). This was also a key conclusion of PPP scholars and practitioners at an international PPP conference (Verweij, 2023):

"*It is noted that there are no incentives for excellence. Fines lead to damage control and inhibit innovation. (...) Finally, some participants argue that DBFM(O) is not suitable to encourage innovation, at least if we define innovation as the introduction of new technologies. Instead, DBFMO only encourages the application of existing technical solutions, which have already proven their services in the market. (...) Elements such as functional specification may promote innovation, but penalty discounts and cost-based clauses curtail the willingness to take the risk of using technological solutions that are ahead of the prototype phase*" (Klijn et al., 2015).

Measuring performance is accepted as a necessary part of project management and this chapter has been written with the intention of providing a clear and straightforward guide for those who are required to develop and implement performance measurement systems in the context of projects (Crawford et al., 2008). However, to quote Streatfield (2003), 'measuring performance is not as simple as it seems.' He points out that most approaches to performance measurement adopt a rational linear view of cause and effect relationships underpinned by the desirability and possibility of 'being in control'. Even the popular idea of a

performance dashboard supports this view of a project or organisation being hierarchically controlled by feedback from selected performance indicators (Turner, 2016). As Streatfield says: '*It is assumed that people will be motivated when they are involved in a democratic process of designing measures as rational, sequential systematic steps*' (Streatfield, 2003), but in reality performance measurement tends not to be done either effectively or consistently (Crawford et al., 2008).

Performance measurement involves assessment processes that allow us to receive feedback on, or make judgements about or in some way analyse a set of activities, capabilities, capacity, processes or practices (Crawford et al., 2008). These assessment processes can take many forms but should be directly relevant to their audience, purpose and use. They should measure what they are intending to measure as unambiguously as possible. Participatory development of measures is desirable to improve understanding and buying as meaningful assessment evolves with increasing understanding and ownership (Crawford et al., 2008; Turner, 2016). At the end of the day, measuring performance is politically sensitive and is most effectively undertaken in a spirit of learning and improvement (Aaltola, 2017).

2.3 | CONCEPTUAL MODEL

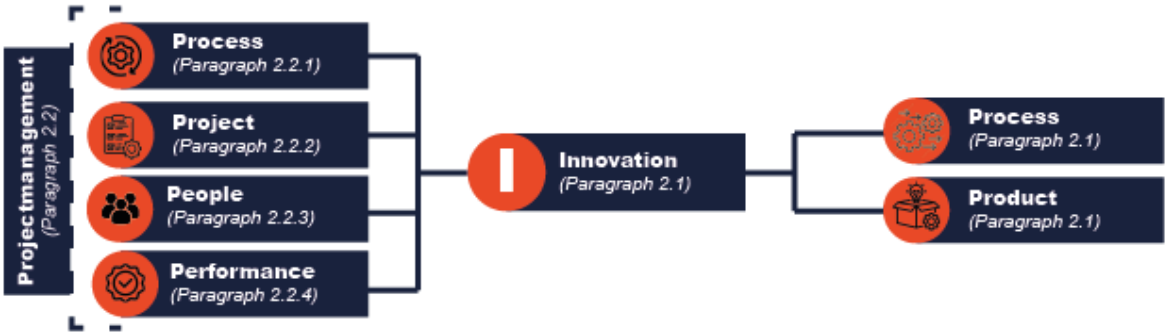

Figure 2: Conceptual model (author)

The conceptual model, as indicated by figure 2, for this research aims to explore how Public-Private Partnerships (PPPs) (further elaborated on in the methodology) can effectively drive innovation in infrastructure projects, with a specific focus on product and process innovations. Building on the theoretical framework, this model synthesises insights from project management theory and innovation typologies.
Innovation in the infrastructure industry is multifaceted, encompassing four primary types: product, process, organisational, and financial innovations (Russell et al., 2006). This study focuses on two key areas:

- **Product Innovation integrates** advanced construction technologies, materials and designs into infrastructure projects. It includes both the development of new products and the adoption of existing innovations, which are crucial for enhancing project outcomes.
- **Process Innovation** refers to implementing improved methods and techniques in construction and service delivery, such as logistical technologies, site preparation methods, and IT tools for project management.

The project management perspective underpins this conceptual model. Drawing from Turner's (2016) premises, the model integrates the following key elements:

- **Process:** Effective time management and flexible scheduling are essential for adapting to uncertainties, fostering innovation and improving project outcomes. The model suggests that innovation thrives in environments where processes are both structured and adaptable.
- **Project:** PPPs are highlighted for their agility and adaptability, crucial for fostering innovation. Each project's unique nature, combined with the private sector's expertise, facilitates balancing cost efficiency and client satisfaction, ultimately driving innovative practices.
- **People:** Stakeholder management is central to this model. Engaging diverse stakeholders effectively creates an environment conducive to innovation by ensuring that various needs and contributions are optimally utilised to enhance project outcomes.
- **Performance:** Performance measurement is vital for linking innovation to project success. The model emphasises the importance of using both quantitative metrics and qualitative assessments to evaluate the impact of innovations on project performance.

This conceptual model is the researcher's theoretical foundation, further methodological elaborated on in Chapter 3. It outlines the barriers and conditions to project management and innovation represented in the model. These elements will be tested through three real-life case studies. PPPs (as forms of projectmanagement in infrastructure development) are integral to the methodology, particularly in finding out of innovation is happening. Using this conceptual model as a basis for the research, the theoretical barriers and conditions will be empirically tested. The research will assess whether the model is comprehensive, if there are missing barriers and conditions, and whether the conditions for innovation scaling and project management are reconcilable.

CHAPTER 3 | METHODOLOGY

This chapter addresses the methodology of data collection and analysis in this research. Several steps are at the basis of data collection, which are illustrated in table 1. The different steps illustrated in table 1 are further elaborated in this chapter.

Step	Description
1	Puposeful selection method for case study to select useable cases
2	Case study by doing semi-structured interviews with public and private partners in May and June 2024
3	Desk research on case studies to further enhance results
4	Data analysis and arranging the results

Table 1: Research steps (author)

3.1 | PURPOSEFUL SELECTION METHOD

The research method employed a purposeful case selection (Palinkas et al., 2013), a crucial step that ensured a comprehensive and representative sample. This method was instrumental in identifying projects that not only met the specific criteria outlined but also provided a rich and varied dataset, facilitating a thorough exploration of sustainable practices and their implications. The chosen cases were selected based on the following critical criteria:

1. **Innovation**: Projects that showcased innovative approaches and novel solutions to sustainability challenges were selected—this criterion highlights practices and strategies that could potentially set new benchmarks.
2. **Stakeholder Engagement**: played a pivotal role in the case selection process. Cases were chosen based on stakeholder engagement and collaboration level and are formed through PPP collaborations. Projects with active involvement from multiple stakeholders, public bodies and private organisations were prioritised. This emphasis on stakeholder engagement was crucial in understanding the dynamics of collaborative efforts.
3. **Size of Project**: The selection process was guided by the project's budget and scope of tasks. This approach ensures a range of projects defined as more extensive, more complex endeavours, thereby enriching the depth and breadth of the study.
4. **Availability of Sources**: Emphasis was placed on selecting cases with readily available and accessible data sources. This criterion was intended to facilitate a thorough analysis and ensure the robustness and reliability of the findings.
5. **Time Frame**: The cases were also chosen based on their maturity stage within the project timeline. This consideration allowed for examining projects at different developmental stages, providing valuable insights into the evolution and progression of innovative practices over time.
6. **Location**: Projects were selected in the Netherlands to facilitate physical meetings and direct stakeholder interactions. This localised focus enabled a more hands-on approach to data collection and analysis, fostering a deeper understanding of the contextual factors influencing sustainable practices within the Dutch context.

This research employs a case study methodology, a valuable tool for understanding how theoretical concepts apply in specific real-world contexts (Flyvbjerg, 2006). A case study allows for an in-depth examination of processes and contexts, revealing how causes and outcomes are linked (Flyvbjerg, 2011). Given Wirth et al.'s (2018) assertion that qualitative and in-depth empirical data is crucial for understanding conditions for innovation, the case study approach is particularly pertinent. Furthermore, Yin (2014) notes that case studies are precious when studying real-life phenomena where the boundaries between context and phenomenon are blurred, as with innovation. Public-private partnerships are situated in a specific context, making separating them from their context difficult and making a case study enjoyable for this research. Additionally, quantifying the benefits of an innovation, on an infrastructure project can sometimes be daunting or practically impossible, depending on the type of innovation and the metric of interest, and this assumes that details of the innovation are known (Russel et al., 2006).

It is essential to explain the rationale behind this design choice to address the inquiry about the need for variation in project size and timeframe while maintaining consistency in innovation and stakeholders. The six criteria (innovation, project size, availability of sources, time frame, location, and stakeholder engagement) provide a robust and nuanced representation, enhancing the validity and reliability of the research findings and instilling confidence in the conclusions drawn.

Variation in Project Size and Timeframe:

- **Rationale**: Different project sizes and timeframes offer a comprehensive understanding of how innovation is managed and implemented across various scales and durations. This variation ensures that the research findings are not limited to a specific type of project but are applicable across a spectrum of scenarios.
- **Benefits**:
    - **Comparative Analysis:** Allows for the identification of patterns and differences in innovation processes across small and large projects, as well as short-term and long-term projects.
    - **Generalizability**: Enhances the generalizability of the findings by demonstrating that the principles of project management and innovation hold true across different contexts.
    - **Rich Insights**: Provides richer insights into the challenges and strategies unique to projects of varying sizes and durations, contributing to a more holistic understanding.

Consistency in Innovation and Stakeholders:

- **Rationale**: Keeping innovation and stakeholder involvement consistent across case studies ensures that the variables of interest (process, project, people and performance) are controlled. This consistency allows the research to focus on the impact of size and timeframe variations without confounding influences from differing innovation practices or stakeholder dynamics.
- **Benefits**:
    - **Focused Analysis**: Facilitates a more focused analysis of how project size and timeframe influence outcomes, as the innovation processes and stakeholder interactions remain constant.
    - **Validity**: Enhances the internal validity of the study by reducing variability that could obscure the true effects of project size and timeframe.

In conclusion, combining varied project sizes and timeframes, consistent innovation, and stakeholder factors allows for robust exploration.
The case studies outlined in Table 2 have been selected for this research based on the selection method.

#	Case	Type	Location	Planning* *(tenderphase)*	Project budget*	Public partner	Private partner
1	A58 "Innova58"	Part of Living Lab	Tilburg - Eindhoven	2017-T.B.D.	572 million	RWS	Gebr. Van Kessel
2	A12 "IJsselbruggen"	Two-phase approach	Arnhem	2019-2026	72 million	RWS	Consortium Savera
3	A20/A15 "Blankenburg-verbiding"	DBFM(O)	Rotterdam	2017-2024	2.227 million	RWS	Consortium BAAK

Table 2: Research data collection

* *Sources used: MIRT report 2024 - Ministry of Infrastructure and Water Management, 2024a*

3.2 | COMPARATIVE CASE STUDY

The objective of this study is to examine innovation within PPPs by analysing three distinct types of project management approaches: the standard method of PPP in the Netherlands known as DBFM(O), the two-phase approach outlined in the 'Towards a Vital Infrastructure Sector' plan (2020), and the variant of PPP represented by Living Labs.

1. DBFM(O) approach

DBFM is a concession model in which the public partner defines the project but delegates design, construction, maintenance, and sometimes financing to the private partner over an extended period (Koppenjan & Van Ham, 2002). While it has become the standard PPP form in the Netherlands for national public infrastructure (Rijkswaterstaat, 2020), some argue that these projects lack actual public-private partnership characteristics due to a purely contractual relationship, limited risk-sharing, and constrained co-production (Van den Hof, 2018). Challenges identified in DBFM projects include potential quality compromises due to strict time and budget controls, high transaction costs, a high-risk profile, and limited opportunities for innovation and flexibility (Verweij, 2020; Koppenjan et al., 2020). The practical case investigating DBFM is called "Badblankenburgverbinding". The Blankenburgverbinding is a new highway (the A24) that will connect the A20 at Vlaardingen with the A15 at Rozenburg starting in 2024 (Rijkwaterstaat, 2024b), see figure 3 (elaborated further on in chapter 4.1).

Figure 3: Development of Badblankenburgverbinding (Rijkwaterstaat, 2024b)

2. Two-phase approach

The 2-phase approach, outlined in the 'Towards a Vital Infrastructure Sector' plan (2020), has primary and secondary goals to enhance collaboration between Rijkswaterstaat (RWS) and the market. The primary goal is leveraging market expertise to reduce project risks and improve feasibility, manageability, and predictability. In contrast, the secondary goal aims to decrease transaction costs to support a financially healthy and productive sector. In this two-stage process, pricing for the construction phase is determined after the design or engineering phase, reducing uncertainties and financial risks and facilitating better risk allocation (Kluitenberg, 2020). The practical case (elaborated further in chapter 4.1) investigating the 2-phase approach is the A12 IJsselbruggen, see figure 4. Since 2017, it has been known that the two steel IJsselbruggen on the A12 towards Germany need renovation and reinforcement. From the end of 2019 until 2026, the two steel A12 IJssel bridges will be renovated (Rijkswaterstaat, 2024c).

Figure 4: Development of IJsselbruggen (Rijkwaterstaat, 2024c)

3. Living Labs approach

Living labs are characterised by the convergence of concepts, methods, and real-life contexts, as Neef et al. (2017) highlighted. Two ideal types of living labs are identified: Product-Oriented Labs (POLs) and Urban Transition Labs (UTLs), each with distinct differences in concept, method, and context, aiming for optimal innovation through a participatory mindset. Successful organisation of living labs necessitates attention to core

principles such as user engagement, sustainability, openness, collaboration, and result orientation, contributing to strategic knowledge and innovation agendas and requiring further research on the effects of different lab characteristics, funding, power relations, and data collection validation. The practical case (elaborated further in chapter 4.1) investigating the living lab's approach is the A58 Tilburg - Eindhoven; see Figure 5. At the Kloosters rest area (between Tilburg and Eindhoven), there is a Living Lab with a unique, evident test site for infrastructure innovation. It is part of the InnovA58 project (Rijkswaterstaat, 2024d). The testing ground currently consists of (1) an innovation strip along the highway, (2) a symbiotic innovation pavilion "Hoeve Nieuwe Zwaneburg", (3) Kloosters 2.0 rest area, (4) an innovation site, and potentially a 5th component: the Low Tech Campus (ibid).

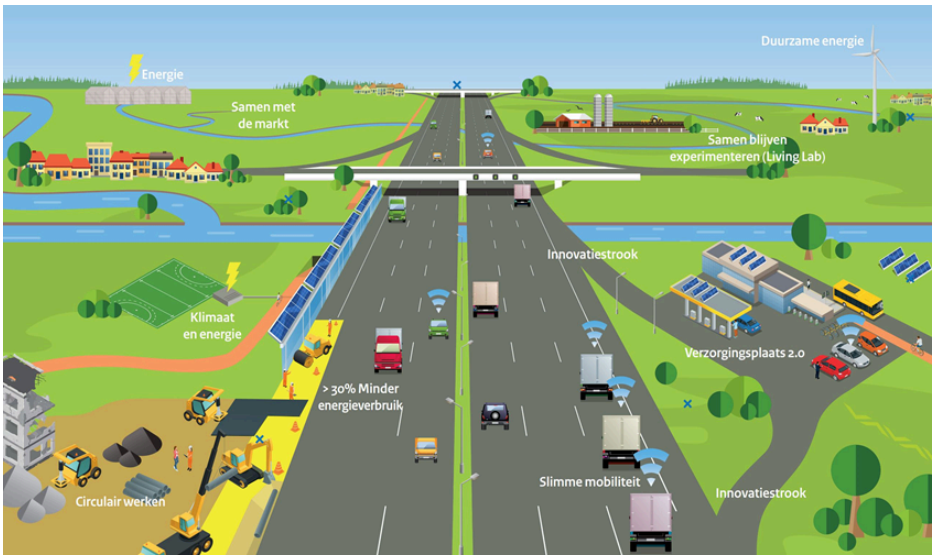

Figure 5: Development of IJsselbruggen (Rijkwaterstaat, 2024d)

The study chose a comprehensive set of real-world cases by employing these three distinct project management approaches within PPPs and utilising the purposeful selection criteria outlined in section 3.1. This approach allows for thoroughly examining and comparing each approach's innovative practices, challenges, and outcomes. By analysing these selected cases, the study aims to provide valuable insights and recommendations to enhance the effectiveness and efficiency of innovation within PPPs, ultimately contributing to the advancement of sustainable and collaborative practices in infrastructure development and management.

3.3 | DESK RESEARCH

In addition to the semi-structured interviews, desk research for this thesis involved an extensive review of various documents, ranging from master theses to implementation plans and environmental impact reports (Krul, 2021). When conducting desk research, it is vital to use various information sources. Typically, a combination of sources is utilised, making it essential to structure the research well. The following table 3 provides an overview of the critical documents analysed:

#	Name	Type	Author	Pages	Date
1	Hoofdrapport MIRT 2024	Report	RWS	415	2024

2	Innovation upscaling and citizen participation: two conflicting elements of the living lab concept?	Master thesis	J. van der Wal	90	2021
3	De barrières en kansen voor circulaire innovatie in de bouwsector	Master thesis	R. Busse	66	2018
4	12e Voortgangsrapportage SmartwayZ.NL	Report	SmartwayZ.NL	75	2023
5	Tracébesluit / MER Blankenburgverbinding	Environmental impact report	Rijkswaterstaat	34	2015
6	Toepassing 2-fasen aanpak bij Rijkswaterstaat projecten	Guidance plan	Rijkswaterstaat	91	2023
7	Op weg naar een vitale infrasector	Guidance plan	Rijkswaterstaat	52	2020
8	Wat kunnen we leren van InnovA58?	Learning history	L. Chahboun	44	2021

Table 3: Overview desk research documents (All sources are placed in the reference list)

In addition to these primary documents, the research also incorporated insights from interviews, magazine articles, and various online resources, particularly from the websites Innova58.nl, Blankenburgverbinding.nl, and Vitaleinfrasector.nl. While desk research offers a broad range of data, a significant challenge is that the information retrieved needs to be completed or may not directly align with the specific problem statement (Krul, 2021). Since the data was collected initially with a different goal than the research goal, it becomes imperative to critically assess the relevance and timeliness of the information gathered (ibid). The supplementary sources used in this research play a crucial role in providing context and enhancing the depth of analysis, contributing to a more comprehensive understanding of the research topic. Special attention was given to each source's reliability to ensure the findings' accuracy and credibility (Krul, 2021). For instance, data from Rijkswaterstaat (RWS) is considered reliable due to its status as a recognised research institute, in contrast to data from anonymous websites, which are far less trustworthy.
Moreover, additional measures were taken during the collection phase to guard against plagiarism. Given the extensive use of literature, it was essential to utilise a plagiarism checker to verify the originality of the work and prevent any unintended academic misconduct (Krul, 2021). This careful consideration of source reliability and plagiarism safeguards strengthens the integrity and robustness of the research findings.

