

Promoting construction innovation

*A public infrastructure client's adaptation of
procurement and project management strategies*



Klara Granheimer

Construction Management and Building Technology

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Abstract

The construction and infrastructure sector is a significant contributor to global carbon emissions, necessitating substantial changes to support, what can be called, the sustainability transition. Public infrastructure clients are expected to lead this transition by promoting construction innovation, while engineering consultants, involved in the planning and design of projects, play a key role in supporting these efforts. Public procurement is widely recognized – politically – as a key strategic tool for promoting innovation and advancing sustainability, despite the project-based sector the role of project management remains largely overlooked. However, previous research highlights the importance of both procurement and project management strategies in promoting construction innovation. To effectively promote innovation, these strategies must be adapted to the specific characteristics of each project and should emphasize flexibility and involvement of actors. Despite the procurement and project management strategies' acknowledged significance, they are often treated as separate governance mechanisms within previous research, failing to account for their interconnected nature.

The purpose of this thesis is to increase the understanding of how a public infrastructure client promotes innovation towards the sustainability transition through adaptation of procurement and project management strategies in planning and design of new infrastructure. A longitudinal single-case study of the largest public infrastructure client in Sweden, the Swedish Transport Administration (Trafikverket), provides empirical insights.

The findings show that despite high expectations for public clients to promote innovation – especially in designated pilot projects – these projects are evaluated and managed through conventional linear processes, short-term goals, and paradigms. While innovation is acknowledged as a multidimensional concept requiring flexibility and collaboration, procurement and project management strategies remain predominantly control-oriented, emphasizing efficiency, problem-solving, and monitoring. This approach is found to limit the perceived promotion and impact of construction innovation in practice.

By problematizing the concept of comprehensive governance – integrating procurement and project management – this thesis highlights how public clients' reliance on detailed process control and the aligning with a hard paradigm, which is not well-suited to promote construction innovation. The research underscores the interdependence of procurement and project management strategies, advocating for a holistic governance perspective in construction management research and practice. Addressing this interconnection, both within research and practice, is crucial for developing strategies that effectively promotes construction innovation supporting the sustainability transition in public infrastructure projects.

Keywords: Construction innovation, Engineering consultant, Procurement strategy, Project management strategy, Hard paradigm, Soft paradigm, Infrastructure project

Sammanfattning

Bygg- och anläggningssektorn bidrar kraftigt till globala koldioxidutsläpp, vilket kräver omfattande förändringar för att driva en hållbarhetsomställning. Offentliga beställare förväntas leda denna omställning genom att främja innovation hos sina leverantörer. Teknikkonsulter, som är involverade i planering och projektering av projekt, spelar en nyckelroll i att stödja dessa insatser. Även om offentlig upphandling är politiskt erkänd som ett strategiskt verktyg för att främja hållbarhet, har projektledningens roll som ett kompletterande styrmedel i stort sett förbisetts. Tidigare forskning har dock betonat vikten av både upphandlings- och projektledningsstrategier för att främja innovation inom bygg- och anläggningssektorn. För att innovation effektivt ska kunna främjas måste dessa strategier anpassas till de specifika egenskaperna hos varje projekt och bör särskilt främja flexibilitet och samarbete. Trots upphandlings- och projektledningsstrategiernas erkända betydelse behandlas de ofta som separata styrningsmekanismer i tidigare forskning, vilket innebär att det faktum att de är sammanlänkade förbises.

Syftet med denna avhandling är att öka förståelsen för hur en offentlig beställare främjar innovation mot en hållbarhetsomställning genom anpassning av upphandlings- och projektledningsstrategier i planering och projektering av ny infrastruktur. En longitudinell fallstudie av Sveriges största offentliga beställare inom bygg- och anläggningssektorn, Trafikverket, har genomförts för att bidra med empirisk förståelse.

Resultaten visar att trots höga förväntningar på offentliga beställare att driva innovation – särskilt i utpekade pilotprojekt – utvärderas och hanteras dessa projekt genom standardprocesser, standardmål och paradigm. Även om innovation erkänns som ett flerdimensionellt koncept som kräver flexibilitet och samarbete, förblir upphandlings- och projektledningsstrategier huvudsakligen kontrollfokuserade, med betoning på effektivitet, problemlösning och granskning. Detta tillvägagångssätt begränsar det upplevda främjandet och effekten av innovation i praktiken.

Genom att problematisera konceptet om en övergripande styrning – som integrerar upphandling och projektledning – belyser denna avhandling hur

offentliga beställares beroende av detaljerad kontroll och anpassning till en linjär projektledningsmetod inte är väl lämpad för att främja innovation. Forskningen understryker sammanlänkningen mellan upphandlings- och projektledningsstrategier och förespråkar ett holistiskt styrningsperspektiv inom byggprojektledningsforskning och praktik. Att adressera denna sammanlänkning är avgörande för att utveckla strategier som effektivt stödjer innovation och långsiktiga hållbarhetsmål i offentliga infrastrukturprojekt.