3.4 | SEMI-STRUCTURED INTERVIEWS

This research involved conducting five semi-structured interviews. Semi-structured interviews are valuable because they encourage spontaneous responses and offer flexibility during the interview process (Husband, 2020). This approach is beneficial for investigating opinions and perceptions on complex topics like innovation (Hook et al., 2007).

Using semi-structured interviews, the researcher gains more profound insights into participants' statements (Husband, 2020). This method enables respondents to express their views freely. It allows for further explanation or discussion when needed, essential when tackling intricate subjects like project management and innovation upscaling. However, there are challenges associated with semi-structured interviews, including potential language barriers, unclear or ambiguous questions, and the risk of respondents providing socially desirable answers (Hook et al., 2007). To address these challenges, it is crucial to adopt an interactive interview style that clarifies ambiguous questions and helps overcome language barriers (ibid).

The interviews were conducted in May and June 2024. In total, five interviews were conducted as suggested by Table 4.

#	Respondent	Function	Case	Time	Date	Mode
1	Respondent A	Projectmanager	A12	52 min	7/5/2024	Phone
2	Respondent B	Programmamanager	A58	50 min	7/6/2024	Online
3	Respondent C	Transitiemanager	A58	30 min	11/06/2024	Online
4	Respondent D	Contractmanager	A20/A15	45 min	11/6/2024	Online
5	Respondent E	Innovatie manager	A58	52 min	17/6/2024	Phone

Table 4: Respondent's overview interviews (author)

Questions were prepared in advance to conduct the semi-structured interviews and are provided in Appendix 1. Follow-up questions were asked as needed to ensure the collection of important information (Salmons, 2011). The interview questions were designed to start with more accessible topics and gradually progress to more complex ones. Although the questions were prepared beforehand, the semi-structured nature of the interviews allowed both the interviewer and interviewee the flexibility to deviate from the script.

Due to the location of the infrastructure interviews, all interviews were conducted online, with some conducted on the phone when necessary. Non-physical interviews have their own challenges. While technology such as Skype or Google Meet enables real-time exchanges, it can be difficult for the interviewer and interviewee to maintain focus, and unstable internet connections can disrupt the process (Salmons, 2011). Despite these challenges, video meetings facilitate personal communication and authenticity (ibid). These difficulties were considered during the preparation and execution of the interviews.

3.5 | DATA ANALYSIS

After conducting the interviews and desk research, the next crucial step involved transcribing and coding the data for analysis. The transcription of the interviews was meticulously performed manually, with the researcher listening to the audio recordings slowly to ensure every word was accurately captured. This careful approach minimised the risk of information loss, ensuring the transcriptions were detailed and precise. Each transcript was meticulously

documented with a respondent tracking number, the respondent's name, the interview date, and its duration. These transcripts are available for review upon request.

Once the five interviews were transcribed and returned to the respondents for review, this step allowed respondents to correct any errors or request the deletion of specific sentences. Only a few respondents made minor adjustments, such as correcting names or offering additional interview suggestions; all sentences were retained. Data analysis only began after receiving the respondents' approval of the transcripts. This review process was instrumental in enhancing the research's quality by eliminating minor errors and occasionally incorporating additional clarifications provided by the respondents.

The data was coded using Atlas to analyse the transcripts and desk research systematically. Atlas.ti software efficiently manages and organises qualitative data (Atlas.ti, 2020). Chametzky (2016) explains that coding "allows you to move from raw data to a well-developed theory" and facilitates identifying and tagging significant themes that help understand and evaluate the interviews. The coding process involved three distinct phases: open coding, axial coding, and selective coding (Ravenstein, 2017).

- **Open Coding:** In this initial phase, the researcher labelled parts of the transcripts with relevant information without relying on predefined categories. The open coding phase was exploratory, as the researcher needed clarification on the patterns or themes to look for. This phase helped create a foundational set of codes that captured the essence of the raw data.
- **Axial Coding:** The codes generated during open coding were organised into central and subthemes in the next phase. This process involved distinguishing between more and less significant elements, with necessary codes labelled according to a pre-established coding scheme (Appendix 3). This coding scheme was derived from the conceptual model outlined in Chapter 2.6. By grouping the most relevant fragments of the interviews under standard codes, the data became more structured and more accessible to analyse.
- **Selective Coding:** The final phase involved establishing connections between different codes by comparing them and identifying relationships between recurring concepts. This phase was crucial for synthesising the data, as it allowed the researcher to draw meaningful conclusions by comparing the interview data with findings from the desk research, thereby enhancing the validity of the results.

The interviews, conducted initially in Dutch, were translated into English and presented in Chapter 4. The coding process was guided by the coding scheme provided in Appendix 3, with coding categories rooted in the components of the conceptual models. While many codes were formulated deductively based on existing theories and models, additional inductive codes emerged organically during the axial and selective coding phases as new patterns were discovered. Ultimately, all identified codes were utilised effectively, with none requiring merging or remaining unused, demonstrating the robustness of the coding process.

This rigorous approach to transcription, review, and coding ensured the analysis was comprehensive and nuanced, providing a solid foundation for the subsequent interpretation and discussion of the research findings.

3.6 | ETHICS

When conducting research, it is imperative to adhere to strict ethical guidelines to ensure the integrity of the study and the well-being of all participants involved. As Aagaard-Hansen and Vang Johanssen (2008, p.15) emphasise, although formal ethics codes in research are relatively recent, they universally draw on the enduring principles of respect, beneficence, and justice. Respect involves treating participants with dignity and consideration throughout the research process. Beneficence requires the researcher to actively minimise any potential environmental, physical, or emotional harm from the research activities. Justice pertains to the equitable distribution of the research's benefits and burdens, ensuring fairness to all participants (Aagaard-Hansen & Vang Johanssen, 2008). A crucial aspect of maintaining ethical standards is the researcher's awareness of their positionality and reflexivity. As Hennink et al. (2010) point out, recognising one's positionality as a researcher fosters a more profound understanding between the researcher and the participants, enhancing the research's overall quality and ethical rigour.

During my study at the University of Groningen, several concepts such as DBFM (Design, Build, Finance, Maintain), PPP (Public-Private Partnership), and project management were touched upon, albeit to a limited extent. This limitation had both positive and negative implications. On the one hand, it allowed for an unbiased and open-minded exploration of the research topic, uncoloured by preconceived notions. On the other hand, the lack of familiarity with these concepts required significant time and effort to grasp their implications fully, presenting a challenge in the research process.

Adhering to these ethical principles was paramount throughout this research, particularly during the interview process. Treating respondents with respect was not only a moral obligation but also critical to maintaining the integrity of the data collected. Respondents were provided with information and confirmation sheets approved by the Research Ethics Committee to further uphold the principles of beneficence and justice, as outlined in Appendix 2. Moreover, all interviews were anonymised to protect the privacy of the participants, a practice endorsed by Coffelt (2018). Although most respondents consented to use their names, the decision to anonymise all results was made to focus on the behaviours and experiences of the participants rather than their identities. As Coffelt notes, "for the social scientist, peoples' behaviours and experiences are of great interest, rather than an exposé about individuals" (ibid., p.228). To ensure this, respondents were assigned numbers from 1 to 5, and all quotes used in the research were presented anonymously, as detailed in table 4. This approach not only protected the participants' identities but also reinforced the ethical foundation of the research.

CHAPTER 4 | RESULTS

In the previous chapters, we delved into the theoretical foundations of innovation and project management (Chapter 2) and outlined the methodological approach to analyze three case studies (Chapter 3). This chapter presents the interviews and desk research findings, systematically addressing the obstacles identified throughout the study. These obstacles, crucial to our understanding, are visually represented in the conceptual model, a key tool for grasping the complexities of our research, illustrated in Figure 6 below.

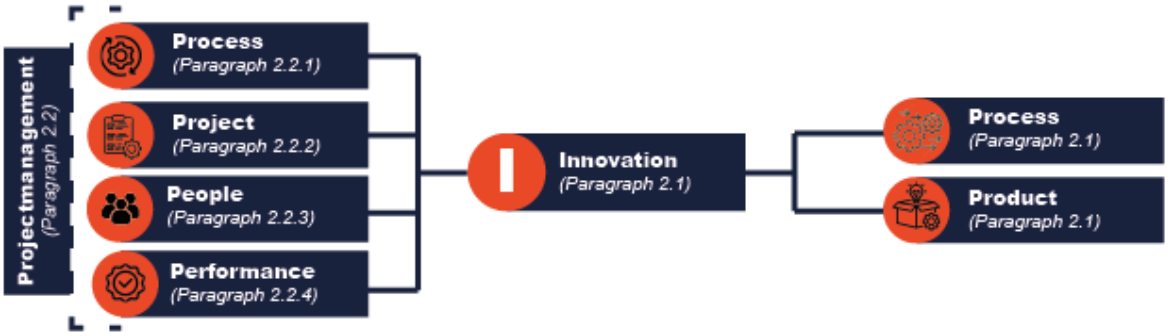

Figure 6: Conceptual model (author)

Following the presentation and analysis of these obstacles, the chapter will discuss the future trajectory of innovation, contextualizing these findings within the theoretical frameworks discussed in Chapter 2. The results presented are derived from a comprehensive analysis of the data, including coding and desk research, as well as the detailed transcripts generated during this study.

Five primary codes were identified: innovation, process, project, people, and performance. These codes are central to the conceptual model and were initially introduced in Chapter 2. The chapter will systematically compare these codes across the three case studies, providing a robust and thorough analysis of how each factor influences the overall research findings. The analysis will culminate in a structured scoring scheme, which is detailed in Section 4.6. This scoring scheme is significant as it offers a comprehensive overview of the findings, providing a clear and concise summary of the research outcomes.

Each subsection within this chapter will delve into specific subcodes developed during the coding process, allowing for a deeper exploration of key points. This structured and methodical approach ensures that the data from the interviews and desk research is presented clearly and critically about the theoretical frameworks and case studies. By aligning the findings with established theories and real-world examples, we validate the importance of existing knowledge and aim to provide a nuanced understanding of the research outcomes, offering valuable insights into the interplay between innovation and project management.

4.1 | INNOVATION

This chapter explores innovation in Dutch infrastructure projects, emphasizing the role of PPPs in driving technological advancements. As this research will discuss, PPPs play a significant role in funding and implementing innovative solutions in infrastructure projects. The following subcodes, defined in chapter 2, will be explored:

- **Innovative solutions**: This subcode focuses on the specific practical, real-world technological advancements implemented in infrastructure projects.
- **Meaning of innovation**: This subcode examines how innovation is conceptualized and understood within the context of infrastructure projects.

Focusing on the InnovA58 living lab, we see how delays in road widening due to nitrogen issues have opened opportunities for testing new methods. The A12 IJsselbruggen project, a major bridge construction project, highlights innovations such as sustainable asphalt, worker-support exoskeletons, and hybrid generators, which aim to reduce CO2 emissions and enhance safety. The A20/A15 Blankenburgverbinding project, a large-scale road construction project, demonstrates innovative problem-solving and collaboration in overcoming unforeseen challenges.

4.1.1 | INNOVATIVE SOLUTIONS

On the A58 routes between Sint Annabosch-Galder and Eindhoven-Tilburg, InnovA58 is a living lab project focused on construction and infrastructure at the A58. Due to nitrogen-related issues in the Netherlands, the road widening plans have been delayed by several years (projectteam InnovA58, 2019). This delay has created an opportunity to intensively test promising construction and infrastructure products and methods within the innovation project, which can later be applied to (road)projects. To facilitate this, InnovA58 have established testing grounds for innovation sites near the Kloosters parking area on the A58 near Eindhoven (Rijkswaterstaat, 2024e). In these projects, they collaborate on sustainable innovation with numerous partners in the market, co-governments, knowledge institutions, and organised community initiatives (Van der Wal, 2021, RDA*[1]., B, C & E).

Figure 7: Map of the locations of all the innovation at the InnovA58 project (Rijkswaterstaat, 2024e)

[1] In the results chapter, references to respondents driven answers, denoted as "RDA.," correspond to those detailed in Chapter 3.

During this research in particular, we investigated Hoeve Nieuw Zwanenburg (RDA., B, C & E), which is an innovative field lab for biobased buildings in the ground, road, and water construction sector (GWW), see picture 7, number 15. This project, a sister initiative of InnovA58, is driven by Rijkswaterstaat's network organisation NOVA (NOVA enhances Rijkswaterstaat's agility and flexibility by driving innovation in processes, organisation, and collaboration while exploring new methods like network analysis, blockchain, and informal learning (Ministry of I&W, 2024b)). Here, various partners follow a design-oriented approach to develop sustainable construction solutions. Hoeve Nieuw Zwanenburg uses fibre crops such as hemp, miscanthus, jute, and sunn hemp for biobased building components (de Vaan, 2024). These materials are locally cultivated on the nine hectares of land surrounding the historic farm in Oirschot, see Figure 8. This field lab aims to develop sustainable and circular construction methods with practical applications in bridges, locks, viaducts, slopes, and signage (de Vaan, 2024).

Figure 8: The farm is located right next to the A58 and cultivates various crops on 5 hectares of land. (Rijkswaterstaat 2024f)

Three distinct innovation pilot projects can be identified for the two-phase approach with the A12 IJsselburggen. First, sustainable asphalt use has gained considerable traction within the road construction sector, especially after it was revealed that asphalt application is one of the highest CO2-emitting activities (RDA., A). Consequently, the industry has been experimenting with asphalt mixtures that can be applied effectively at lower temperatures, significantly reducing CO2 emissions (Dura Vermeer, 2024a). The project is now entering a more significant phase after successful trials on a smaller scale and competition for sustainable asphalt mixtures organised by Rijkswaterstaat (Oosterveld, 2023). The tender for A12 IJsselbruggen involves extensive maintenance on the A2 between the Oudenrijn and Everdingen junctions and the A12 between junction 13 (Nieuwerbrug) and the Oudenrijn junction (RDA., A; Dura Vermeer, 2024b). The sustainable asphalt mixture was applied at the temporary construction site, where fewer regulatory constraints allowed for greater experimentation (ibid), see figure 9.

Figure 9: Test of asphalt Roof2Roof at construction site (Dura Vermeer, 2024a)

Within the Savera IJsselbruggen consortium, Hollandia Services is collaborating with Dura Vermeer on renovating the A12 IJsselbruggen for Rijkswaterstaat (RDA., A). Within this project, a second innovation is the trial of using exoskeletons, see figure 10. Given the extensive overhead work required on the IJsselbruggen over the coming years, adopting exoskeletons could provide substantial physical support for welders and ironworkers, mitigating physical strain and preventing injuries (Dura Vermeer, 2022). To evaluate the effectiveness of exoskeletons, both Hilti and Skelex models were subjected to tests in their facility (ibid). The test setup aimed to simulate the overhead tasks that workers will perform on the IJsselbruggen (RDA., A). The initial feedback from this trial has been very positive, suggesting that exoskeletons can significantly reduce physical burden and enhance worker comfort and safety (ibid).
The third established innovation is about hybrid generators, see figure 10. They are considered to be low-noise, environmentally friendly, and reliable, as discussed by Combined Hybrid Drive Electric (Hakkers, 2023). It replaces the large diesel engine at existing construction sites. Due to its compact size, it can almost always be installed. Its very low emissions compared to other hybrid solutions are partly thanks to the intelligent use of the right components. Four hybrid generators have already proven themselves as power suppliers during the repair work on the IJsselbruggen on the A12 near Arnhem (RDA., A).

Figure 10: Exoskelet and hybrid generators of Hollandia (Dura Vermeer, 2022; Hakkers, 2023)

The A20/A15 Blankenburgverbinding project encompasses various innovative approaches. An unforeseen and significant issue arose during the second tunnel element's sinking. The

tunnel's location marked the transition between the salt water of the North Sea and the river's fresh water, a dynamic the project team anticipated (RDA., D). However, an unexpected interplay of forces occurred, presenting a novel challenge (Ballast Nedam, 2024). This event allowed the team to explore solutions for this previously unknown phenomenon. By modelling the event, the project team identified the issue and adjusted the sinking system, recalculating based on the new, increased forces, see Figure 10. (Ministry of I&W, 2022; Ballast Nedam, 2024). Collaboration was crucial, involving consortium partners and the client, Rijkswaterstaat, to achieve the common goal (RDA., D).

Figure 11: Location project, next to the port of Rotterdam

Additionally, the COVID-19 pandemic significantly impacted the Blankenburgverbinding project (Ministry of I&W, 2023; RDA., D). To prevent delays, BAAK, in collaboration with Rijkswaterstaat, relocated the construction of the two tunnel elements to the dry dock of Damen Verolme Rotterdam, see figure 11. Initially, the tunnel elements were to be constructed atop the approaches to the Maasdeltatunnel (Ballast Nedam, 2024; RDA., D). They were utilising the Damen Verolme dry dock, which allowed for a reorganisation of the work, enhancing the project's schedule robustness (Ministry of I&W, 2023c). The yard's proximity to the construction site minimised the transport distance for the sinking operation.
The third innovation involves the two massive sections of the Maasdeltatunnel, unprecedented in size for the Netherlands (Ballast Nedam, 2024). Their large dimensions are due to shipping considerations (Ministry of I&W, 2023c). The sinking process requires halting all shipping on the Nieuwe Waterweg for two weekends, effectively shutting down the Port of Rotterdam, see figure 11. With the usual-sized sections, six elements and thus six weekends of closure would have been necessary; with the larger sections, only two weekends are required (Ballast Nedam, 2024).