Nyckelord: Innovation, Tekniska konsulter, Upphandlingsstrategi, Projektledningsstrategi, Hårt paradigm, Mjukt paradigm, Infrastrukturprojekt

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Being a PhD student has been a lot of fun! Staying curious and delving deep into a subject that has become increasingly interesting over time has been incredibly rewarding. Although there have been difficult moments when I doubted my own abilities, most of the time, I have felt fortunate to have this as my job. It is not without a hint of sadness that I write this acknowledgment. I am grateful to everyone who has made this period such an enjoyable experience.

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Appended papers

- Paper 1 **Granheimer, K.**, Karrbom Gustavsson, T., and Eriksson, P. E. (2022). Public procurement of engineering services: The influence of task characteristics on organisational control. *Engineering, Construction and Architectural Management*, 31(13), 208-222.
- Paper 2 **Granheimer, K.**, Eriksson, P. E., and Karrbom Gustavsson, T. (2022). Adaptability in Public Procurement of Engineering Services Promoting Carbon Reduction: An Organizational Control Perspective. *Sustainability*, 14(10), 5958.
- Paper 3 **Granheimer, K.**, Eriksson, P. E., and Hedgren, E. (2025). Innovation outcomes and processes in the planning and design phase of a public infrastructure project. *Construction Innovation*, 25(7), 1-22.
- Paper 4 **Granheimer, K.**, and Engström, S. (to be submitted). Sustainability transition stuck in the project management paradigm? Exploring project management in two Swedish infrastructure projects assigned to drive innovation. Working paper, to be submitted to a scientific journal.

Additional publications

Granheimer, K., Gustavsson, T. K., & Eriksson, P. E. (2021). Public procurement of engineering services: Governance and control mechanisms. *In Proceedings of the 37th Annual ARCOM Conference, ARCOM* (pp. 470-479).

Granheimer, K. (2020). Procurement of Engineering Consultants: A literature study. (Available online: 2025-04-02)
https://fudinfo.trafikverket.se/fudinfoexternwebb/Publikationer/Publikationer_006101_006200/Publikation_006175/Litteraturstudie.pdf

Granheimer, K. (2022). Public procurement of engineering services: Task characteristics, control modes and effects on adaptability. Licentiate thesis, KTH Royal Institute of Technology.

Granheimer, K., Gustavsson, T. K., and Hedgren, E. (2024). Innovation i konsultuppdrag: En fallstudie av TSK70. Research report. (Available online: 2025-04-02)
https://fudinfo.trafikverket.se/fudinfoexternwebb/Publikationer/Publikationer_008101_008200/Publikation_008136/7726_2024-02-05%20Delrapport-%20Innovation%20i%20konsultuppdrag.pdf

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INTRODUCTION

This chapter outlines the background and rationale for the research presented in this thesis. It begins with an overview of the background, leading to a description of the identified research problem. This is followed by the purpose of the research and the research questions addressed in the thesis. Finally, the chapter concludes with an outline of the thesis structure.

Background

The world faces escalating sustainability challenges, as highlighted by the United Nations General Assembly (2015). Among these, climate change is the most pressing issue due to its extensive and far-reaching impacts on society, both now and in the foreseeable future (IPCC, 2021). Business-as-usual will not suffice, as emphasized by the United Nations (2023, p. 3): 'We cannot simply continue with more of the same and expect a different result.' Instead, addressing this crisis requires contributions at multiple levels worldwide to drive a transition from a fossil-fuel-dependent society to one that is fossil-fuel-independent (United Nations, 2024). As the construction and infrastructure sector is increasingly recognized as a major contributor to global carbon emissions (HM Treasury, 2013; Huang et al., 2018), actors across the industry must implement substantial changes and rethink the entire system (United Nations, 2022), thereby enabling what can be referred to as a *sustainability transition* (Winch et al., 2023). This urgency is further reflected in the

growing body of research on sustainability issues in construction management, as highlighted by Araújo et al. (2020) in their comprehensive literature review.

When addressing grand societal challenges like climate change, innovation is essential (European Commission, 2022), serving as a mean to reach sustainability goals. In the construction and infrastructure sector, innovation activities typically occur within inter-organizational projects involving various actors, including public authorities and private companies, all interconnected through contractual relationships (Rose & Manley, 2012; Hedborg Bengtsson et al., 2018). Consequently, these projects create complex environments that require intense collaboration among the actors involved (Kuitert et al., 2019).