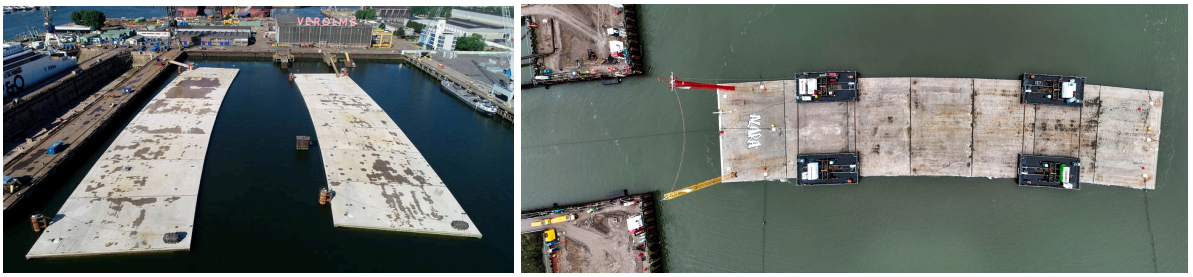

Figure 11: Tunnel elements in dry dock of Damen Verolme (left) and sinking of tunnel elements (Ballast Nedam, 2024)

4.1.2 | MEANING OF INNOVATION

In this research, we are examining product and process innovations in infrastructure projects, focusing on how PPPs can encourage such innovations. Innovations refer to "significant technological improvements" in products and processes (Russell et al., 2006; Verweij, 2020). One of the first aspects that stands out in analysing all three case studies is the varying definition of innovation, something that is also discussed in the literature (Russell et al., 2006; Verweij, 2023)

First of all, in InnovA58, genuinely new products are being realised, such as the "Nieuwe Zwaneburg" farm, where biobased products are being developed (Rijkswaterstaat, 2024f). Here, radical experimentation with untested theories is taking place. Interestingly, mainly public partners, such as educational institutions and the government, are involved (RDA., C). What could be reflected in this quote:

(RDA., C) *"A contractor? Maybe in the future, but we do not want to place a contractor at the centre because it immediately introduces a profit model. We are still cautious about that, but eventually, we will need to move in that direction. In InnovA58, we work exclusively with contractors and scientific organisations, such as TNO, to test things. So, contractors are very much on board there. That is further along in the chain."*

Throughout the InnovA58 project, more evolved innovations take place. It shows a unique collaboration with market parties (but also shows that market parties are involved later on due to the risky nature of immature innovations) (RDA., C). It is clear that this is the only place in the Netherlands where innovations are thoroughly tested (Sluis, 2024).

Almost everything seems innovative in the Bad Blankenburg connection project (RDA., D). Techniques are applied that have never been used on a larger scale, such as the newly designed tunnels and schedule optimisation in a dock (Ballast Nedam 2024, Ministry of I&W, 2023c), which could be reflected by one of the quotes of the respondents.

(RDA., D) *"[...] what I said is that when you look at our project as a whole, it is quite innovative. However, this is mainly due to the combination of techniques and the scale at which it is implemented, but there is nothing that someone knowledgeable would say, "Wow, I have. I have never seen that before." Everything has been done before."*

Thus, while these techniques are proven products (RDA., D), the A20/A15 Blankenburgverbinding infrastructure projects are inherently risk-averse, also due to their DBFM contract. They address challenges with new methods but avoid entirely new products due to their inherent risks. This underscores the variability in the interpretation and application of innovation between living labs and DBFM projects.

The A12 IJsselbruggen takes a middle position. Here, the private party is willing to innovate by setting an innovation percentage of 1% of the total contract sum (RDA., A). This encourages small incremental innovations. This approach was made possible through joint discussions at the beginning of the tender (Vitale Infrasector, 2021). Although the innovations are proven products, they are further developed within the project (RDA., A). The innovations are minor adjustments, almost like a hobby (RDA., A). Nevertheless, the work must be done; these innovations are essentially extras.

Summarising this chapter, table 5 provides a comparative analysis of the three different approaches—Living Labs, Two-phase approach, and DBFM(O) —focusing on their capacity to foster innovative solutions and the meaning of innovation at the projects.

	Living Labs		Two-phase approach		DBFM(O)	
Innovative solutions	++	**Focus**: Sustainable construction next to A58 **Key Innovation:** Biobased building materials tested at Hoeve Nieuw Zwanenburg. **Benefit:** : Delays due to nitrogen issues allowed extensive innovation testing.	+	**Focus**: Road maintenance with sustainability. **Key Innovations:** Sustainable asphalt, worker-support exoskeletons, and hybrid generators. **Benefit**: Reduce CO2 emissions, improve safety, and enhance work efficiency.	+-	**Focus**: Overcoming unique challenges in construction. **Key Innovations**: Adjusted sinking system for unforeseen forces, construction reorganization to avoid delays. **Benefit**: Minimized disruptions to shipping and project timeline.
Meaning of innovation	++	Radical experimentation with biobased products, primarily led by public partners, with market involvement delayed due to high risks.	+	Encourages small, incremental innovations, allowing proven products to be further refined within the project.	+-	Uses proven techniques on a large scale, reflecting innovation through their combination rather than entirely new products

Table 5: Scoring of casestudys based on innovation variables (author)

4.2 | PROCESS

In the realm of infrastructure projects, planning is pivotal in fostering innovation. Literature (Khamooshi & Cioffi, 2013) consistently underscores that large-scale projects with extended timelines offer fertile ground for developing and integrating innovative practices. This chapter delves into the impact of project planning on innovation. The following subcodes, defined in chapter 2, will be explored:

- **Impact of project planning:** This subcode explores the role of planning in setting the stage for innovation by establishing clear objectives, aligning resources, and creating an environment that encourages creative problem-solving.
- **Endphase of projects:** This subcode covers how project teams manage the transition from active development to final delivery, ensuring that innovative practices are not lost but rather solidified and potentially transferred to future projects.
- **Initial phase:** This subcode examines how decisions made in the initial phase can either enable or hinder innovative practices throughout the project lifecycle.

These subcodes highlight the critical role of setting clear goals, navigating uncertainties, and fostering collaboration to sustain innovation throughout various project phases. By

examining these dynamics, we explore how strategic project planning facilitates innovation and ensures its continuity beyond project completion, thereby contributing to long-term growth.

4.2.1 | IMPACT OF PROJECTPLANNING

Literature shows that large projects with long lead times are favorable for innovation (Turner, 2016; Demirel et al., 2016). These projects provide sufficient time to develop new ideas while simultaneously monitoring progress (Kodwo & Allotey, 2014). This creates a stable environment where innovations can mature and eventually be integrated into standard practices. In all three case studies, it is recognized that setting clear goals and deadlines is crucial to maintaining focus and preventing time from being wasted on peripheral issues (RDA., A, B, D & E). A respondent's comment about the A12 IJsselbruggen project underscores the importance of project planning in fostering innovation:

(RDA., A) *“I have noticed that every project offers opportunities for innovation, and here we have already created space for innovation.”*

At InnovA58 living labs, and through the underlying concept, the goal is to encourage the production to look beyond current methods and to think about future needs and possibilities over the next ten to twenty years (Chahboun, 2021). This forward-thinking approach helps identify innovations that can deliver long-term benefits and prevents the overarching system from becoming stuck in outdated processes (ibid). Within the Zwaneburg farm project they use a natural cycle, the cycle of sowing and harvesting, which helps in planning and executing actions within the organization (Rijkswaterstaat, 2024f; RDA., C). This rhythm provides a structured approach that fits the dynamics of the organization and its projects (RDA., C.). The dynamic aspect here is continuous testing, followed by discussions of results to attract new partners (van der Wal, 2021). This cycle is repeated annually, but at the moment there is a set enddate: the plot is available for 10 years. Planning in this whole proces is uncertain as indicated by one of the respondents:

(RDA., C.) *“You don't know what will happen with nitrogen policies, what the new government will do about it, and what will happen with the road expansion. Some people say that the road expansion of the A58 will no longer proceed. It's all very uncertain. I actually think it's nice that this is still temporary for now.”*

In a two-phase approach, the project is executed in two stages after contract award (Rijkswaterstaat, 2023). In the first phase, the client and contractor work closely together, conducting research and design activities aimed at reducing risks and uncertainties while making the best use of their combined expertise (Ministry of I&W, 2023d). For project components with significant uncertainties, final pricing occurs at the end of the first phase, along with the establishment of a definitive design, schedule, and risk distribution (Rijkswaterstaat, 2023). One respondent indicated that the current structure still fits within existing contract forms with some suspended conditions.

(RDA., A) *“This two-phase approach is an innovation in itself. What's interesting about this process is that it falls within the standard contracts, so it's essentially a regular contract, but with the concept of splitting it into two phases and including suspensive conditions that must be met to move from phase one to phase two. Conditions have been added to proceed to*

the second phase. Yes, it is an innovation, but it's something you could apply to any project. This requires parties to learn how to handle uncertainties, as they don't know everything yet but still need to issue assignments to the involved parties."

In the A20/A15 Badblankenburg connection project, collaboration is highly valued, even though it requires a significant investment of time (Rijkswaterstaat, 2015). This trend is also evident in the other two case studies. When managed effectively, collaboration can actually speed up processes by reducing internal bureaucracy and shortening lead times (RDA., D). Indicated by one of the respondents that a somewhat tight schedule compels continuous creative thinking (ibid). This underscores the importance of efficient collaboration and communication within the organization to streamline innovation processes.

4.2.2 | ENDPHASE OF PROJECTS

Several respondents have highlighted the challenge of sustaining innovations as projects conclude (RDA., A, B, D). A significant issue arises when the project ends without a clear path for implementing innovations (De Groot et al., 2022). If the team member responsible for an innovation moves to another project, continuity may be disrupted, leading to the innovation being shelved (RDA., B). Often, proven innovations are set aside and only revisited later when applicable.

(RDA., B) *"I actually think the crux of the matter is that our organization [inidicating Rijkswaterstaat] is very good at piloting projects, but they often get bogged down by the cumbersome bureaucracy within our own organization. It's especially the implementation of the final phase of innovations that often goes wrong here. This has been known for a long time, but we are not always able to take effective steps to address it. However, the reality is not so black and white. There are many projects that you could say were major innovations, but are no longer seen as such because we have fully integrated them into production."*

In living labs, innovations are further developed as there is no inherent endphase, but in the A12 and A20/A15 projects, innovations cease at the project's end (as indicated by RDA., B). Respondents emphasize that it is essential to clearly communicate these innovations to various parties, otherwise, they are lost (Chahboun, 2021). This highlights the importance of a structured approach for the integration and continuation of innovations.
Another problem is that many organizations lack the appropriate infrastructure to effectively implement and maintain innovations (Chahboun, 2021). This can be due to a lack of resources, such as time, budget, or expertise. Additionally, organizational culture plays a crucial role; without a culture that promotes and supports innovation, valuable ideas are unlikely to be fully realized (Chahboun, 2021; Ministry of I&W, 2023b).

(RDA., D) *"In ongoing projects that are primarily not about innovation, innovation doesn't happen often. The project manager of an ongoing project is very good at controlling the scope, and avoiding side tracks is one of the first things you learn as a project manager. If you don't, you just get overwhelmed: you risk not meeting the scope, going over budget, messing up your schedule, and people walking away. So, you simply avoid that. Introducing innovations in regular projects, which make up about 90 percent of the work of Rijkswaterstaat, is very difficult. Some regular projects do have an innovation task defined, and time and budget are reserved for it. However, this is often not fully utilized, and innovation projects are usually kept separate from regular production work."*

What we see at the A20/A15 Blankenburgverbinding, as explained by the quote above, if there is no innovation goal set it will never happen. This stands in stark contrast to projects like the InnovA58. Another crucial factor is the involvement of management and the strategic vision of the organization (RDA., D). Innovations must be supported not only technically and operationally but also strategically embedded in the organization's long-term goals (ibid). This means there must be a clear roadmap for the integration of innovations, with regular evaluations to monitor progress and make necessary adjustments (Rijkswaterstaat, 2024g) .

At last at the A12 IJsselbruggen. Creating an ecosystem where knowledge is shared and common goals are pursued can lead to more sustainable and effective innovations (Ministery of I&W, 2023b). For instance, the A12 IJsselbruggen project exemplifies this approach through its innovation committee, as highlighted by the following statement.

(RDA., A) *"We have also established a meeting structure called the innovation committee. Initially, these meetings were held every four weeks, but later we reduced the frequency to once every six weeks, aiming to explore innovations, draw lessons from them, and subsequently generate a business case based on our findings."*

It should be noted, that while the private partner will continue with the innovation after project closure, it also has the financial incentive to do so. As it would like to use its competitive advantage in the future (RDA., A).

4.2.3 | INITIAL PHASE

It is evident that innovation must be established from the outset of a project. As one respondent highlights: "*If a project does not have a clear innovation aim, even if it aligns with Rijkswaterstaat's innovation goals, it will not materialize*" (RDA., D). This principle is clearly applied in the InnovA58 and A12 projects.

As noted by Chahboun (2021) in the 'lessons learned' from the InnovA58 project, it is crucial to involve the right expertise from Rijkswaterstaat early on, both in managing the area and in the planning and implementation stages. Leveraging this knowledge during the exploration phase enhances the transition from exploration to planning (RDA., B). Moreover, initial expectations for innovation should not promise solutions to external problems or cost reductions that may lead to dissatisfaction (Chahboun, 2021). Proper management of expectations from the start is essential to avoid discontent and ensure successful innovation integration (Van der Wal, 2021).

At the A12 IJsselbruggen the projectteam has introduced an innovative approach where 1 percent of the total project contract sum is allocated for innovation. This was established in the first phase (RDB., A.). This money is invested by the construction consortium in innovations that are applicable not only to the current project but also to future projects (Dura Vermeer, 2022; Hakkers, 2023). This approach promotes continuous improvement and knowledge sharing within the sector, which is essential for progress.
Establishing an innovation percentage ensures that innovation is an integral part of the project from the outset. It creates an obligation for the involved parties to actively seek and invest in new technologies and methods. This can lead to a culture of continuous improvement and experimentation, which is crucial for advancing the infrastructure sector. Moreover, this approach not only fosters the development of new solutions for the current

project but also promotes the creation of valuable knowledge and technologies that can be applied in future projects. This results in a cumulative effect that benefits the entire sector.

The A20/A12 Badblankenburg connection project lacks this ambitious approach. As a result, we observe optimizations and design improvements, but not radical experiments. This highlights a critical lesson: *in the absence of a deliberate focus on innovation, projects tend to achieve only incremental improvements rather than pioneering changes*. Without a clear innovation strategy, projects often prioritize risk mitigation and adherence to existing standards, neglecting exploration of new possibilities.
Additionally, there were several delays in the A20/A12 project, making it too risky to test new components (van Ooijen, 2024; Bezemer, 2023; Milieufederatie, 2018). The presence of numerous interests and the pressure to meet deadlines can reduce the willingness to explore innovative solutions. This highlights the importance of a robust risk management strategy that allows room for experimentation without compromising the core objectives of the project. It is crucial to find a balance between managing risks and fostering innovation (RDA., D). This is highlighted by the following respondents comment.

(RDA., D) "*Yes, that's the main thing, it's like if you find innovation itself important. Then you should also focus on that, and we are doing that now but in a limited way. We have a number of objectives that we consider important. Like sustainability, I mentioned safety, we discussed, inconvenience to the environment, which by the way usually goes hand in hand with safety. Yes, and based on those objectives, we are not opposed to innovation, but I would almost say that's as far as we go at the moment at RWS. It's not like we're saying, go ahead and innovate except, yes, as I said, that separate branch of innovation in certain projects.*"

Summarizing this subchapter the table 6 provides a comparative analysis of the three different approaches—Living Labs, Two-phase approach, and DBFM(O) —focusing on the role of projectmanagement in fostering innovation.

	Living Labs		Two-phase approach		DBFM(O)	
Impact of planning	++	Emphasize forward-thinking, planning for future needs, and using natural cycles to structure innovation.	+	Reduce risks and uncertainties, fitting within standard contracts but allowing for flexibility	+-	Effective teamwork and communication help streamline innovation processes despite tight schedules
Endphase of projects	+	Continuous development of innovations due to no set end phase. Creating a knowledge-sharing ecosystem enhances the sustainability of	+	Innovations are supported through structured meetings and committees. Creating a knowledge-sharing ecosystem enhances the sustainability of	-	Without clear innovation goals, advancements are unlikely. Projects need management involvement and strategic planning to sustain innovations.

		innovations.		innovations.		
Initial phase	++	Innovation is established from the outset, involving the right expertise early and managing expectations to prevent dissatisfaction	+	Allocates 1% of the contract sum for innovation at the beginning, fostering continuous improvement and future applicability	-	Lacks a dedicated innovation focus, resulting in incremental improvements and limited experimentation due to delays and risk aversion

Table 6: Scoring of casestudys based on innovation variables (author)

4.3 | PROJECT

In the dynamic realm of project management within Rijkswaterstaat, integrating innovation is a cornerstone for achieving technical excellence, organisational resilience, and growth. This section explores how Rijkswaterstaat navigates the complexities of integrating innovation while focusing on quality and cost-efficiency. The following subcodes, defined in chapter 2, will be explored:

- **Quality and price**: This subcode explores how innovation is leveraged to enhance quality without compromising budgetary constraints. The focus is on understanding how innovative solutions are evaluated and implemented to optimise quality and cost-efficiency.
- **Targets during projects**: This subcode focuses on the specific goals and objectives set during the project lifecycle and how these targets drive innovation.

Research increasingly suggests linking innovation to project indicators like quality, price, and clearly defined targets is vital to optimising outcomes (Petersen, 2019; Himmel & Siemiatycki, 2017; Verweij, 2023). Project managers are crucial in this process, especially in maintaining flexibility across project stages (Satheesh et al., 2023). These variables deserve further practical investigation to understand their impact on fostering innovation and delivering added value.

4.3.1 | QUALITY AND PRICE

The successful integration of innovation into an organization hinges not only on overcoming technical challenges but also on addressing human and cultural factors (Chahboun, 2021). Resistance to change is a natural response in any organization, as people gravitate towards routines and predictability (RDA., B). To counteract this, it is essential to foster a culture that embraces innovation by providing adequate training, support, and incentives (Chahboun, 2021). This helps employees feel more comfortable and capable of adapting to new systems and processes.

Moreover, strategic quality management plays a role in mitigating resistance, as articulated in the quote (RDA., C) below of the InnovA58 project. Clearly articulating the benefits of innovation and how it aligns with the organization's goals can help in gaining buy-in from companies. Leadership must also lead by example, demonstrating a commitment to innovation and change.

"The University of Eindhoven, collaborates with us on bridges made of flax, a crop that grows on land. The sizing is still in development, but the bridges are already suitable for cars and trucks. The binder, which was originally 80% chemical, is now only 20% chemical due to an innovation process, making it 80% natural. If we can make this binder completely natural, it would be a breakthrough.[...] If we want to do something new, it must meet three life cycles and be almost better than steel, which I find unrealistic to set such high requirements. [...] It's also challenging for us that biobased materials are only allowed if they are recyclable, which adds an extra challenge. At the same time, steel is also not fully recycled yet; new steel is still being produced. So if you want to be fair, you should also stop steel production and fully recycle to have a good story. It's very ingrained in the culture and in the minds of those who think that way. But if you think differently and say: we only have six years until 2030, what more can we do? Where are the real opportunities and how can we seize them? That perspective is still lacking in my opinion, but that's what we strive for."