Even though, construction and infrastructure projects are regarded as complex, in general, (Atli & Krystallis, 2025), projects emphasizing innovation aimed at supporting the sustainability transition are considered even more complex, due to them requiring changes of an entire system (Winch et al., 2023). As public clients manage complex projects and are expected to contribute to the sustainability transition, they play a critical role in promoting radical (supplier-led) innovation (Kadefors et al., 2021; Lenderink et al., 2022), facilitating the adaptation of new technologies (Bosch-Sijtsema et al., 2021), and achieving long-term benefits (Lenderink et al., 2022; Swedish Climate Policy Council, 2024). While public clients are often described as promoters or drivers of innovation (Blayse & Manley, 2004; Bygballe & Ingemansson, 2014), engineering consultants are seen as creators of innovation in the planning and design (Rose & Manley, 2012; Hu et al., 2022), and contractors as implementers of innovation in the production (Rose & Manley, 2012).

In the planning and design of projects, engineering consultants typically engage in extensive exploration and iterative processes (Benabdellah et al., 2020), particularly during physical planning, where investigations are conducted in accordance with the democratic process to ensure that the client secures the right to expropriate land required for constructing, for example, a new road (Witzell, 2019). The work of engineering consultants stands in contrast to the more linear, execution-focused work of contractors (Mitchell et al., 2011; Williams et al., 2019). Although engineering consultants are considered particularly important for innovation in construction and infrastructure projects (Rose & Manley, 2012; Eriksson & Kadefors, 2015), clients seem to constrain their innovation potential. A study on

product innovation obstacles found that engineering consultants perceive clients as overly focused on short-term cost reduction rather than long-term benefits, such as lifecycle considerations (Rose et al., 2019).

Managing stakeholder interests is a crucial aspect of any infrastructure project (Olander & Landin, 2005). As construction projects grow in complexity, addressing a wider range of stakeholder concerns – such as biodiversity, circularity, and climate adaptation – becomes increasingly important, particularly in the context of the sustainability transition (Kuitert et al., 2019; Keusters et al., 2022). This shift makes engineering consultancy work more complex but also more essential (Keusters et al., 2022; 2024). Consequently, both public clients and engineering consultants play a critical role in enabling the construction and infrastructure sector to contribute to the sustainability transition through innovation. Public clients should actively promote innovation in ways that support engineering consultants, thereby advancing long-term sustainability goals. Given the inherent complexity of these projects and the substantial changes needed, adaptations in how public clients procure (Kadefors et al., 2021) and manage projects are necessary (Kivilä et al., 2017).

At a broader political level, public authorities – including public clients – are urged to use public procurement strategically to foster innovation aligned with societal goals (European Commission, 2021; OECD, 2023). In contrast, project management is less commonly recognized as a strategic tool for similar aims, despite research indicating its potential for strategic impact (Shenhar & Dvir, 2007; Rokio et al., 2024). Moreover, recent years have seen a rise in papers using the terms “strategy/strategic” and “innovation” in a leading project management journal (Slavinski et al., 2023). Research on procurement strategies promoting construction innovation typically focuses on inter-organizational control, such as clients overseeing engineering consultants (Ning et al., 2023) or contractors (Järvenpää et al., 2024). Despite recognizing that construction projects involve multiple organizations and actors (Rose & Manley, 2012; Hedborg Bengtsson et al., 2018), project management literature often treats project management as an internal function (Shenhar & Dvir, 2007). The primary focus remains on intra-organizational control, such as project managers overseeing internal teams (Liu & Wang, 2016). In response, Kivilä et al. (2017) suggest that project management research should expand beyond internal control to explore external aspects (such as adapting procurement strategies), particularly in relation to achieving long-term

organizational goals, such as those related to the sustainability transition. This aligns with research emphasizing the need for public clients to adapt both procurement strategies (Kadefors et al., 2021; Lenderink et al., 2022) and project management strategies (Kivilä et al., 2017; Guerrero & Engström, 2024) to effectively promote innovation in inter-organizational projects.

In this thesis, procurement and project management strategies refer to intentional courses of action that align with and support a certain direction, such as the sustainability transition. For instance, a procurement strategy includes intentional decisions related to procurement alternatives such as specifications, supplier selection, and performance evaluation (Eriksson and Laan, 2007). Similarly, a project management strategy includes intentional decisions regarding practices and purposes related to goals, success measures, and working processes (Guerrero & Engström, 2024). Both procurement strategy (Maqsoom et al., 2020; Järvenpää et al., 2022) and project management strategy (Kivilä et al., 2017; Lalic et al., 2022) should be adapted to the specific characteristics of each project. To address the inherent complexity involved in contributing to the sustainability transition, previous research highlights two key aspects that needs to be emphasized with the projects: flexibility (Sabini et al., 2019; Atli & Krystallis, 2025) and the involvement of actors (Kivilä et al., 2017; Di Maddaloni & Sabini, 2022). These two priorities align with findings from prior research on promoting innovation through procurement strategies (e.g., Caldwell et al., 2009; Nilsson Vestola, 2024) and project management strategies (e.g., Eriksson et al., 2017; Kivilä et al., 2017), all situated within the construction management field.

According to Sweden's national climate goals, the transport sector – including both transport services and infrastructure – is expected to achieve net-zero greenhouse gas emissions by 2045. As a central actor in this transition, the Swedish Transport Administration (STA), the country's largest public infrastructure client, is tasked with leading the sustainability transition of the sector. In 2024, the government formally assigned the STA the responsibility of coordinating efforts among other actors in the sector to help achieve this goal (Regeringen, 2024).

As such a significant public client – managing 2,500 road and railway projects and procuring services worth 66 billion SEK (Trafikverket, 2024) – the STA not only plays a central role in the sustainability transition but also serves as a key driver of innovation within the sector. The agency operates under a government mandate

(Förordning 2010:185) that explicitly requires the agency to 'strive to increase productivity, innovation, and efficiency in the markets for investments, operations, and maintenance' (Section 2, Item 10). Additionally, in 2016, the Swedish government adopted a National Procurement Strategy to encourage public authorities, including the STA, to use procurement more strategically. This strategy outlined seven objectives, with objective five focusing on public procurement that promotes innovation and objective six emphasizing environmental responsibility (Regeringskansliet, 2016). Consequently, the STA is mandated to contribute to the sustainability transition, by actively promote innovation through adapting both procurement and project management strategies.

Research problem

Public infrastructure clients must establish comprehensive governance that integrates two distinct yet interconnected components: adaptation of procurement strategies and project management strategies, to promote construction innovation for the sustainability transition. Therefore, this thesis relates to three independent fields within construction management: construction innovation, procurement strategy, and project management strategy. Research across these fields highlights the challenges project actors face in implementing both innovation outcomes and appropriate innovation processes, as well as the difficulties public clients encounter in promoting such innovation.

Within construction innovation, researchers report that project actors struggle to implement radical innovation (Brockman et al., 2016; Cantarelli & Genovese, 2021). Adapting technologies from other sectors – such as digital twins, automation, or sensors – presents challenges (Cantarelli & Genovese, 2021). Similarly, adapting technologies with the potential to transform the entire sector, such as BIM, has also been found challenging (Linderoth, 2010). Additionally, implementing innovation that provide long-term benefits beyond individual projects remains difficult (Rose et al., 2019; Larsson et al., 2022). In contrast, incremental innovation (Brockman et al., 2016), isolated radical innovation (e.g., material replacements in movable bridges) (Lenderink et al., 2022), and adopting innovation from other projects are more common (Cantarelli & Genovese, 2021). Innovation with short-term benefits for individual projects are also frequently implemented (Ozorhon et al., 2016). Since radical innovation (Lenderink et al., 2022), long-term benefits (Larsson et al.,

2022), and technology adaptation (Bosch-Sijtsema et al., 2021) are essential for the sustainability transition, construction and infrastructure actors struggle to implement innovation in line with that, while more easily focusing on other types of innovation.

Although research on procurement strategies (Lenderink et al., 2022) and project management strategies (Kivilä et al., 2017) has documented cases where public clients successfully promote innovation, many studies report the opposite. Research suggests that public clients often struggle to adapt procurement strategies to promote innovation (e.g., Caldwell et al., 2009; Nilsson Vestola et al., 2024), primarily due to their emphasis on detailed control (Bygballe & Ingemansson, 2014; Järvenpää et al., 2024). Similarly, studies highlight that rigid project management strategies may slow down or even hinder innovation (Ivory, 2005; Koppenjan et al., 2011; Guerrero & Engström, 2024).

Engineering consultants are key contributors to construction innovation (Rose & Manley, 2012; Hu et al., 2022), particularly in advancing the sustainability transition (Keusters et al., 2022; 2024). However, research has largely overlooked the planning and design, especially in terms of adapting procurement strategies (Eriksson & Kadefors, 2015; Eriksson, 2024) and project management strategies (Guerrero & Engström, 2024) to promote innovation. This gap highlights the need for further exploration to enhance understanding in this area.

Purpose and research questions

The purpose of this thesis is to increase the understanding of how a public infrastructure client promotes innovation towards the sustainability transition through adaptation of procurement and project management strategies in planning and design of new infrastructure.