In terms of pricing, the importance of detailed pre-planning cannot be overstated. Accurate cost estimation and resource allocation are critical to the success of any project. The experience with the renovation of the A12 IJsselbruggen underscores this necessity (RDA., A; Rijkswaterstaat, 2020). The two-phase approach, while beneficial for fostering collaboration between the client and contractor, introduces its own set of challenges, such as the potential for unexpected high pricing from contractors (Ministry of I&W, 2023f). Transparency and building in time for exit arrangements provides a safety net, ensuring that both parties can navigate unforeseen circumstances without significant setbacks (ibid).

Transparency is fundamental to successful project execution. Open communication about pricing structures, profit margins, and risk management strategies fosters trust and ensures that all stakeholders are aligned (Ministry of I&W, 2023). For Rijkswaterstaat, this means being clear about their requirements and decision-making processes, which in turn encourages contractors to be transparent about their proposals and constraints (Rijkswaterstaat, 2020).

(RDA., D) *"In such a large complex project, ideally, you want to stick to your plan as much as possible, but that's not always feasible, for various reasons. [...] In our case, we found a much higher concentration of ammonium in the soil, which meant that the intended water-cement mixture wouldn't work. We had to develop and use a different water-cement mixture for the anchor piles we needed to install. So, you start experimenting with what will actually work. An advisory agency Effectivs supported us to figure out: under which conditions does two hours remain structurally safe in the tunnel? Because that's the requirement we have. Ultimately, we examined both the execution of the concrete parts and the cladding, finding a blend that has now become somewhat standard in tunnel construction for Rijkswaterstaat. These are innovations that arise along the way. Ideally, you want to avoid them because they consume a lot of time and money, but sometimes they are necessary, representing another type of innovation."*

What we see at the A20/A15 Blankenburgverbinding is that the passage (RDA., D) emphasizes that some innovations are not the result of proactive planning but are reactive, arising out of necessity. These reactive innovations, although potentially costly, can lead to significant advancements and become industry standards (RDA., D). When the standard water-cement mixture proved ineffective due to the soil conditions, the team had to

experiment with alternative solutions. This adaptive approach is crucial in complex projects, where flexibility and problem-solving are necessary to overcome challenges. The process of trial and error, supported by advisory agencies like Effectivs, led to the development of a new mixture that eventually became a standard in tunnel construction for Rijkswaterstaat.

4.3.2 | TARGETS DURING PROJECTS

This section delves into the strategic alignment and operational challenges of target-setting within Rijkswaterstaat, drawing insights from organizational practices and stakeholder interactions. At InnovA58, strategic alignment with organizational goals and directives from key stakeholders, including the Secretary-General of I&W, is critical. This alignment ensures that targets are not only meaningful but also contribute directly to overarching objectives, emphasizing the strategic nature of target-setting within the organization. Secondly, the quote below (RDA., B) reveal the complexities involved in decision-making and prioritization. Rijkswaterstaat engages in discussions with clients and stakeholders to deliberate on choices, recognizing the need to allocate resources efficiently amid competing demands. This process underscores the organization's commitment to prudent resource management and effective governance.

(RDA., B) *“Yes, that's exactly how it works. As an implementation organization, we act on behalf of our owner, in this case, the Secretary-General of I&W. When faced with dilemmas like these, we engage in discussions with our client to deliberate on choices. We cannot do everything at once, so we must prioritize. One of the steps we have taken is implementing basic quality standards for our services. This helps us determine the qualities we can attach to our service delivery and where to allocate our resources. Sometimes, this means that innovation does not immediately receive additional funding. For instance, together with ProRail, we decided to scale back on natural habitat management within our area, due to costs and capacity constraints. While others are making progress, we are taking a step back. These are the kinds of discussions we have with our client, even if they sometimes conflict with our broader goals.”*

A12 IJsselbruggen, and what we see at a lot of projects, is that setting clear targets within a project is crucial for driving innovation and maintaining progress. By breaking down the project into interim milestones, such as quarterly focus points, teams can stay aligned with overarching goals while concentrating on specific, manageable objectives (RDA., A). This approach not only provides direction but also motivates team members by giving them short-term goals to achieve (ibid). Tailoring focus points to each team's strengths and responsibilities ensures that everyone contributes effectively. Ultimately, setting and achieving these smaller targets helps maintain momentum, leading to steady progress and successful innovation.

(RDA., A) *“Certainly, I try to guide this by introducing an innovation with an interim milestone as a focal point for the project. We work on a project with quarterly established focus points. In this context, we usually have our own focus point as project teams. This approach helps to motivate at least some people to try and achieve this goal within the set period, which in turn helps us make progress.”*

Moreover, the setting of targets involves a comprehensive approach to resource allocation. This includes implementing basic quality standards and making informed decisions on funding priorities. At A20/A15 Badblankenburgverbinding, the organization navigates dilemmas and challenges by balancing innovation aspirations with practical constraints, ensuring that initiatives align with sustainability and safety imperatives (Ministry of I&W, 2023g). Additionally, the quote (RDA., D) below illustrate Rijkswaterstaat's proactive stance towards innovation. Initiatives such as the Safety Coaching Ladder certification exemplify the organization's commitment to pushing industry standards and achieving high safety benchmarks (Ministry of I&W, 2023g). These efforts not only enhance project outcomes but also position Rijkswaterstaat as a leader in innovation within the infrastructure sector.

(RDA., D) *"For example, consider Innova 58, as the name suggests, it had a clear innovation objective. They wanted to try out several things, and they really dove into that. While innovation wasn't explicitly stated in our project objectives, sustainability and safety were emphasized. Regarding safety, we've innovated from the project side; for instance, we're the first project in the Netherlands certified at Safety Coaching Ladder level four, not just claiming it ourselves but externally certified. Throughout that process, which ran until the end of last year, Rijkswaterstaat has been very influential and supportive. Not because the contractor wouldn't want to innovate, but they're often distracted by day-to-day urgencies, dealing with delays, and so on. We've had more organizational stability to keep pushing forward continuously. When you set a goal like this and allocate the necessary resources—dedicating people and budget—you can innovate quite significantly with the contractor. This effort also has ripple effects, generating interest from other projects within RWS and even attracting visits from organizations like ProRail. They want to learn from our experience, which shows we've made a meaningful impact on the sector."*

Lastly, the impact and influence of target-setting within Rijkswaterstaat extend beyond individual projects. The organization's strategic targets attract interest and recognition from industry stakeholders, fostering collaboration and setting benchmarks for best practices in project management and infrastructure development.

	Living Labs		Two-phase approach		DBFM(O)	
Quality and price	+-	Meeting stringent sustainability goals, like circular materials, requires a shift in mindset and strategy.	+	Effective pre-planning and transparent communication are essential for managing complex projects.	+-	Unplanned challenges led to costly but necessary innovations that advanced to new industry standards.
Targets during projects	+	Targets align with organizational goals and directives from key stakeholders,	+	The project employs quarterly focus points to drive progress, motivate teams, and ensure alignment with	+-	The project balances innovation with practical constraints, emphasizing safety and

		such as the Secretary-General of I&W		overarching goals.		sustainability.

Table 7: Scoring of casestudys based on innovation variables (author)

Summarizing this subchapter the table 7 provides a comparative analysis of the three different approaches—Living Labs, Two-phase approach, and DBFM(O) —focusing on the role of strategic project planning in fostering innovation.

4.4 | PEOPLE

Every case study shows that the public site, Rijkswaterstaat, uses IPM to optimise internal and external collaboration. Integral Project Management (IPM) involves projects executed by an integrated project team. The tasks assigned to each team member are precise throughout all project phases.
IPM distinguishes five processes, each with a specific role, forming the five-role model (van Heeren, 2010). Five individuals primarily fill these roles, but multiple people can fulfil different roles, each with its support team. The processes and corresponding roles are outlined below.

- **Project Management**: Focuses on ensuring quality, support, and alignment. The project manager is ultimately responsible for achieving good project results.
- **Project Control**: Manages risks and all control aspects of the project. The project control manager is responsible for identifying and managing (potential) integrated risks.
- **Environmental Management**: The environmental manager maintains balance with the environment and stakeholders throughout the project and handles all contacts with the external environment.
- **Technical Management**: Controls technical and organisational risks. The technical manager is responsible for the technical and substantive input in the project.
- **Contract Management**: Manages risks between the client and the market, including during the procurement phase. The contract manager is responsible for contacts and contracts with various market parties.

The public partner, Rijkswaterstaat, proactively fosters innovation by promoting collaboration among diverse stakeholders and embedding innovation tasks within project teams. Recognising and addressing cultural and organisational barriers that impede innovation, the organisation is committed to fostering solutions such as fostering equitable collaboration, enhancing ownership, and cultivating a culture of continuous learning. This chapter delves, defined in chapter 2, into the following subcodes:

- **Leadership**: This subcode gives comparisons and contrasts in leadership styles and approaches between public and private partners within projects and their impact on innovation.
- **Dealing with conflicts**: This subcode explores methods and strategies for managing and resolving conflicts and disagreements within project teams.
- **Concept of dare**: This subcode explores the willingness of team members and leaders to take risks and try new, untested solutions as part of the innovation process.

4.4.1 | LEADERSHIP

At InnovA58, collaboration within Rijkswaterstaat is structured around the model of the five O's (In Dutch: Overheid, Ontwerpers, Ondernemers, Onderzoekers & onderwijs en de Omgeving): government, designers, entrepreneurs, researchers and education, and the environment (Chahboun, 2021). This model aims for equitable collaboration on major societal challenges at active, physical locations (Van der Wal, 2021). This promotes interdisciplinary cooperation and utilizes diverse perspectives and expertise to tackle complex challenges. A significant challenge in innovation is the cultural divide between groups adept at handling complex projects and those comfortable with predictable work, which can hinder collaboration and slow innovation (RDA., B). Cultivating an equal relationship between client and contractor, with openness to ideas at its core, is crucial for successfully realizing innovations (RDA., C; Chahboun, 2021). Resistance to change is a major obstacle within the organizations, often rooted in a tendency to cling to familiar methods, potentially obstructing innovation (Ministry of I&W, 2023e; RDA., B). It is important not to simply pass on responsibilities but to jointly decide on priorities and support each other. The concept of a 'band of Gideons', where everyone helps and collaborates, can assist in achieving ambitious goals (Ministry of I&W, 2023e). Something that is talked about by one of the respondents and also discussed by Rijkwaterstaat.

(RDA., B) *"We shouldn't just pass on responsibilities, but truly decide together what is important and support each other. In the past, this was often referred to as a kind of 'band of Gideons', where you help each other and collaborate. I think we do this too little. Often, we get too stuck in roles, tasks, and responsibilities, which can sometimes cause the ambition to truly achieve something to fade away."*

As indicated in A12 IJsselbruggen, Rijkswaterstaat collaborates intensively with private parties on innovations, with the private sector often dedicating more effort and time than the reactive public sector (RDA., A). To foster innovation, one to ten members within project organization are appointed as innovation collaborators, integrating the role of innovation coordinator within the team structure (ibid). This approach demonstrates a pragmatic method where innovation tasks are integrated into existing roles to ensure flexibility and engagement. Rijkswaterstaat views collaboration between the public and private sectors as a growing niche that needs expansion (Rijkswaterstaat, 2020). Innovation demands courage, curiosity, and a pragmatic approach of trial and error (RDA., A.). Everyone should contribute to innovation based on their talents, discipline, and networks (ibid). While caution in involving contractors in the early stages of innovation is understandable, their eventual engagement is crucial for scaling and implementation (Rijkswaterstaat, 2020). This is highlighted by the following quote:

(RDA., A.) *"We do like to try new things, so we are curious, but at the same time, we also think: okay, if we want to do this, what do we need? So what we have done is tried to integrate a small organizational structure into the project organization, but we have concluded that it is quite difficult and challenging to maintain to keep the people involved motivated. Nevertheless, as project managers, we bear ultimate responsibility for determining which innovations we find promising and where we want to allocate funds, and which ones we do not."*

Rijkswaterstaat has developed a learning system focused on individual, team, and organizational learning (Rijkswaterstaat, 2024h). This system helps enhance knowledge and skills, contributing to a culture of continuous improvement and innovation. As seen in the A20/A15 Blankenburgverbinding project, project managers are trained to manage project scope and avoid tangents to prevent budget overruns and delays (RDA., D). This underscores the need for stringent project management to successfully implement innovations. What we also see, which is inherent to DBFM(O) projects, is that it is clear that on all aspects the private partner takes the forefront (RDA., D). Public-private partnerships in infrastructure projects like DBFM models involve a division of roles where private contractors often lead in innovation and efficiency, driven by their contractual obligations and financial incentives, which we can see in the following quote:

(RDA., D) *"It's usually the private party. Yes, in our case, even in a DBFM (Design, Build, Finance, Maintain) with a fixed price agreement, the design is outlined during the tendering process and then they move into the detailed design phase, start thinking about optimizations, and then they come up with nice ideas and suggestions to approach things differently. Sometimes we [inidcating the public partner] are also the driver, even in heat-resistant cladding, we are clearly the driver, but generally, it's the contractor who sees opportunities to save costs and time. That's what they're primarily looking for, because they've agreed to a fixed price.*

In fostering innovation within infrastructure projects, the composition of project teams plays a pivotal role, as highlighted by the recognition that purely technical approaches can sometimes lead to compromises with suboptimal solutions. This insight underscores the value of multidisciplinary teams, where the inclusion of diverse expertise mitigates the risk of narrow perspectives. The statement emphasizes that while engineers are crucial for technical insights, a team solely composed of technical experts may overlook broader implications or more effective solutions. Conversely, teams lacking technical proficiency may struggle to implement viable solutions. Therefore, achieving a balance with a diverse mix of disciplines becomes essential, ensuring that social, technical, and other perspectives complement each other. Such interdisciplinary collaboration not only enriches the innovation process by fostering comprehensive problem-solving approaches but also enhances the potential for achieving superior project outcomes that align with both technical feasibility and broader societal needs.

4.4.2 | DEALING WITH CONFLICTS

The InnovA58, A12 IJsselbruggen, and A20/A15 Badblankenburgverbinding projects all face similar challenges. Ownership of the innovation process within Rijkswaterstaat remains difficult, despite the acknowledged importance and excitement of pioneering efforts (RDA., A, B, C, D & E; Chahboun, 2021). However, practical involvement often falls short due to the urgent demands of daily operations (RDA., A, B & D). This highlights the need for dedicated time and resources to be specifically allocated to innovation initiatives, ensuring they receive the necessary focus and attention to succeed alongside ongoing priorities.

This challenge is pervasive across projects involving diverse stakeholders and interests, whether they are innovative ventures or routine maintenance tasks (RDA., B). To effectively navigate these complexities, project teams routinely assemble teams equipped with

expertise in conflict resolution, business strategy, and relationship management (RDA., B; Ministry of I&W, 2023a).
The process begins by aligning all stakeholders around a clear, shared goal—an essential foundation that must be solidified early on (Chahboun, 2021; Busse, 2018). Understanding and respecting each party's unique interests are equally crucial, as these can often diverge or conflict significantly. Without upfront clarification and alignment of interests, collaborative efforts are prone to friction and inefficiency. Highlighted by the following quote:

(RDA., B) "*People who are good at this usually don't have conflicts if we take this seriously and also pay attention to understanding each other's interests, sometimes even outside formal meetings. It's about truly getting to know and understand each other. Problems often arise when parties rigidly cling to their own interests without considering those of others, which can occur on both sides.*"

With a shared goal established, the next step involves structuring the project, such as defining roles and establishing legal frameworks (RDA., B). However, past experiences have taught us that attempting to impose structure without first achieving alignment on goals and interests can lead to resistance and suboptimal outcomes (RDA., B; Chahboun, 2021). Therefore, we have adopted a proactive approach that prioritizes initial discussions aimed at fostering mutual understanding and agreement on overarching objectives (ibid).

Central to this approach is open and reasoned dialogue among stakeholders (RDA., A, B, C, D & E). This involves addressing core issues comprehensively and articulating desired outcomes clearly (RDA., A, B & D). Additionally, rigorous validation by technical experts is crucial to assess the feasibility and potential impacts of proposed changes (RDA., D). We emphasize thorough consultation with the entire project management team, recognizing that even seemingly minor technical adjustments can have profound environmental or operational repercussions that require careful consideration (RDA., D & B).
Ultimately, the success of any initiative hinges on the extent to which it aligns with shared interests and promotes collective benefits. If an initiative fails to achieve this alignment, it often becomes clear that the project should not proceed, reinforcing the importance of prioritizing initiatives that foster cohesion and deliver meaningful value to all stakeholders involved.

4.4.3 | CONCEPT OF DARE

What is emphasized throughout all cases is a dual approach towards innovation, combining a human aspect of curiosity and eagerness to try new things with a pragmatic assessment of requirements. This balance is crucial for effective innovation, where enthusiasm is tempered by practical considerations. The data reveals a preference among team members for engaging with complex, challenging projects over repetitive tasks (RDA., A, B, C, D & E). This preference drives their motivation and creativity, as indicated by the following quote:
"One of the points is that people like me enjoy tackling complex projects and thinking about how things can be done differently. We love constantly facing new challenges. Repetitive work suits us less, while the main production flow consists precisely of predictable work. That also has to be, because it is efficient, but this difference in preferences is culturally determined and causes different groups not to mix well. One group finds the other boring,

while the other group wonders what the rest are doing, because it doesn't directly affect their work."

At InnovA58 innovation is approached as an iterative process involving trial and error, as indicated by quote underneath this text. Success is achieved through continuous experimentation, learning from failures, and adjusting strategies. This approach acknowledges the unpredictability and inherent risk of innovative endeavors (Chaboun, 2021). While systems, financial resources, and time are necessary to create an environment conducive to innovation, they are not sufficient on their own (RDA., B; Van der Wal, 2021)

(RDA., C) *"Yes, it is mainly a matter of daring, being very curious, and not talking too much with thick policy documents, but just doing and trying to see what works. That is really trial and error, I think. A good example is the flax fiber bridge. Can we use less chemistry as a binder and more natural materials? These are constantly small innovation projects being set up and seeing where it takes us."*

Indicated by a respondent of A12 IJsselbruggen: (RDA., A) *"Well, we sometimes just do whatever. [...] We do like trying new things, so we are curious, but at the same time, we also think: okay, if we want this, what do we need? So what we did was try to integrate a small organizational structure into the project organization, but we concluded that it is quite challenging and difficult to maintain to keep the involved people motivated."*

Overall, the statement highlights the tension between the desire to innovate and the practical challenges of doing so within a traditional project structure. It suggests that while the team is willing to explore new possibilities, they are still grappling with how to sustain these efforts in a way that keeps the team engaged and motivated.