As three construction management-related fields – construction innovation, procurement strategy, and project management strategy – are essential for enhancing such understanding but are typically treated separately in research (Kivilä et al., 2017), this thesis aims to integrate them into a joint discussion by addressing the following research questions:

RQ1: What challenges does a public client face in promoting innovation towards the sustainability transition in planning and design of new infrastructure?

RQ2: How does a public infrastructure client adapt its procurement strategies to promote innovation towards the sustainability transition, in planning and design of new infrastructure?

RQ3: How does a public infrastructure client adapt its project management strategies to promote innovation towards the sustainability transition, in planning and design of new infrastructure?

To answer these questions, empirical material was collected through a longitudinal single-case study of the STA.

Outline of the thesis

This compilation thesis consists of an integrating text, structured into six chapters, and four appended papers. Chapter One introduces the research background, along with a discussion of the problematization that leads to the purpose and the three research questions. Chapter Two presents the three relevant fields of literature and theoretical frameworks, serving as the 'lens' through which the research findings from the appended papers are interpreted. Chapter Three outlines the research process and methods, including study descriptions and a discussion of research quality. Chapter Four summarizes the four appended papers, followed by Chapter Five, in which the answers to the research questions are presented and discussed. Finally, Chapter Six concludes the thesis by presenting theoretical and practical contributions, as well as a discussion of research limitations and future research directions.

LITERATURE FIELDS AND FRAMEWORKS

This chapter outlines the research context of this thesis in relation to three fields of literature: construction innovation, procurement strategy, and project management strategy. These fields form the foundation of the study and represent the areas to which it aims to contribute. Additionally, the frameworks relevant to each field of literature are presented.

Construction innovation

Construction innovation serves as the common empirical ground, with procurement strategy and project management strategy functioning as two distinct yet interrelated mechanisms employed by public infrastructure clients to promote innovation towards the sustainability transition, as illustrated in Figure 1. The transition arrow at the bottom represents the shift from a fossil-fuel-based system (illustrated in black) to a system independent of fossil fuels (illustrated in green). While the linear representation of the arrow may suggest a straightforward process, this is a clear simplification of the complex, non-linear nature of the transition needed.

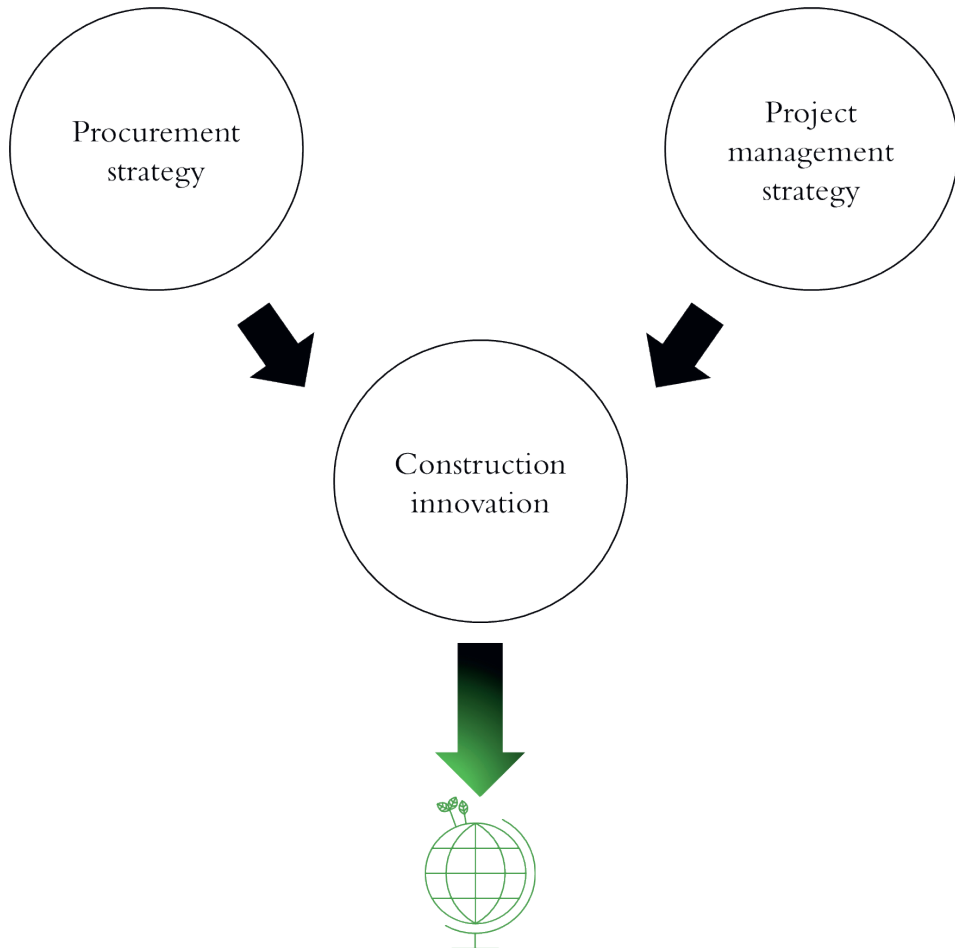


Figure 1: Three fields of literature.

Innovation as a multidimensional concept

Understanding innovation is complex and multifaceted. Innovation is widely recognized as a multidimensional concept (Crossan & Apaydin, 2010; Cantarelli & Genovese, 2021), with the two components – innovation outcome and innovation process – referred to in the Oslo Manual (OECD/Eurostat, 2018). These two components are also distinguished by researchers to understand innovation (e.g., Crossan & Apaydin, 2010; Cantarelli & Genovese, 2021).

According to the Oslo Manual (OECD/Eurostat, 2018, p. 22), an innovation outcome (referred to simply as "innovation") and an innovation process (referred to as "innovation activity") are defined as follows:

Innovation outcome:

“A new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).”

Innovation process:

“...all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation.”

To define and explore what construction innovation is or could be, various construction innovation researchers have illustrated this through frameworks encompassing different dimensions (Cantarelli & Genovese, 2021; Larsson et al., 2022). Different authors have employed various dimensions and categorizations. Some do not explicitly link these categories and dimensions to the two components included in the Oslo Manual’s definition of innovation (Slaughter, 1998; Gopalakrishnan & Damanpour, 1997), whereas others do, often referring to the similar terms "innovation as an outcome" and "innovation as a process" (e.g., Crossan & Apaydin, 2010; Cantarelli & Genovese, 2021).

Among the researchers who explicitly link different dimensions to the two components of innovation as an outcomes and processes, Crossan and Apaydin’s (2010) framework, which comprises ten dimensions, is potentially the most referenced innovation framework. Developed from an (intra-)organizational innovation perspective, their framework is based on an extensive literature review (ibid). Cantarelli and Genovese (2021) applied Crossan and Apaydin’s (2010) framework in their literature review, examining the most common dimensions and categories in the megaproject literature, whereof a substantial part of the included literature related to the construction and infrastructure sector. They identified seven key dimensions (ibid). Their innovation framework will serve as the foundation for understanding innovation in this thesis, as well as a framework for elaborating on previous research related to construction innovation in general and the sustainability transition in particular.

Innovation framework

The innovation framework based on Cantarelli and Genovese (2021) is illustrated in Figure 2. To align with the purpose of this thesis, four adjustments to the framework will be justified in the following sections. In the following sections, the dimensions and categories related to innovation as an outcome will first be presented, followed by the dimensions and categories related to innovation as a process. In addition to presenting the framework itself, findings from previous research that have applied the included dimensions and categories will also be discussed, especially focusing on innovation related to the sustainability transition.

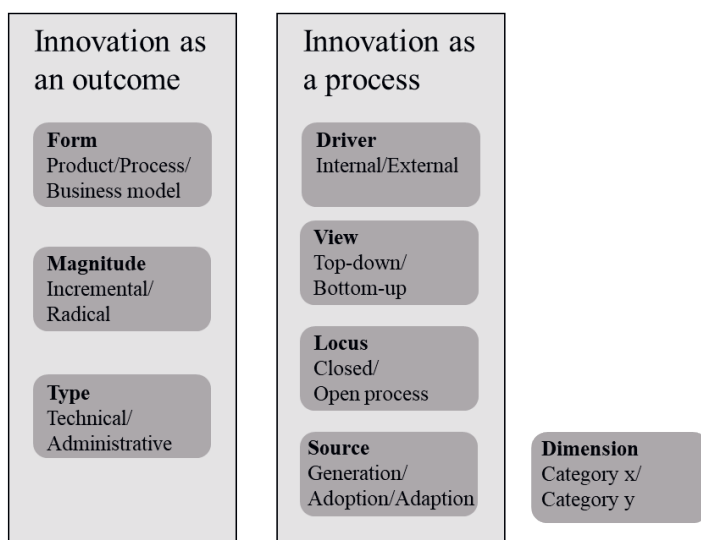


Figure 2: The seven key dimensions by Cantarelli and Genovese, 2021.