What we see at the A20/A15 Blankenburgverbinding is that successful innovation depends more on the intrinsic motivation of the individuals involved, as indicated by the quote. A willingness to take risks, or a "Risk Appetite," is essential for innovation. The text acknowledges that innovation comes with the possibility of failure, which can result in higher costs or longer timelines than anticipated. However, this same risk-taking can also lead to significant breakthroughs and savings, underscoring the unpredictable nature of innovation outcomes.

(RDA., D) *"Yes, well, it is not a system thing, I think. Yes, with money and time you can create circumstances. But ultimately, I think it relies heavily on the intrinsic motivation of the people involved and also what I mentioned earlier, a Risk Appetite to try things out, because innovation inherently brings risks. It can also fail, or failing sounds fatal, but in any case, it can take more time and money than you had in mind. It can also eventually lead to savings, but you never know that for sure beforehand."*

Summarizing this subchapter the table 8 provides a comparative analysis of the three different approaches—Living Labs, Two-phase approach, and DBFM(O) — in examining the dynamics of innovation within infrastructure projects, it becomes evident that effective project team composition is crucial.

	Living Labs		Two-phase approach		DBFM(O)	
Leadership	+	Utilizes a collaborative model involving government, designers, entrepreneurs, researchers, and education to tackle societal challenges through interdisciplinary cooperation.	+	Emphasizes intensive collaboration between Rijkswaterstaat and private parties, with innovation roles integrated into the project team to ensure flexibility and active engagement.	+-	Highlights the importance of public-private partnerships, with private contractors often leading innovation and efficiency, driven by contractual obligations in DBFM projects.
Dealing with conflicts	+-	**Similar challenges:** Ownership of the innovation process within remains difficult. Innovation requires dedicated resources and early stakeholder alignment on shared goals to avoid conflicts. Structuring projects should follow goal alignment, with open dialogue and expert validation ensuring feasibility and collective benefits.				
Concept of dare	+	Innovation is seen as a continuous process of trial and error, with success coming from experimenting, learning from failures, and adapting strategies.	+-	The project team is open to trying new things but struggles with maintaining motivation and integrating innovation into the traditional project structure.	-	Success in innovation heavily relies on the intrinsic motivation of individuals and their willingness to take risks. While innovation can lead to significant breakthroughs, it also comes with the possibility of failure, requiring a high tolerance for uncertainty and risk.

Table 8: Scoring of casestudys based on innovation variables (author)

4.5 | PERFORMANCE

In this chapter, we delve into the multifaceted aspects of performance within the InnovA58 project, focusing on how innovation and sustainability practices are integrated and managed across various phases of the project. Performance is not merely about achieving immediate results but also about understanding and optimizing the processes that lead to long-term success. This requires a comprehensive approach that includes strategic planning, effective implementation, and continuous improvement. The following subcodes, defined in chapter 2, will be explored:

- **Innovation on sustainability**: This subcode focuses on innovations that specifically target sustainability goals.
- **Complexity**: This subcode addresses the challenges and intricacies that arise due to the multifaceted nature of projects.

4.5.1 | INNOVATION ON SUSTAINABILITY PRACTICES

The goal of achieving a complete Circular Economy by 2030 is ambitious (Rijkswaterstaat 2024a). The progress in this area has been notable, which we see at the InnovA58 project, with the pace of change accelerating in recent years. Two years ago, achieving such a goal seemed far-fetched, but current advancements suggest it is within reach (RDA., B & E). The idea is to move beyond merely offsetting carbon emissions through renewable energy sources and focus on the circularity of materials. This involves using locally produced materials, thereby reducing the carbon footprint associated with transportation and fostering local economies (RDA., C).

(RDA., C) *“Saying 'We have a wind farm at the Maasvlakte and thus we are CO2-neutral' is too simplistic for me. It's also about transitioning materials to become truly circular. This means using materials produced locally, for example in the Netherlands, and incorporating them into the infrastructure projects we carry out. So yes, I wonder if we will make it by 2030. People say it might actually be 2040 or 2050, but I would like to speed things up. That's why we started this field lab.”*

However, the statement as indicated by the quote above, "We have a wind farm at the Maasvlakte and thus we are CO2-neutral," oversimplifies the broader challenge. True sustainability involves more than just renewable energy; it requires a systemic change in how materials are sourced, used, and recycled. Transitioning to a circular economy means integrating locally produced materials into infrastructure projects, reducing dependency on non-renewable resources, and minimizing waste (Rijkswaterstaat, 2024a).

Despite the ambitious goals, there are practical limitations and competing priorities. The immediate focus on replacing and renovating critical infrastructure, such as bridges and tunnels, often takes precedence over sustainability initiatives (RDA., B). Ensuring the safety and functionality of essential infrastructure is paramount, and this results in sustainability being viewed as an additional, rather than primary, objective (RDA., C). The reality is that while sustainability goals provide direction and motivation, they must be balanced with other pressing needs.

“We indeed have multiple sustainability goals, and you specifically asked about the goal to be climate-neutral and circular by 2030. That is absolutely a wonderful goal that provides a lot of focus and greatly helps. But to be honest, we will probably not achieve that goal. I also see that it is sometimes viewed as an extra, because our real priority at this moment lies in the replacement and renovation tasks. We are managing this enormous project, ensuring that our bridges and tunnels do not collapse. Hence, the pursuit of maximum sustainability currently receives less attention. This is a choice we have to make."

The establishment of a field lab dedicated to speeding up the transition to sustainability demonstrates a proactive approach. By fostering innovation and experimenting with new methods and materials, RWS can accelerate progress towards its climate-neutral and circular economy goals. The field lab serves as a testing ground for scalable solutions that can be implemented on a broader scale.

At the A12 IJsselbruggen, two of the three key innovations are strategically focused on fostering a more sustainable environment. These initiatives reflect a strong commitment to

integrating sustainability into the project's core objectives. However, beyond these initial steps, there is a noticeable lack of detailed information or evidence on the ongoing efforts and progress made in advancing these sustainable innovations throughout the project. This absence of comprehensive updates or insights into how these innovations evolve and contribute to long-term environmental goals suggests a potential disconnect between the initial sustainability intentions and their practical application.

What we see at A20/A15 Blankenburgverbinding is that thet have the ambition achieving Net Zero Emissions by 2030. But it is a complex but potentially attainable goal for Rijkswaterstaat (RWS) as indicated by one of the respondents of the A20/A15 Blankenburgverbinding (RDA., D). The transition to sustainable electricity through the Maasvlakte Two wind turbine project is a significant milestone (Rijkswaterstaat 2015). This project supplies enough energy to cover all the activities of RWS, representing a substantial move towards sustainability. However, it is essential to recognize that sustainability is not just about offsetting emissions on paper but involves a comprehensive and tangible shift in operational practices (RDA., D).

Electrifying equipment on construction sites and setting stringent requirements for contractors to follow suit is another positive step. Although it is currently not mandatory but incentivized through the MVI method, making such practices compulsory could accelerate the transition (RDA., D). This highlights the importance of forward-thinking in planning, ensuring adequate infrastructure for electrification, such as charging facilities and robust electrical connections, to support the increased demand for electric equipment. In the planning phase, foresight is critical. RWS and other clients must anticipate the needs for electrification and ensure the availability of necessary infrastructure, like sufficient charging facilities and robust power grids. Innovations such as mobile batteries are emerging, providing flexibility and aiding the transition (Hakkers, 2023).

4.5.2 | COMPLEXITY

Finding a balance between embracing and managing complexity is crucial for effective collaboration and achieving results (Robertson, Caruana and Ferreira, 2023). Complexity is inherent in our world, and recognizing and integrating it is essential. Attempts to oversimplify can lead to the loss of critical interconnections (De Groot et al., 2022). This underscores the importance of a holistic approach in innovation projects, where the complexity of systems is acknowledged and leveraged. The InnovA58, A12 IJsselbruggen, and A15/A20 Badblankenburgverbinding projects exemplify a period of transition within Rijkswaterstaat. These projects showcase an active exploration of sustainable energy solutions and circular waste utilization.

Rijkswaterstaat is actively exploring sustainable ways to supply energy and utilize circular waste (e.g. at the InnovA58 project). When circular waste cannot be used directly on the construction site, further investigation during the project duration can be valuable (RDA., A). This demonstrates a strong focus on sustainability and a commitment to maximizing the effective use of materials. The organizational culture within Rijkswaterstaat is heavily oriented towards the present, safety, and strict regulations (RDA., B). Innovations must meet high standards, which can sometimes be unrealistic and hinder progress (RDA., C). For instance at the InnovA58 project, biobased materials are only permitted if they are

recyclable, adding an extra layer of challenge (RDA., C). These stringent requirements can delay the implementation of innovative solutions.

A culture shift is needed to move the focus from the present to the future (Minstry of I&W, 2023b; Cahbhoun, 2021). With only six years remaining until 2030, it is crucial to identify and seize opportunities. Developing strategies and actions focused on the future, without hindering present operations, is a key priority. This requires a forward-looking perspective, as the organization is currently primarily focused on immediate concerns (RDA., B & E).

Rijkswaterstaat and the market are collaboratively working towards a sustainable, innovative, and financially healthy infrastructure sector through the program 'On the way to a vital infrastructure sector' with project such as A12 IJsselbruggen. Market transformation expert Lucas Simons (Ministry of I&W, 2023b) explains the complexities of such transitions, emphasizing that true transitions should break existing patterns and require strategic planning, leadership, and addressing the interests of multiple stakeholders.

Simons (Ministry of I&W, 2023b) outlines a five-phase transition process:

1. **Phase Zero:** Recognizing the problem without feeling the urgency to act until a crisis occurs.
2. **Baby Phase:** Beginning movement and experimentation with pilots and projects.
3. **Adolescent Phase:** Evaluating successful practices, embracing new methods, and overcoming resistance.
4. **Young Adult Phase:** Scaling up and embedding the new practices, addressing new barriers.
5. **Adult Phase:** Achieving the new normal and fully implementing the transition.

Simons (Ministry of I&W, 2023b) stresses the importance of having a clear vision, understanding the specific phase of the transition, and being prepared for the challenges and resistance that come with it. He advises continuous monitoring and adapting metrics to ensure the transition progresses effectively, highlighting the need to reward frontrunners and address those who resist change.

Summarizing this subchapter the table 9 provides a comparative analysis of the three different approaches —Living Labs, Two-phase approach, and DBFM(O) — the InnovA58 project exemplifies a forward-thinking approach to project management and innovation within the infrastructure sector.

	Living Labs		Two-phase approach		DBFM(O)	
Innovation on sustainability	+	The ambition to achieve a Circular Economy by 2030 is challenging but increasingly seen as achievable. Focus is shifting	-	Two out of three innovations focus on sustainability, but there is a lack of detailed information on ongoing efforts and progress in these areas.	+	The goal of Net Zero Emissions by 2030 is ambitious but potentially attainable, with significant milestones like the Maasvlakte Two wind turbine project. Electrification of construction

		from merely offsetting carbon emissions to ensuring material circularity and using locally produced materials.				equipment and forward-thinking infrastructure planning are critical for advancing sustainability.
Complexity	+	Forward-thinking in project management, highlighting strategic planning, knowledge sharing, and sustainability are key to performance in infrastructure innovation. There is a shift towards future-oriented strategies essential to capitalize on opportunities leading up to 2030, moving beyond immediate concerns. The organization's present-focused culture, safety concerns, and strict regulations can hinder innovation by setting unrealistic standards.				

Table 9: Scoring of casestudys based on innovation variables (author)

4.6 | FINAL OVERVIEW

Drawing on all the findings, the table 10 below serves as a comprehensive comparative summary, encapsulating the key insights and outcomes. This final summary is designed to provide a clear and concise overview of the results, highlighting the critical aspects of each variable for reference and analysis.

Code	Living Labs		Two-phase approach		DBFM(O)	
Innovation	**++**		**+**		**+-**	
Innovative solutions	++	**Focus**: Sustainable construction next to A58 **Key Innovation:** Biobased building materials tested at Hoeve Nieuw Zwanenburg. **Benefit:** : Delays due to nitrogen issues allowed extensive innovation testing.	+	**Focus**: Road maintenance with sustainability. **Key Innovations:** Sustainable asphalt, worker-support exoskeletons, and hybrid generators. **Benefit**: Reduce CO2 emissions, improve safety, and enhance work efficiency.	+-	**Focus**: Overcoming unique challenges in construction. **Key Innovations**: Adjusted sinking system for unforeseen forces, construction reorganization to avoid delays. **Benefit**: Minimized disruptions to shipping and project timeline.
Meaning of innovation	++	Radical experimentation with biobased products, primarily led by public partners, with market involvement delayed due to high risks.	+	Encourages small, incremental innovations, allowing proven products to be further refined within the project.	+-	Uses proven techniques on a large scale, reflecting innovation through their combination rather than entirely new products
Process	**++**		**+**		**-**	
Impact of planning	++	Emphasize forward-thinking, planning for future needs, and using natural cycles to structure innovation.	+	Reduce risks and uncertainties, fitting within standard contracts but allowing for flexibility	+-	Effective teamwork and communication help streamline innovation processes despite tight schedules
Endphase of projects	+	Continuous development of innovations due to no set end phase. Creating a knowledge-sharing ecosystem enhances the sustainability of innovations.	+	Innovations are supported through structured meetings and committees. Creating a knowledge-sharing ecosystem enhances the sustainability of innovations.	-	Without clear innovation goals, advancements are unlikely. Projects need management involvement and strategic planning to sustain innovations.
Initial phase	++	Innovation is established from the outset, involving the right expertise early and managing expectations to prevent dissatisfaction	+	Allocates 1% of the contract sum for innovation at the beginning, fostering continuous improvement and future applicability	-	Lacks a dedicated innovation focus, resulting in incremental improvements and limited experimentation due to delays and risk aversion
Project	**+-**		**+**		**+-**	
Quality and price	+-	Meeting stringent sustainability goals, like circular materials, requires a shift in mindset and strategy.	+	Effective pre-planning and transparent communication are essential for managing complex projects.	+-	Unplanned challenges led to costly but necessary innovations that advanced to new industry standards.
Targets during projects	+	Targets align with organizational goals and directives from key stakeholders, such as the Secretary-General of I&W	+	The project employs quarterly focus points to drive progress, motivate teams, and ensure alignment with overarching goals.	+-	The project balances innovation with practical constraints, emphasizing safety and sustainability.

People	**+**		**+**		**+-**	
Leadership	+	Utilizes a collaborative model involving government, designers, entrepreneurs, researchers, and education to tackle societal challenges through interdisciplinary cooperation.	+	Emphasizes intensive collaboration between Rijkswaterstaat and private parties, with innovation roles integrated into the project team to ensure flexibility and active engagement.	+-	Highlights the importance of public-private partnerships, with private contractors often leading innovation and efficiency, driven by contractual obligations in DBFM projects.
Dealing with conflicts	+-	**Similar challenges:** Ownership of the innovation process within remains difficult. Innovation requires dedicated resources and early stakeholder alignment on shared goals to avoid conflicts. Structuring projects should follow goal alignment, with open dialogue and expert validation ensuring feasibility and collective benefits.				
Concept of dare	+	Innovation is seen as a continuous process of trial and error, with success coming from experimenting, learning from failures, and adapting strategies.	+-	The project team is open to trying new things but struggles with maintaining motivation and integrating innovation into the traditional project structure.	-	Success in innovation heavily relies on the intrinsic motivation of individuals and their willingness to take risks. While innovation can lead to significant breakthroughs, it also comes with the possibility of failure, requiring a high tolerance for uncertainty and risk.
Performance	**+**		**+-**		**+**	
Innovation on sustainability	+	The ambition to achieve a Circular Economy by 2030 is challenging but increasingly seen as achievable. Focus is shifting from merely offsetting carbon emissions to ensuring material circularity and using locally produced materials.	-	Two out of three innovations focus on sustainability, but there is a lack of detailed information on ongoing efforts and progress in these areas.	+	The goal of Net Zero Emissions by 2030 is ambitious but potentially attainable, with significant milestones like the Maasvlakte Two wind turbine project. Electrification of construction equipment and forward-thinking infrastructure planning are critical for advancing sustainability.
Complexity	+	Forward-thinking in project management, highlighting strategic planning, knowledge sharing, and sustainability are key to performance in infrastructure innovation. There is a shift towards future-oriented strategies essential to capitalize on opportunities leading up to 2030, moving beyond immediate concerns. The organization's present-focused culture, safety concerns, and strict regulations can hinder innovation by setting unrealistic standards.				
TOTAL	**++**		**+**		**+-**	

Table 10: Overview main points result (author)

CHAPTER 5 | CONCLUSIONS AND DISCUSSION

To compose a conclusion, this chapter first addresses the secondary research questions. Following this, the main research question is answered by formulating conditions for innovation upscaling, culminating in a general conclusion. In establishing these conditions, the theoretical framework is compared with the study's results and analysis, highlighting the differences between theory and findings. The final sections of this chapter provide recommendations for further research, and a reflection on the study.

5.1 | MAIN FINDINGS

5.5.1 | SECONDARY RESEARCH QUESTIONS

(SUB)QUESTION 1: *How do projects drive innovation in different PPP structures?*

Living Labs are the most innovative approach, offering a flexible, collaborative environment ideal for developing new technologies. This method, exemplified by InnovA58 and Hoeve Nieuw Zwanenburg, encourages radical experimentation and high-risk, high-reward innovations, making it the leading model for substantial progress in infrastructure projects.

The Two-Phase Approach, seen in the A12 IJsselbruggen project, supports incremental innovation within a structured framework. While more limited, it facilitates practical advancements like sustainable asphalt and worker-support exoskeletons.

The DBFM(O) model, used in the A20/A15 Blankenburgverbinding project, prioritizes stability and cost-effectiveness, focusing on adapting existing methods rather than pioneering new technologies, resulting in fewer opportunities for innovation.

(SUB)QUESTION 2: *How do process indicators within different PPP structures create innovation through project management?*

Large-scale projects with long timelines are ideal for innovation, providing time to develop and integrate new practices. Examples like InnovA58 and A12 IJsselbruggen show that clear goals and aligned resources from the start foster an innovative environment.

Sustaining innovation post-project is challenging, especially if there are no clear implementation paths or key team members move on. The A12 IJsselbruggen project addresses this by establishing an innovation committee and offering financial incentives to continue innovation. Effective communication and integration strategies are crucial to prevent innovations from being sidelined after completion. The initial project phase is vital for establishing innovation focus. The A12 IJsselbruggen project, which allocates 1% of the contract sum for innovation, demonstrates how early investment fosters ongoing improvement. In contrast, projects like A20/A15, without a clear innovation strategy, often result in only incremental advancements due to risk aversion.

Living Labs foster innovation through long timelines, flexible planning, and continuous development, allowing for ongoing experimentation and adaptation. Two-Phase Approaches balance risk and flexibility, leading to innovative solutions refined over time. DBFM(O) Models focus on stability and cost-effectiveness, often resulting in incremental innovations

due to their conservative risk management. Successful innovation in these PPP structures relies on clear goal-setting, strategic planning, and effective management throughout the project's lifecycle, ensuring innovation is embedded from the start and sustained beyond completion.

(SUB)QUESTION 3: *How do project indicators within different PPP structures create innovation through project management?*

In conclusion, target-setting within Rijkswaterstaat is crucial for strategic alignment, resource management, and innovation across projects. At InnovA58, aligning targets with organizational goals ensures that project objectives contribute to broader aims. The A12 IJsselbruggen project shows how clear interim milestones maintain progress and drive innovation by breaking down objectives into manageable tasks.

At A20/A15 Blankenburgverbinding, balancing innovation with practical constraints highlights the importance of integrating safety and sustainability into project targets. The Safety Coaching Ladder certification demonstrates how setting high safety benchmarks can elevate industry standards and improve outcomes. Overall, target-setting within Rijkswaterstaat not only guides project execution but also influences industry practices and sets new benchmarks.

In Public-Private Partnerships (PPPs), temporary organizations are more agile and adaptable, focusing on unique tasks to drive innovation. Quality in PPPs balances client satisfaction with efficient resource use, requiring open communication, flexibility, and a holistic approach to quality. Rijkswaterstaat exemplifies commitment to innovation, sustainability, and stakeholder engagement through strategic target-setting and transparent cost management.

(SUB)QUESTION 4: *How do people indicators within different PPP structures create innovation through project management?*

In project management, Rijkswaterstaat employs Integral Project Management (IPM) to optimize internal and external collaboration. IPM assigns clear roles to team members across five processes: Project Management, Project Control, Environmental Management, Technical Management, and Contract Management. This structured approach fosters innovation through proactive collaboration and addresses cultural barriers to innovation. Effective leadership and equitable collaboration are crucial for overcoming resistance to change and ensuring successful innovation. Engaging diverse stakeholders early and maintaining continuous learning and conflict resolution mechanisms are essential for aligning interests and achieving project goals. Multidisciplinary teams enhance problem-solving by balancing technical and broader societal perspectives, and a culture of trial and error is vital for fostering innovation.

(SUB)QUESTION 5: *How do performance indicators within different PPP structures create innovation through project management?*

Tthe various dimensions of performance, emphasizing the critical importance of strategic planning, knowledge sharing, and sustainability practices. Strategies Between Project Phases highlighted the need for a more integrated approach to managing transitions

between project phases. By leading in innovation, the InnovA58 team has set a standard in the sector, earning recognition and positive feedback that underscores the effectiveness and inspiration of their methods. Innovation on Sustainability Practices showcased the ambitious goals of achieving net-zero emissions and a complete circular economy by 2030. The Maasvlakte Two wind turbine project and the electrification of construction equipment at the A20/A15 Blankenburgverbinding illustrate significant strides towards sustainability. However, the journey towards true sustainability involves a comprehensive shift in operational practices and material sourcing, underscoring the complexity and long-term nature of these goals. Complexity discussed the inherent complexities in achieving sustainable and innovative infrastructure. The cultural shift required within organizations like Rijkswaterstaat highlights the balance between immediate operational needs and long-term sustainability objectives. By recognizing and managing complexity, the project can effectively navigate the challenges of innovation and sustainability.

5.1.2 | MAIN RESEARCH QUESTION

Based on chapter one to four and the answers to the secondary research questions, an answer to the main research question is formulated. The main research question is: *How can infrastructural projects optimize innovation within public-private partnership arrangements, while creating some conditions to enhance innovation realization?*

Infrastructural projects can optimize innovation within public-private partnership (PPP) arrangements through strategic approaches and conditions that address potential obstacles based on the following conditions. For a connection of results with these conditions, refer to Appendix 4.

CONDITION 1 **Sustainability Integration**

Embedding sustainability principles into the core of infrastructural projects demonstrates a commitment to environmental stewardship and long-term viability. Goals such as achieving Net Zero Emissions and transitioning to a Circular Economy guide innovation efforts towards renewable energy sources, sustainable materials, and waste reduction strategies. Innovations that prioritize sustainability not only enhance project resilience and mitigate environmental impacts but also challenge regulatory requirements and societal expectations. Integrating sustainability considerations into project design and decision-making ensures that innovations contribute to both project success and broader sustainability goals.

CONDITION 2 **Integrated Process Management**

Implementing a holistic process management approach ensures that innovation is seamlessly integrated throughout all project phases. From initial planning and design to execution, monitoring, and maintenance, each phase should be strategically aligned with goals. Documenting and managing forward-thinking targets between project phases is critical to maintaining continuity and momentum in innovation initiatives. Integrated project collaboration among stakeholders, promotes knowledge sharing, and facilitates coordinated efforts to overcome challenges that may impede innovation realization.

CONDITION 3 Knowledge Sharing and Collaboration

Emphasizing knowledge sharing and collaboration is essential for fostering a culture of innovation within PPP infrastructural projects after project closure. Project teams should actively exchange insights, best practices, and lessons learned with internal stakeholders, external partners, and industry peers. Together by leveraging Effective pre-planning collective expertise, projects can accelerate innovation adoption, mitigate risks, and capitalize on emerging opportunities. Collaboration also extends beyond traditional boundaries to include open innovation practices, engaging stakeholders such as academia, research institutions, and technology providers to co-create innovative solutions.

CONDITION 4 Strategic Leadership and Vision

Effective leadership is foundational to optimizing innovation within infrastructural projects. Project leaders should articulate a ownership of the innovation that aligns innovation goals with broader project objectives and societal needs. Leadership extends beyond setting goals to actively championing innovation, fostering a culture where creativity and experimentation are valued. Leaders must empower project teams to explore unconventional solutions, manage risks, and learn from setbacks. By providing strategic direction and unwavering support, leaders create an environment conducive to breakthrough innovations.

CONDITION 5 Monitoring and Evaluation

Establishing robust monitoring and evaluation mechanisms is crucial for assessing the progress, impact, and effectiveness of innovation initiatives. Metrics should be tailored to capture both short-term outcomes, such as cost savings and efficiency gains, and long-term impacts, including environmental sustainability and societal benefits. The organization's present-focused culture, safety concerns, and strict regulations can hinder innovation by setting unrealistic standards. Continuous evaluation enables project teams to identify successful strategies, address challenges promptly, and refine innovation approaches based on real-time data and stakeholder feedback.

By adhering to these strategic approaches and conditions, infrastructural projects within public-private partnerships can optimize innovation, overcome obstacles, and achieve sustainable development goals. Sustainability integration, integrated project management, knowledge sharing and collaboration, strategic leadership and vision and robust monitoring collectively empower projects to innovate successfully, deliver value to stakeholders, and contribute positively to societal and environmental well-being.

5.2 | DISCUSSION

The observation that innovation has the potential for radical change within specific contexts highlights an important tension: while some projects may achieve transformative results, the broader operational framework of many organizations, including Rijkswaterstaat, is geared towards maintaining existing processes and managing incremental improvements. This focus on stability and continuity limit the scope and scale of innovation efforts. For instance, in many large organizations, innovation is constrained by established protocols and risk

aversion, which prioritise predictable outcomes over exploratory, disruptive changes (Himmel & Siemiatycki, 2017).

The research does not address how programs themselves impact innovation, which is a notable gap. Programs—comprising multiple projects and strategic initiatives—can provide a structured approach to fostering innovation by aligning resources, timelines, and objectives across various initiatives (Busscher et al., 2024). Programmatic innovation management could create synergies and leverage insights from different projects, but this requires a strategic framework that integrates innovation goals with program execution.

Other critical aspects of project management, such as risk management, scope definition, capacity efforts and international influences, also play significant roles in shaping innovation outcomes (Russel et al., 2006). Managing risks effectively can facilitate innovation by allowing for calculated experimentation and flexibility. Clearly defined scopes and objectives help in focusing efforts and resources, while international influences can introduce new ideas and best practices from diverse contexts. Design, portfolios, and political factors further complicate the innovation landscape, as they involve balancing competing priorities and navigating external pressures.

What we observe is a gradual shift in the system towards more sustainable practices, but this incremental change raises important questions. Can minor adjustments within the existing socio-economic framework lead to substantial systemic transformation? Adapting entrenched systems often results in modest changes that may not address the root causes of stagnation (Jänicke, 2008). The InnovA58 project illustrates that more profound, systemic changes are sometimes necessary to achieve significant innovation. This project demonstrates that breakthrough innovations often require foundational shifts in approach, mindset, and processes.

The challenge lies in balancing the need for incremental improvements with the pursuit of more radical changes (Warner, 2010). Organisations may need to explore new paradigms and strategies that go beyond incremental adjustments to stimulate substantial innovation (Jänicke, 2008). As evidenced by InnovA58, such endeavours may involve embracing new technologies, rethinking traditional methodologies, and challenging established norms. Ultimately, driving transformative innovation requires not just incremental adjustments but a willingness to undertake bold, pioneering changes that redefine the boundaries of possibility.

5.3 | REFLECTION

This chapter reflects on the research process, discussing what went well, what did not, and what can be learned from these research experiences. This research was characterised by a cyclical process, where previous steps were often revisited. This led to adjustments, especially in the early stages of the research process. Initially, it took much work to formulate a concrete research objective with corresponding research questions, which hindered the progress of the research. The difficulty in defining the research objective was due to my limited knowledge of PPP arrangements within project management and the vast amount of available information on the subject. It was challenging to absorb, understand, and organise this information, which took considerable time.

My personal experience with writing my master's thesis has been mixed. I had very positive experiences with the topic and data collection. However, processing the extensive literature and establishing the theoretical framework could have been more positive. Enhancing the framework for analysing innovation within PPP arrangements should be further researched. Forming an opinion or stance based on scientific literature was particularly difficult. A very positive experience during this research process was conducting the interviews and the data obtained from them. The interviews were interesting and highly educational, providing valuable insights and information that have significantly enriched my understanding of the subject.

Another aspect of this research is the representativeness of the respondents. As described in Chapter 3, respondents were selected from the three cases (public clients and private organisations). Initially, at least three respondents were supposed to represent each target group, but this was only sometimes possible due to time constraints. For future research, aim for a more representative selection of respondents by allocating more time for selection and conducting interviews. Due to the relatively small number of interviewees, the influence of an individual respondent is significant. To prevent a powerful influence of one respondent, the responses of all interviewees were compared with each other and compared with deskresearch.

These positive and negative research experiences have resulted in the current study, which explores innovation within three infrastructure projects in the Netherlands. This research, while exploratory, has the potential to be expanded to provide a more comprehensive understanding of the success factors of innovation in the Netherlands. Despite being an exploratory study, it provides good insight into the factors contributing to innovation success within infrastructure projects in the Netherlands. I am optimistic about its future expansion and continuation, and it holds potential for further research and discovery.

REFERENCES

Aagaard-Hansen, J. & Vang Johansen, M. (2008). Research ethics across disciplines. Anthropology today, 24(3), 15-19.

Aaltonen, K. *et al.* (2016) 'Stakeholder Dynamics during the Project Front-End: The Case of Nuclear Waste Repository Projects,' *Project Management Journal*, 46(6), pp. 15–41. https://doi.org/10.1002/pmj.21549.

Aaltola, K. (2017) 'PROJECT MANAGEMENT HANDBOOK,' *ResearchGate* [Preprint]. https://www.researchgate.net/publication/320101542_PROJECT_MANAGEMENT_HANDBOOK.

Abatecola, G., Breslin, D. and Kask, J. (2020) 'Do organizations really co-evolve? Problematizing co-evolutionary change in management and organization studies,' *Technological Forecasting and Social Change*, 155, p. 119964. https://doi.org/10.1016/j.techfore.2020.119964.

Aghion, P. and Tirole, J. (1994) 'The management of innovation,' *The Quarterly Journal of Economics*, 109(4), pp. 1185–1209. https://doi.org/10.2307/2118360.

Ackermann, F. and Eden, C. (2011) 'Strategic Management of Stakeholders: Theory and practice,' *Long Range Planning*, 44(3), pp. 179–196. https://doi.org/10.1016/j.lrp.2010.08.001.

Atlas.ti (2020). What is Atlas.ti? https://atlasti.com/product/what-is-atlasti/

Basu, R. and Wright, J.N. (2003) *Quality beyond six Sigma*, *Routledge eBooks*. https://doi.org/10.4324/9780080515502.

Baker, B.N., Murphy, D.C. and Fisher, D. (1988) 'Factors affecting project success,' *Project Management Handbook*, 2, pp. 902–919. https://doi.org/10.1002/9780470172353.ch35.

Ballast Nedam (2024). *Nieuwe technische kennis bij afzinken Blankenburgverbinding* https://www.ballast-nedam.nl/nieuwsoverzicht/2024/nieuwe-technische-kennis-dankzij-onbekend-fenomeen-bij-afzinken-tunnelelement-blankenburgverbinding#:~:text=Technisch%20hoogtepunt%3A%20een%20afzinktunnel%20van,leverde%20waardevolle%20nieuwe%20kennis%20op.

Breslin, D. (2015) 'What evolves in organizational co-evolution?,' *Journal of Management & Governance*, 20(1), pp. 45–67. https://doi.org/10.1007/s10997-014-9302-0.

Beise, M. and Rennings, K. (2005) '*Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations,*' Ecological Economics, 52(1), pp. 5–17. https://doi.org/10.1016/j.ecolecon.2004.06.007.

Busscher, T. et al. (2024) Programmamanagement bij Rijkswaterstaat: State of the Art in Theorie en Praktijk. https://research.rug.nl/files/884766763/2024_Rijkswaterstaat_Busscher_Joustra_Posthumus_Verweij_.pdf.

Busse, R. (2018) 'De barrieres en kansen voor circulaire innovatie in de bouwsector' https://frw.studenttheses.ub.rug.nl/1445/1/Richard_Busse_.pdf

Chametzky, B. (2016) 'Coding in classic grounded theory: I've done an interview; now what?,' Sociology Mind, 06(04), pp. 163–172. https://doi.org/10.4236/sm.2016.64014.

De Groot, B., Leendertse, W. and Arts, J. (2022) 'Co-Evolution of Organizations in Infrastructure Planning: The role of Communities of Practice as windows for Collective learning across Project-Oriented Organizations,' *Administration & Society*, 54(7), pp. 1328–1356. https://doi.org/10.1177/00953997221100379.

De Roo, G., Rauws, W. and Zuidema, C. (2020) 'Rationalities for adaptive planning to address uncertainties,' in *Edward Elgar Publishing eBooks*. https://doi.org/10.4337/9781786439185.00011.

Calhoun, K.M. *et al.* (2002) 'Planning and re-planning in project and production scheduling,' *Omega*, 30(3), pp. 155–170. https://doi.org/10.1016/s0305-0483(02)00024-5.

Caloffi, A. *et al.* (2017) 'Public–private partnerships and beyond: Potential for innovation and sustainable development,' *Environment and Planning C: Politics and Space*, 35(5), pp. 739–745. https://doi.org/10.1177/2399654417711496.

Chahboun, L. (2021) 'Een learning history: Wat kunnen we leren van InnovA58?: een innovatieve wegverbreding of een wegverbreding met innovatie?' https://open.rijkswaterstaat.nl/publish/pages/37925/een_learning_history_wat_kunnen_we_leren_van_innova58_een_innovatieve_wegverbreding_of_een_wegve.pdf

Bezemer, D. (2023) Eerste tunneldeel Blankenburgverbinding afgezonken. https://www.cementonline.nl/eerste-tunneldeel-blankenburgverbinding-afgezonken.

Coffelt, T. A. (2018). ‘’Confidentiality and Anonymity of Participants’’, In: Allen, M., The Sage Encyclopedia of Communication Research Methods. 4th edition, Thousand Oaks, Sage Publications Inc. 228-230.

Crawford, L. *et al.* (2008) 'Governance and support in the sponsoring of projects and programs,' *Project Management Journal*, 39(1_suppl), pp. S43–S55. https://doi.org/10.1002/pmj.20059.

Demirel, H.Ç. *et al.* (2016) 'Flexibility in PPP contracts – Dealing with potential change in the pre-contract phase of a construction project,' *Construction Management and Economics*, 35(4), pp. 196–206. https://doi.org/10.1080/01446193.2016.1241414.

Dura Vermeer (2022). *‘Werken met een exoskelet op project A12 IJsselbruggen’* https://duravermeer.smarpshare.com/app.microblog/#/6220d27974ca9f00010bba95.

Dura Vermeer (2024a) *Dura Vermeer maakt gebruik van circulaire bitumen Roof2Road*. https://www.duravermeer.nl/nieuws/dura-vermeer-zet-in-op-circulaire-bitumen/.

Dura Vermeer (2024b) *De verbinding.* Magazine. P 8-12. https://www.duravermeer.nl/media/5honmwic/de-zomer-verbinding-2021.pdf

Eskerod, P. and Jepsen, A.L. (2016) *Project stakeholder management*, *Routledge eBooks*. https://doi.org/10.4324/9781315245881.

Eversdijk, A. and Korsten, A.F.A. (2015) 'Motieven en overwegingen achter publiek-private samenwerking,' *Beleidsonderzoek Online* [Preprint]. https://doi.org/10.5553/beleidsonderzoek.000515.

Flyvbjerg, B. (2006) 'Five misunderstandings about Case-Study research,' *Qualitative Inquiry*, 12(2), pp. 219–245. https://doi.org/10.1177/1077800405284363.

Flyvbjerg, B. (2011) 'Case study,' *ResearchGate* [Preprint]. https://www.researchgate.net/publication/235953309_Case_Study.

Gareis, R., Huemann, M. and Martinuzzi, R.-A. (2011) *What can project Management learn from considering sustainability principles?* https://research.wu.ac.at/en/publications/what-can-project-management-learn-from-considering-sustainability-6.