Innovation as an outcome

Form (and Type)

Crossan and Apaydin (2010) divide this dimension into three categories: process, product, and business model innovation, thus related to what is being innovated. Similarly, scholars in construction innovation classify product and process innovation as technical aspects, while organizational innovation (including business model innovation) are viewed as administrative or non-technical aspects (Ozorhon, 2013; Bygballe & Ingemansson, 2014). Another related dimension, “Type”

distinguishes between technical and administrative innovation (Crossan & Apaydin, 2010). Given the overlap between the dimensions of “Form” (product, process and business model innovation) and “Type” (technical and administrative innovation) (Crossan & Apaydin, 2010), this research combines them into a single dimension, called “Form”, encompassing three categories: product, process and administrative innovation. This is the first adjustment to the innovation framework by Cantarelli and Genovese (2021) and explains how the originally identified seven key dimensions are reduced to six in this thesis.

Product innovation – refers to the introduction of products that are novel and meaningful (Wang & Ahmed, 2004). For instance, this includes new sustainable materials (Kadefors et al., 2021), solar panels (Winkler, 2024), advanced components or technical improvements, like enhanced road designs or asphalt quality (Rose et al., 2019).

Process innovation – refers to the implementation of new production methods and technologies aimed at enhancing production processes (Wang & Ahmed, 2004). In regards to the sustainability transition, this includes adopting technologies such as drones and robotics, as well as integrating circular approaches to material management (Lenderink et al., 2022). Additionally, in the planning and design, process innovation may involve adopting an explorative approach that incorporates the interests of multiple stakeholders (Keusters et al., 2022). Process innovation influences the core processes, linked to the core operational activities (Crossan & Apaydin, 2010).

Administrative innovation – refers to organizational and managerial aspects, like organizational structures and administrative processes (Crossan & Apaydin, 2010; Brockmann et al., 2016), integrating expertise from different organizations or different types of collaboration contracts such as PPP (public-private partnership) (Cantarelli & Genovese, 2021). In contrast to process innovation, administrative innovation influences non-core processes that are not directly linked to core operational activities (Crossan & Apaydin, 2010).

Magnitude

This dimension reflects the degree of change, with researchers using a continuous scale from incremental to radical to assess the extent of change (Crossan & Apaydin, 2010; Brockmann et al., 2016). Although the Oslo Manual (OECD/Eurostat, 2018,

p. 22) may provide mixed signals regarding the magnitude of innovation – referring both to "new or improved" and to innovation that "differ significantly" – this dimension is frequently applied in construction innovation research (e.g., Brockman et al., 2016; Cantarelli & Genovese, 2021). As a result, incremental innovation appears to be widely accepted as a legitimate form of innovation within this field of literature.

Incremental innovation – refers to the enhancement of existing products or processes through the application of existing knowledge (Slaughter, 1998). This type of innovation typically leads to small-scale improvements in established practices, routines, and technologies (Crossan & Apaydin, 2010). Such innovation generally involves moderate uncertainty and produce predictable outcomes (Slaughter, 1998). Incremental innovation, within multiple industries, are often developed by internal knowledge resources, including competencies and actors familiar with existing processes and routines (Wilden et al., 2023). Due to their lower risk, incremental innovation is more common than radical innovation in infrastructure projects (Brockmann et al., 2016; Cantarelli & Genovese, 2021).

Radical innovation – refer to disruptive changes in existing products, methods, or techniques (Slaughter, 1998). Previous research indicates that radical innovation is more frequently developed through external knowledge resources – namely, competencies and actors from outside the (construction) industry – since they are not constrained by existing processes and routines (Hu et al., 2022; Duan et al., 2023). Previous research has reported successful, albeit relatively isolated, radical innovation, such as the realization of a bio-based composite bridge deck in a movable bridge (Lenderink et al., 2022). However, radical innovation that impact the entire construction sector and potentially contributing to the sustainability transition (Bosch-Sijtsema et al., 2021), would necessitate changes in actor roles as well as intra-organizational aspects within the different project actors, like the adoption of BIM (Linderoth, 2010).

Driver

This dimension pertains to the underlying reasons for initiating innovation (Bygballe & Ingemansson, 2014). While Crossan and Apaydin (2010) and Cantarelli and Genovese (2021) associate the driver with innovation as a process, this thesis, consistent with other scholars, argues for its inclusion as an outcome dimension, as it is inherently goal-oriented (Bygballe & Ingemansson, 2014; Brockmann et al.,

2016; Larsson et al., 2022). This is the second adjustment to the innovation framework by Cantarelli and Genovese (2021), namely, relocating the driver dimension to the component innovation as an outcome.

Scholars identify innovation drivers as either internal or external to an organization (Crossan & Apaydin, 2010), such as a contractor (Cantarelli & Genovese, 2021). However, given the inter-organizational nature of infrastructure and construction projects, where collaboration among multiple actors is essential (Rose & Manley, 2012; Hedborg Bengtsson et al., 2018), actors within the collaborative project context can be viewed as internal, while those outside this context may be considered external, as suggested by Brockmann et al. (2016). This alternative perspective is the third adjustment made to the innovation framework (Cantarelli & Genovese, 2010).