Garvin, D., (1984), ‘*What does product quality really mean?’* Sloan Management Review, 25(2)

Geraldi, J. and Söderlund, J. (2018) 'Project studies: What it is, where it is going,' *International Journal of Project Management*, 36(1), pp. 55–70. https://doi.org/10.1016/j.ijproman.2017.06.004.

Gori, G.F., Lattarulo, P. and Mariani, M. (2017) 'Understanding the procurement performance of local governments: A duration analysis of public works,' *Environment and Planning C: Politics and Space*, 35(5), pp. 809–827. https://doi.org/10.1177/0263774x16680109.

Hassard, J., *Aspects of time in organization, Human Relations* (1991), Vol. 44, No. 2, pp. 105-125.

Hakkers (2023) *‘hybride aandrijfsysteem maakt emissieloos werken haalbaar.’* https://www.bouwmachines.nl/59493/hybride-aandrijfsysteem-maakt-emissieloos-werken-haalbaar.

van Heeren, B., (2010) *‘Het vijftal van Rijkswaterstaat’* Onderzoeksrapportage. https://open.rijkswaterstaat.nl/publish/pages/154847/het_vijftal_van_rijkswaterstaat.pdf

Hennink, M., Hutter, I. and Bailey, A. (2020) Qualitative research methods. SAGE Publications Limited.

Hodge, G.A., Greve, C. and Boardman, A.E. (2010) *International Handbook on Public-Private Partnership*. Edward Elgar Publishing.

Hodge, G. and Greve, C. (2019) *The logic of Public–Private partnerships*. The enduring Interdependency of Politics and Markets. https://doi.org/10.4337/9781784716691.

Hoppe, E. and Schmitz, P. (2013) *Contracting under Incomplete Information and Social Preferences: An Experimental Study*. https://econpapers.repec.org/RePEc:oup:restud:v:80:y:2013:i:4:p:1516-1544.

Hook, J.N. et al. (2007) 'Structured and semistructured interviews,' in SAGE Publications, Inc. eBooks, pp. 24–37. https://doi.org/10.4135/9781412982733.n3.

Husband, G. (2020) 'Ethical data collection and recognizing the impact of Semi-Structured interviews on research respondents,' Education Sciences, 10(8), p. 206. https://doi.org/10.3390/educsci10080206.

Himmel, M.E. and Siemiatycki, M. (2017) 'Infrastructure public–private partnerships as drivers of innovation? Lessons from Ontario, Canada,' *Environment and Planning C: Politics and Space*, 35(5), pp. 746–764. https://doi.org/10.1177/2399654417701430.

Hueskes, M., Verhoest, K. and Block, T. (2017) 'Governing public–private partnerships for sustainability,' *International Journal of Project Management*, 35(6), pp. 1184–1195. https://doi.org/10.1016/j.ijproman.2017.02.020.

Hwang, B. and Low, L.K. (2012) 'Construction project change management in Singapore: Status, importance and impact,' *International Journal of Project Management*, 30(7), pp. 817–826. https://doi.org/10.1016/j.ijproman.2011.11.001.

Jänicke, M. (2008) 'Ecological modernisation: new perspectives,' *Journal of Cleaner Production*, 16(5), pp. 557–565. https://doi.org/10.1016/j.jclepro.2007.02.011.

Jänicke, M. and Jacob, K. (2004) 'Lead Markets for Environmental Innovations: A new role for the Nation State,' *Global Environmental Politics*, 4(1), pp. 29–46. https://doi.org/10.1162/152638004773730202.

Jugdev, K. and Müller, R. (2005) 'A Retrospective look at our Evolving Understanding of Project Success,' *Project Management Journal*, 36(4), pp. 19–31. https://doi.org/10.1177/875697280503600403.

Kaplan, R. S. and D. P. Norton. 2004. Measuring the strategic readiness of intangible assets. *Harvard Business Review* (February): 52-63.

Khamooshi, H. and Cioffi, D.F. (2013) 'Uncertainty in task duration and cost estimates: fusion of probabilistic forecasts and deterministic scheduling,' *Journal of Construction Engineering and Management*, 139(5), pp. 488–497. https://doi.org/10.1061/(asce)co.1943-7862.0000616.

Koenen, I. (2018) *topvrouw-rijkswaterstaat-baalt-van-trage-innovaties-tempo-moet-omhoog*. https://www.cobouw.nl/265094/topvrouw-rijkswaterstaat-baalt-van-trage-innovaties-tempo-moet-omhoog.

Kodwo, A.-A. and Allotey, S.E. (2014) 'Cost overruns in building construction projects: a case study of a Government of Ghana project in Accra,' *Developing Country Studies*, 4(24). https://www.researchgate.net/publication/348845167_Cost_Overruns_in_Building_Construction_Projects_A_Case_Study_of_a_Government_of_Ghana_Project_in_Accra.

Klijn, E.H. and Koppenjan, J. (2015) *Governance networks in the public sector*, *Routledge eBooks*. https://doi.org/10.4324/9781315887098.

Kluitenberg, R. (2020) *Korte introductie twee-fasen-proces*. https://www.ibr.nl/korte-introductie-twee-fasen-proces/#:~:text=Wat%20houdt%20het%20twee%2Dfasen,perspectief%20op%20een%20betere%20risicoverdeling.

Koppenjan, J.F.M., Klijn, E.H., Duijn, M., Klaassen, H.L., Van Meerkerk, I.F., Metselaar, S.A., Warsen, R. & Verweij, S. (2020). *Leren van 15 jaar DBFM-projecten bij RWS: Eindrapport.* Rijkswaterstaat en Bouwend Nederland

Krul, A. (2021). *Hoe voer je deskresearch uit?* Scribbr. https://www.scribbr.nl/onderzoeksmethoden/deskresearch/

Kwak, Y.H., Chih, Y. and Ibbs, C.W. (2009) 'Towards a comprehensive understanding of public private partnerships for infrastructure development,' *California Management Review*, 51(2), pp. 51–78. https://doi.org/10.2307/41166480.

Larsson, J. *et al.* (2022) 'Innovation outcomes and processes in infrastructure projects – a comparative study of Design-Build and Design-Build-Maintenance contracts,' *Construction Management and Economics*, 40(2), pp. 142–156. https://doi.org/10.1080/01446193.2021.2024864.

Lehtinen, J. and Aaltonen, K. (2020) 'Organizing external stakeholder engagement in inter-organizational projects: Opening the black box,' *International Journal of Project Management*, 38(2), pp. 85–98. https://doi.org/10.1016/j.ijproman.2019.12.001.

Lewis, M.K. (2021) *Rethinking public private partnerships*. Edward Elgar Publishing.

Lundin, R.A. and Söderholm, A. (1995) 'A theory of the temporary organization,' *Scandinavian Journal of Management*, 11(4), pp. 437–455. https://doi.org/10.1016/0956-5221(95)00036-u.

Loosemore, M. (2015) 'Building a new third construction sector through social enterprise,' *Construction Management and Economics*, 33(9), pp. 724–739. https://doi.org/10.1080/01446193.2015.1090006.

Maltzman, R. and Shirley, D. (2010) *Green Project Management*. CRC Press.

Milieufederatie (2018) *'Vertraging voor aanleg Blankenburgtunnel'*. Natuur en Milieufederatie Zuid-Holland. https://milieufederatie.nl/nieuws/vertraging-voor-aanleg-blankenburgtunnel/.

Ministerie van Infrastructuur en Waterstaat (2022) *Grootste afzinkoperatie ooit - IeNw*. https://magazines.rijksoverheid.nl/ienw/ienwcontact/2022/05/grootste-afzinkoperatie-ooit.

Ministerie van Infrastructuur en Waterstaat (2023a) *Publiek-Private samenwerking*. https://www.rijkswaterstaat.nl/zakelijk/zakendoen-met-rijkswaterstaat/publiek-private-samenwerking.

Ministerie van Infrastructuur en Waterstaat (2023b) *'Blijf de transitie omarmen, ook als het moeilijk wordt.'* https://www.magazinesrijkswaterstaat.nl/zakelijkeninnovatie/2023/04/hoe-werken-transities.

Ministerie van Infrastructuur en Waterstaat (2023c) *'Tunnelelementen bouwen bij Damen Verolme Rotterdam - Blankenburgverbinding.'* https://www.blankenburgverbinding.nl/nieuws/2428922.aspx.

Ministerie van Infrastructuur en Waterstaat (2023d) Vertrouwen in vernieuwende manier van werken met de markt. https://www.magazinesrijkswaterstaat.nl/zakelijkeninnovatie/2023/04/casus-a12-ijsselbruggen

Ministerie van Infrastructuur en Waterstaat (2023e) *Gideonsbende werkt hard aan samenwerkingscultuur in infrasector.* https://www.magazinesrijkswaterstaat.nl/zakelijkeninnovatie/2023/04/houding-en-gedrag.

Ministerie van Infrastructuur en Waterstaat (2023f) *Transparantie blijft essentieel in samenwerking infrasector*. https://www.magazinesrijkswaterstaat.nl/zakelijkeninnovatie/2023/04/interview-jean-luc-beguin-en-job-dura.

Ministerie van Infrastructuur en Waterstaat (2023g) *'Blankenburgverbinding gestegen naar trede 4 op Veiligheidsladder'* https://www.blankenburgverbinding.nl/nieuws/2653894.aspx?t=Blankenburgverbinding-gesteg en-naar-trede-4-op-Veiligheidsladder.

Ministerie van Infrastructuur en Waterstaat (2024a) 'MIRT overzicht 2024' https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2023/09/19/mirt-ove rzicht-2024/mirt-overzicht-2024.pdf

Ministerie van Infrastructuur en Waterstaat (2024b) *NOVA*. https://www.rijkswaterstaat.nl/over-ons/onze-organisatie/organisatiestructuur/corporate-dienst/nova.

Mitchell, R.H., Agle, B.R. and Wood, D.J. (1997) 'Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts,' *Academy of Management Review*, 22(4), p. 853. https://doi.org/10.2307/259247.

Müller, R. and Turner, R. (2007) 'The influence of project managers on project success criteria and project success by type of project,' *European Management Journal*, 25(4), pp. 298–309. https://doi.org/10.1016/j.emj.2007.06.003.

Moore, W. E., Man, Time and Society (New York: Wiley, 1963).

Neef, M.R. *et al.* (2017) *Wegwijs in living labs in infrastructuur en ruimtelijke planning: Een theoretische en empirische verkenning*. https://research.rug.nl/nl/publications/wegwijs-in-living-labs-in-infrastructuur-en-ruimtelijke-pla nning-.

Oosterveld, B., (2023) Duurzaam asfalt grootschalig toegepast op A2 en A12 | Infrasite. https://www.infrasite.nl/aanbesteden/2023/01/24/duurzaam-asfalt-grootschalig-toegepast-op-a 2-en-a12/.

van Ooijen, T. (2024) 'BAAK loopt vertraging tunnelbouw volledig in,' Al Het Nieuws Uit Rozenburg, 13 June. https://www.rodi.nl/rozenburg/nieuws/398816/baak-loopt-vertraging-tunnelbouw-volledig-in.

Palinkas, L.A. *et al.* (2013) 'Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research,' *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), pp. 533–544. https://doi.org/10.1007/s10488-013-0528-y.

Parasuraman, A., Zeithamel, V. and Berry, L., (1985), A conceptual model of service quality, Journal of Marketing, 49(Fall), 41-50

Patanakul, P., Iewwongcharoen, B. and Milosevic, D. (2010) 'An Empirical Study on the use of Project Management Tools and Techniques across Project Life-Cycle and their Impact on Project Success,' *Journal of General Management*, 35(3), pp. 41–66. https://doi.org/10.1177/030630701003500304.

Petersen, O.H. (2019) 'EVALUATING THE COSTS, QUALITY, AND VALUE FOR MONEY OF INFRASTRUCTURE PUBLIC-PRIVATE PARTNERSHIPS: A SYSTEMATIC LITERATURE REVIEW,' *Annals of Public and Co-operative Economy*, 90(2), pp. 227–244. https://doi.org/10.1111/apce.12243.

Project Management Institute (2021) *The Project Management and a Guide to the Project Management Body of Knowledge (PMBOK Guide).* 7th edn. EAN: 9781628256642

Projectteam InnovA58 (2019) *Wegverbreding A58 en stikstof - InnovA58*. https://www.innova58.nl/Nieuws/1455508.aspx.

Price, A.D.F. and Chahal, K. (2006) 'A strategic framework for change management,' *Construction Management and Economics*, 24(3), pp. 237–251. https://doi.org/10.1080/01446190500227011.

Pinto, J.K. (2016) *Project management: Achieving Competitive Advantage, Global Edition*.
Radicic, D., Pugh, G. and Douglas, D. (2018) 'Promoting cooperation in innovation ecosystems: evidence from European traditional manufacturing SMEs,' *Small Business Economics*, 54(1), pp. 257–283. https://doi.org/10.1007/s11187-018-0088-3.
Rijkswaterstaat (2016) 'Tracébesluit/ MER Blankenburgverbinding'. https://blankenburgverbinding.nl/bibliotheek_/bibliotheek+planstudie/handlerdownloadfiles.ashx?idnv=494702
Rijkswaterstaat (2019) *Toekomstige Opgave Rijkswaterstaat: Perspectief op de uitdagingen en verbetermogelijkheden in de GWW-sector*. https://www.pianoo.nl/sites/default/files/media/documents/Rapport-toekomstige-opgave-rijkswaterstaat-mei2019.pdf.
Rijkswaterstaat (2020). *Op weg naar een Vitale Infrasector: Plan van Aanpak en Aanzet tot een Gezamenlijk Transitieproces*. Rijkswaterstaat
Rijkswaterstaat (2023). Toepassing 2-fasen aanpak bij Rijkswaterstaat projecten. Handreiking. https://www.vitaleinfrasector.nl/PageByID.aspx?sectionID=233831&contentPageID=2475263
Rijkswaterstaat (2024a) *Duurzame infrastructuur*. https://rwsinnoveert.nl/focuspunten/duurzame-infrastructuur/.
Rijkswaterstaat (2024b) *BlankenburgVerbinding*/ https://www.blankenburgverbinding.nl/default.aspx.
Rijkswaterstaat (2024c) *A12: renovatie IJsselbruggen*. https://www.rijkswaterstaat.nl/wegen/projectenoverzicht/a12-renovatie-ijsselbruggen.
Rijkswaterstaat (2024d) *InnovA58: unieke testomgeving voor duurzame innovaties - InnovA58*. https://www.innova58.nl/default.aspx.
Rijkswaterstaat (2024e). Plattegrond innovatieterrein van living lab InnovA58https://innova58.nl/PageByID.aspx?sectionID=136733&contentPageID=2782794
Rijkswaterstaat (2024f). *Hoeve Nieuw Zwanenburg (biobased bouwen) - InnovA58*. https://www.innova58.nl/innovaties/2713439.aspx?t=Hoeve-Nieuw-Zwanenburg-biobased-bouwen.
Rijkswaterstaat (2024g) Roadmaps. https://rwsinnoveert.nl/focuspunten/roadmaps/#:~:text=Rijkswaterstaat%20werkt%20voor%20de%20innovatieopgaven,belangrijke%20of%20trekkende%20rol%20heeft.
Rijkswaterstaat (2024h) *Blankenburgverbinding gestegen naar trede 4 op Veiligheidsladder - Blankenburgverbinding*. https://www.blankenburgverbinding.nl/nieuws/2653894.aspx?t=Blankenburgverbinding-gestegen-naar-trede-4-op-Veiligheidsladder.
Roberts, D.J. and Siemiatycki, M. (2015) 'Fostering meaningful partnerships in public–private partnerships: innovations in partnership design and process management to create value,' *Environment and Planning C Government and Policy*, 33(4), pp. 780–793. https://doi.org/10.1068/c12250.
Robertson, J., Caruana, A. and Ferreira, C. (2023) 'Innovation performance: The effect of knowledge-based dynamic capabilities in cross-country innovation ecosystems,' *International Business Review*, 32(2), p. 101866. https://doi.org/10.1016/j.ibusrev.2021.101866.
Russell, A.D., Tawiah, P. and De Zoysa, S. (2006) 'Project innovation - a function of procurement mode?,' *Canadian Journal of Civil Engineering*, 33(12), pp. 1519–1537. https://doi.org/10.1139/l06-077.
Roumboutsos, A. and Saussier, S. (2014) 'Public-private partnerships and investments in innovation: the influence of the contractual arrangement,' *Construction Management and Economics*, 32(4), pp. 349–361. https://doi.org/10.1080/01446193.2014.895849.
Satheesh, S.A. *et al.* (2023) 'Enabling boundary spanners in public–private collaboration: The impact of support and role autonomy on reducing role stress,' *Public Administration* [Preprint]. https://doi.org/10.1111/padm.12927.
Salmons, J. (2011). Designing and Conducting research with online interviews. Sage Methods.
Söderlund, J. (2004) 'Building theories of project management: past research, questions for the future,' *International Journal of Project Management*, 22(3), pp. 183–191. https://doi.org/10.1016/s0263-7863(03)00070-x.
Smartwayz.nl (2022). *12e Voortgangsrapportage SmartwayZ.NL. https://www.smartwayz.nl/media/2614/smartwayznl-voortgangsrapportage-12_1-jan-1-juli-2022.pdf*
Stead, J.G. and Stead, W.E. (2014) *Sustainable Strategic Management*, *Routledge eBooks*. https://doi.org/10.4324/9781315700533.

Streatfield, P.J. (2003) *The paradox of control in organizations*, *Routledge eBooks*. https://doi.org/10.4324/9780203361504.

Sun, M. and Meng, X. (2009) 'Taxonomy for change causes and effects in construction projects,' *International Journal of Project Management*, 27(6), pp. 560–572. https://doi.org/10.1016/j.ijproman.2008.10.005.

van Sluis., J. (2024) *Nieuwsbrief 10: nieuwe innovaties én een inspirerend zusterproject - InnovA58*. https://www.innova58.nl/Nieuws/2650612.aspx?t=Nieuwsbrief-10-nieuwe-innovaties-en-een-inspirerend-zusterproject.

Tawiah, P.A, and Russell, A.D. (2008) 'Assessing infrastructure project innovation potential as a function of procurement mode,' *Journal of Management in Engineering*, 24(3), pp. 173-186.

Teisman, G.R. and Klijn, E. (2002) 'Partnership arrangements: governmental rhetoric or governance scheme?,' *Public Administration Review*, 62(2), pp. 197–205. https://doi.org/10.1111/0033-3352.00170.

Turner, J.R., Grude, K.V. and Thurloway, L. (1996) *The project manager as change agent: Leadership, Influence and Negotiation*. McGraw-Hill Companies.

Turner, J.R. and Keegan, A. (2001) 'Mechanisms of governance in the project-based organization:,' *European Management Journal*, 19(3), pp. 254–267. https://doi.org/10.1016/s0263-2373(01)00022-6.

Turner, J.R. and Müller, R. (2003) 'On the nature of the project as a temporary organization,' *International Journal of Project Management*, 21(1), pp. 1–8. https://doi.org/10.1016/s0263-7863(02)00020-0.

Turner, R. (2016) *Gower Handbook of Project Management*, *Routledge eBooks*. https://doi.org/10.4324/9781315585741.

Van den Hurk, M. (2018) 'Public–Private partnerships: Where do we go from here? A Belgian perspective,' *Public Works Management & Policy*, 23(3), pp. 274–294. https://doi.org/10.1177/1087724x18757534.

de Vaan, J., (2024). *'Rond historische Oirschotse hoeve groeien straks nieuwe bruggen en viaducten voor Rijkswaterstaat.'* Algemeen Dagblad https://www.ad.nl/oirschot/rond-historische-oirschotse-hoeve-groeien-straks-nieuwe-bruggen-en-viaducten-voor-rijkswaterstaat~a4472f71/?cb=cdcb9007-0f10-407a-9384-899e6ab250f8&%3Bauth_rd=1&auth_rd=1.

Van der Wal, J. (2021) 'Innovation upscaling and citizen participation: two conflicting elements of the living lab concept?' https://sweet-lantern.ch/wp-content/uploads/2024/02/Van-der-Wal-J.-2021.-Innovation-upscaling-and-citizen-participation-two-conflicting-elements-of-the-living-lab-concept.pdf

Van den Hof, J. (2018). De enige echte publieke-private samenwerking. In M. Sanders (red.), *Publiek-private samenwerking: kunst van het evenwicht* (p.131-144). Boom Bestuurskunde. ISBN 9789462367425

Verweij, S. (2020) 'Book Review: Public–private partnerships for infrastructure development: Finance, stakeholder alignment, governance,' *Public Works Management & Policy*, 25(3), pp. 333–336. https://doi.org/10.1177/1087724x20918443.

Verweij, S. (2023) *De meerwaarde van Publiek-Private Samenwerking. Een vergelijkende analyse van Nederlandse infrastructuurprojecten*. ISBN: 978-94-6236-344-1

Verweij, S., Loomans, O. and Leendertse, W. (2019) 'The role of the public partner in Innovation in Transport Infrastructure PPPs: A qualitative comparative analysis of nine Dutch DBFM projects,' *Public Works Management & Policy*, 25(1), pp. 5–32. https://doi.org/10.1177/1087724x19847215.

Visser, W. T. (2002) 'Sustainability reporting in South Africa,' *Corporate Environmental Strategy*, 9(1), pp. 79–85. https://doi.org/10.1016/s1066-7938(01)00157-9.

Vitale Infrasector (2021) Twee-fasen proces bij renovatie IJsselbruggen: tijd, geld, scope én plezier. https://www.vitaleinfrasector.nl/nieuws/2175508.aspx.

Warner, K. (2010) 'Global environmental change and migration: Governance challenges,' Global Environmental Change, 20(3), pp. 402–413. https://doi.org/10.1016/j.gloenvcha.2009.12.001.

Wheeler, D. and Sillanpa¨A, M. (1998) 'Including the stakeholders: The business case,' *Long Range Planning*, 31(2), pp. 201–210. https://doi.org/10.1016/s0024-6301(98)00004-1.

Wild, R. (2002) *Operations Management*. Cengage Learning Business Press.

Wright, J.N. and Race, P. (2004) *The management of service operations*. Cengage Learning EMEA.

Wysocki, R.K. and McGary, R. (2003) *Effective project management: Traditional, Adaptive, Extreme*. John Wiley & Sons.

Yescombe, E.R. (2007) *Public-private partnerships: Principles of Policy and Finance*. Butterworth-Heinemann.
Yin. K., (2014). Case Study Research Design and Methods (5th ed.).,' *Canadian Journal of Program Evaluation*, 30(1), pp. 108–110. https://doi.org/10.3138/cjpe.30.1.108.

APPENDIX 1: Interview guide (in Dutch)

Duur:
Geïnterviewde:
Datum en tijd:

Bedankt dat u de tijd hebt genomen om aan dit interview deel te nemen. Het zal ongeveer 60 minuten duren. Door de vragen te beantwoorden, helpt u mee aan mijn onderzoek naar innovatie bij PPS-projecten.

In het kort heeft de onderzoek de volgende hoofdvraag: "*Hoe kunnen infrastructurele projecten innovatie binnen PPS-overeenkomsten optimaliseren, en tegelijkertijd obstakels te overwinnen die de realisatie van innovatie belemmeren?*"

Met uw toestemming worden de interviews opgenomen om de aandacht vast te houden tijdens het interview en achteraf te controleren of alles goed is neergezet. Deze procedure wordt gebruikt om de antwoorden van de geïnterviewde dubbel te verifiëren. Gegevens zullen worden bewaard op de Google Drive van de Rijksuniversiteit, die bereikbaar is via een beveiligde computer of bestand. Opnames worden na 3 weken verwijderd en transcripties zijn anoniem. Na het interview worden alle persoonlijke gegevens, zoals de naam van de geïnterviewde, verwijderd. De opname zal worden getranscribeerd en bij aanvraag kunnen de resultaten van het onderzoek gedeeld worden met de geïnterviewde.

De respondent tekent voor deelname, maar kan op elk moment het interview beëindigen. De toestemming wordt alleen gebruikt om te bevestigen dat de respondent actief heeft deelgenomen aan dit onderzoek. Alle deelnemers mogen het onderzoek op elk moment verlaten.

Openingsvraag

1. Kunt u iets vertellen over uw ervaring met het bevorderen van innovatie binnen infrastructuurprojecten?

Tijdens het interview wordt er consistent gevraagd naar concrete voorbeelden die dienen als illustratie en verheldering van de gebeurtenissen binnen het project.

Taak:

1. Welke specifieke innovatieve oplossingen worden overwogen of geïmplementeerd in het infrastructuurproject?
2. Welke strategieën worden toegepast om ervoor te zorgen dat vernieuwende oplossingen op een efficiënte manier worden geïntegreerd in het project?
3. Kunt u voorbeelden geven van innovatieve oplossingen die succesvol zijn geïmplementeerd in vergelijkbare projecten?

Team:

1. Welke partij, de publieke of de private partner, neemt over het algemeen het voortouw bij het bevorderen van innovatie?
2. Hoe wordt de rolverdeling binnen een team doorgaans gestructureerd om innovatie te bevorderen?
3. Welke tactieken worden gebruikt om het team te stimuleren bij het genereren van innovatieve ideeën?
4. Hoe gaat u om met conflicten of meningsverschillen binnen het team die mogelijk innovatie kunnen belemmeren?

Tijd:

1. Hoe beïnvloedt de projectplanning het vermogen om te innoveren binnen de publiek-private samenwerking?
2. Welke strategieën zijn er in het verleden gebruikt om ervoor te zorgen dat tijdsbeperkingen de kwaliteit of creativiteit van innovatieve oplossingen niet verminderd?
3. Hoe prioriteert u innovatie naast andere projectmijlpalen en deadlines?

Transitie:

1. Hoe beheerde u overgangen of veranderingen in het project die het innovatieproces mogelijk kunnen beïnvloeden?
2. Welke maatregelen werden genomen om ervoor te zorgen dat de overgang tussen projectfasen soepel verloopt zonder de voortgang van innovatieve initiatieven te belemmeren?
3. Hoe beoordeelt u de impact van veranderingen of overgangen op de algehele innovatiedoelen van het project?

Afsluitende vragen:

1. Afsluitend, wat zijn de belangrijkste obstakels die de realisatie van innovatie in het infrastructuurproject binnen PPS belemmerde?
2. Heeft u nog iets verders toe te voegen of heeft u nog vragen?
3. Wilt u de transcriptie en/of de finale scriptie ontvangen?

Bedankt voor uw deelname

APPENDIX 2: Participation Agreement (in Dutch)

Onderzoeksproject: Master Scriptie Society, Sustainability and Planning | H.Raspe
Titel: Dynamiek van projectmanagement tijdens innovatie

Het doel van dit onderzoek is om te achterhalen hoe Publiek-Private Samenwerkingen (PPS) in de verschillende vormen van infrastructurele contracten innovatie kunnen bevorderen en wat er nodig is om deze ontwikkeling in Nederland in de toekomst te versterken.

Geachte heer/mevrouw,
Dank voor uw medewerking aan mijn onderzoek. Het interview zal fysiek, telefonisch of online plaatsvinden en ongeveer 60 minuten in beslag nemen, afhankelijk van of u een onderwerp extra zou willen toelichten. U kunt het interview ten alle tijden stopzetten of aangeven een vraag niet te willen beantwoorden. De geïnterviewde krijgt all anonimiteit tijdens het volledige onderzoek. Het interview zal worden opgenomen en op een later moment worden getranscribeerd. Wanneer gewenst, is het mogelijk om het transcript achteraf met u te delen zodat u het kunt controleren of feitelijke onjuistheden. De gegevens en het transcript van dit interview zullen vertrouwelijk worden behandeld en de audio opname zal na afloop van het onderzoek verwijderd worden. De scriptie zal worden opgenomen in het archief van de Rijksuniversiteit Groningen; het transcript zal hier niet in opgenomen worden.

<u>Met het ondertekenen van deze overeenkomst verklaar ik dat</u>:

1. Ik deze overeenkomst heb gelezen en begrijp waar het onderzoek over gaat.
2. Ik begrijp dat deelname aan dit onderzoek vrijwillig is en ik begrijp dat ik het recht heb mij terug te trekken uit dit onderzoek tot het moment dat het onderzoek is afgerond.
3. Ik begrijp dat ik niet verplicht ben om individuele vragen te beantwoorden.
4. Ik begrijp dat mijn deelname aan dit onderzoek vertrouwelijk is.
5. Zonder mijn toestemming mag geen materiaal dat mij kan identificeren gebruikt worden in de rapportage.
6. Ik begrijp dat de data van dit interview kan worden gebruikt in artikelen, hoofdstukken van boeken, gepubliceerd en ongepubliceerd werk en in presentaties.
7. Ik begrijp dat alle gedeelde informatie vertrouwelijk zal worden bewaard op de Google Drive van de Rijksuniversiteit, die bereikbaar is via een beveiligde computer of bestand. Opnames worden na 3 weken verwijderd en transcripties zijn anoniem.

Voor verdere vragen kunt u contact opnemen met:

Huub Raspe (student)
h.raspe@student.rug.nl

En

dr. Stefan Verweij (begeleider)
s.verweij@rug.nl

Graag de volgende punten JA of NEE invullen

Ik ga akkoord met de audio opname van dit interview	JA / NEE
Ik wens anoniem te blijven	JA /NEE
Mijn naam mag gebruikt worden in het onderzoek	JA / NEE
Pseudoniem wordt gebruikt in het onderzoek	JA / NEE

”Ik ga akkoord met de deelname aan dit interview en erken ontvangst van deze overeenkomst”

Naam onderzoeker: H.Raspe Datum:

Naam deelnemer: Datum:

Email adres (In het geval dat u het transcript van het interview wil ontvangen):

APPENDIX 3: Coding scheme

The table below shows the coding scheme used to analyse the interviews. Atlas.ti was used for the coding process. The ‘category’ column in the table corresponds to a code group in Atlas.ti. The ‘code’ column corresponds to the various codes that were part of the code group. The ‘definition’ briefly defines the code and provides some subcodes that were used in Atlas.ti.

Category	Code	Definition	Literature
Innovation	Innovative solutions	This subcode focuses on the specific practical, real-world technological advancements implemented in infrastructure projects.	Russell et al., 2006 Verweij, 2020
	Meaning of innovation	This subcode examines how innovation is conceptualised and understood within the context of infrastructure projects.	Russell et al., 2006
Proces	Impact of project planning	This subcode explores the role of planning in setting the stage for innovation by establishing clear objectives, aligning resources, and creating an environment that encourages creative problem-solving.	Khamooshi & Cioffi, 2013
	Endphase of projects:	This subcode covers how project teams manage the transition from active development to final delivery, ensuring that innovative practices are not lost but rather solidified and potentially transferred to future projects.	De Groot et al., 2022
	Initial phase	This subcode examines how decisions made in the initial phase can either enable or hinder innovative practices throughout the project lifecycle.	Demirel et al., 2016 Kodwo & Allotey, 2014
Project	Quality and price	This subcode explores how innovation is leveraged to enhance quality without compromising budgetary constraints. The focus is on understanding how innovative solutions are evaluated and implemented to optimise quality and cost-efficiency.	Turner, 2016
	Targets during projects	This subcode focuses on the specific goals and objectives set during the project lifecycle and how these targets drive innovation.	Himmel & Siemiatycki, 2017
People	Leadership	This subcode gives comparisons and contrasts in leadership styles and approaches between public and private partners within projects and their impact on innovation.	Caloffi et al., 2017
	Dealing with conflicts	This subcode explores methods and strategies for managing and resolving conflicts and disagreements within project teams.	Satheesh et al., 2023
	Concept of dare	This subcode explores the willingness of team members and leaders to take risks and try new, untested solutions as part of the innovation process.	Lundin, 2016
Performance	Innovation on sustainability	This subcode focuses on innovations that specifically target sustainability goals.	Aaltola, 2017
	Complexity	This subcode addresses the challenges and intricacies that arise due to the multifaceted nature of projects.	Radicic et al., 2020

APPENDIX 4: Alignment results with guidelines

Code	Living Labs		Two-phase approach		DBFM(O)		Guideline
Innovation	**++**		**+**		**+-**		
Innovative solutions	++	**Focus**: Sustainable construction next to A58 **Key Innovation:** Biobased building materials tested at Hoeve Nieuw Zwanenburg. **Benefit:** : Delays due to nitrogen issues allowed extensive innovation testing.	+	**Focus**: Road maintenance with sustainability. **Key Innovations:** Sustainable asphalt, worker-support exoskeletons, and hybrid generators. **Benefit**: Reduce CO2 emissions, improve safety, and enhance work efficiency.	+-	**Focus**: Overcoming unique challenges in construction. **Key Innovations**: Adjusted sinking system for unforeseen forces, construction reorganization to avoid delays. **Benefit**: Minimized disruptions to shipping and project timeline.	**Condition 1** **Sustainability Integration**
Meaning of innovation	++	Radical experimentation with biobased products, primarily led by public partners, with market involvement delayed due to high risks.	+	Encourages small, incremental innovations, allowing proven products to be further refined within the project.	+-	Uses proven techniques on a large scale, reflecting innovation through their combination rather than entirely new products	
Process	**++**		**+**		**-**		
Impact of planning	++	Emphasize forward-thinking, planning for future needs, and using natural cycles to structure innovation.	+	Reduce risks and uncertainties, fitting within standard contracts but allowing for flexibility	+-	Effective teamwork and communication help streamline innovation processes despite tight schedules	**Condition 2** **Integrated Process Management**
Endphase of projects	+	Continuous development of innovations due to no set end phase. Creating a knowledge-sharing ecosystem enhances the sustainability of innovations.	+	Innovations are supported through structured meetings and committees. Creating a knowledge-sharing ecosystem enhances the sustainability of innovations.	-	Without clear innovation goals, advancements are unlikely. Projects need management involvement and strategic planning to sustain innovations.	
Initial phase	++	Innovation is established	+	Allocates 1% of the contract sum	-	Lacks a dedicated innovation focus,	

		from the outset, involving the right expertise early and managing expectations to prevent dissatisfaction		for innovation at the beginning, fostering continuous improvement and future applicability		resulting in incremental improvements and limited experimentation due to delays and risk aversion	
Project	**+-**		**+**		**+-**		
Quality and price	+-	Meeting stringent sustainability goals, like circular materials, requires a shift in mindset and strategy.	+	Effective pre-planning and transparent communication are essential for managing complex projects.	+-	Unplanned challenges led to costly but necessary innovations that advanced to new industry standards.	**Condition 3** Knowledge Sharing and Collaboration
Targets during projects	+	Targets align with organizational goals and directives from key stakeholders, such as the Secretary-General of I&W	+	The project employs quarterly focus points to drive progress, motivate teams, and ensure alignment with overarching goals.	+-	The project balances innovation with practical constraints, emphasizing safety and sustainability.	
People	**+**		**+**		**+-**		
Leadership	+	Utilizes a collaborative model involving government, designers, entrepreneurs, researchers, and education to tackle societal challenges through interdisciplinary cooperation.	+	Emphasizes intensive collaboration between Rijkswaterstaat and private parties, with innovation roles integrated into the project team to ensure flexibility and active engagement.	+-	Highlights the importance of public-private partnerships, with private contractors often leading innovation and efficiency, driven by contractual obligations in DBFM projects.	**Condition 4** Strategic Leadership and Vision
Dealing with conflicts	+-	**Similar challenges:** Ownership of the innovation process within remains difficult. Innovation requires dedicated resources and early stakeholder alignment on shared goals to avoid conflicts. Structuring projects should follow goal alignment, with open dialogue and expert validation ensuring feasibility and collective benefits.					
Concept of dare	+	Innovation is seen as a continuous process of trial and error, with success coming from experimenting, learning from failures, and adapting strategies.	+-	The project team is open to trying new things but struggles with maintaining motivation and integrating innovation into the traditional project structure.	-	Success in innovation heavily relies on the intrinsic motivation of individuals and their willingness to take risks. While innovation can lead to significant breakthroughs, it also comes with the possibility of failure, requiring a high tolerance for	

						uncertainty and risk.	
Performance	**+**		**+-**		**+**		
Innovation on sustainability	+	The ambition to achieve a Circular Economy by 2030 is challenging but increasingly seen as achievable. Focus is shifting from merely offsetting carbon emissions to ensuring material circularity and using locally produced materials.	-	Two out of three innovations focus on sustainability, but there is a lack of detailed information on ongoing efforts and progress in these areas.	+	The goal of Net Zero Emissions by 2030 is ambitious but potentially attainable, with significant milestones like the Maasvlakte Two wind turbine project. Electrification of construction equipment and forward-thinking infrastructure planning are critical for advancing sustainability.	**Condition 5** **Monitoring and Evaluation**
Complexity	+	Forward-thinking in project management, highlighting strategic planning, knowledge sharing, and sustainability are key to performance in infrastructure innovation. There is a shift towards future-oriented strategies essential to capitalize on opportunities leading up to 2030, moving beyond immediate concerns. The organization's present-focused culture, safety concerns, and strict regulations can hinder innovation by setting unrealistic standards.					
TOTAL	**++**		**+**		**+-**		