Furthermore, Larsson et al. (2022) highlight the importance of categorizing innovation drivers within infrastructure projects by short- and long-term benefits. This distinction is essential for analyzing innovation aimed at the sustainability transition, where prioritizing long-term benefits is crucial (Ozorhon, 2013; Lenderink et al., 2022). Thus, the fourth and final, adjustment to the innovation framework by Cantarelli and Genovese (2021) consists of adding two categories to the driver dimension: short-term and long-term benefits.

Internal drivers – include available competencies and resources (Crossan & Apaydin, 2010; Ozorhon et al., 2016) that can potentially act as catalysts for innovation. Additionally, internal drivers may encompass goals such as enhancing organizational or team learning and improving profitability (Ozorhon et al., 2016). In the context of public procurement, innovation-friendly procurement strategies can also stimulate innovation among other project actors (Ozorhon & Oral, 2017; Cantarelli & Genovese, 2021).

External drivers – include emerging market opportunities, imposed regulations (Crossan & Apaydin, 2010), government targets (Cantarelli & Genovese, 2021), or goals related to the sustainability transition (Ozorhon & Oral, 2017), all of which can serve as catalysts for innovation.

Short-term benefits – include a focus on improving traditional project success metrics, such as time, cost, and quality (i.e., ‘iron triangle’) (Ozorhon et al., 2016;

Larsson et al., 2022), as well as contract specific benefits, like enhancing the work environment for contractor and sub-contractor employees (Larsson et al., 2022). In infrastructure projects, short-term benefits are often prioritized over long-term benefits (Kuitert et al., 2019; Rose et al., 2019). Rose et al. (2019) found that engineering consultants criticize public clients for placing excessive emphasis on short-term benefits associated with the ‘iron triangle’. This focus, they argue, comes at the expense of long-term benefits, thereby missing opportunities for innovation that could have a significant impact over the project’s lifecycle (ibid).

Long-term benefits – include effects or improvements beyond the scope of the project or the scope of the contract, including sustainability-related aspects (Ozorhon, 2013) and those related to life-cycle cost and product quality (Brockmann et al., 2017; Larsson et al., 2022). Researchers have concluded that innovation aiming for long-term benefits are essential for the sustainability transition (Larsson & Larsson, 2018; Lenderink et al., 2022). Lenderink et al. (2022) observed that public clients, as the owners of infrastructure, have a natural incentive to prioritize innovation with long-term benefits – an incentive not necessarily shared by other actors in the sector.

In Figure 3, the adjusted framework related to innovation as an outcome is illustrated.

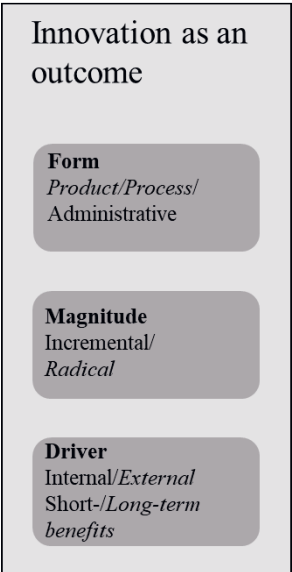


Figure 3: Adjusted framework: innovation as an outcome.

Innovation as a process

View

This dimension addresses how the innovation process is initiated, typically categorized as either top-down or bottom-up (Crossan & Apaydin, 2010). In a *top-down approach*, innovation is proactively driven by directives from R&D activities or management, then implemented within projects (Winch, 1998). Conversely, a *bottom-up approach* is more reactive, with innovation emerging from problem-solving and learning at the project level, subsequently spreading to other projects (Winch, 1998). Davies et al. (2009) found in their analysis of construction of Heathrow Terminal 5 that both top-down and bottom-up approaches were present.

Locus

This dimension refers to the actors involved in the innovation process, categorized as either a *closed process* within a single organization or an *open process* involving multiple organizations (Crossan & Apaydin, 2010). In infrastructure and construction projects, closed innovation processes within a single organization are rare (Cantarelli & Genovese, 2021). Instead, inter-organizational collaboration involving multiple actors – characteristic of an open process – is most common (Rose & Manley, 2012; Hedborg Bengtsson et al., 2018).

In infrastructure and construction projects, various actors – including clients, engineering consultants, contractors (Larsson et al., 2022), sub-contractors, and construction equipment suppliers (Sariola, 2018) – play essential roles in the innovation process. Clients are often seen as the primary drivers of innovation (Bygballé & Ingemansson, 2014; Loosemore, 2015), while engineering consultants contribute in the innovation process during the planning and design through innovative design (Rose & Manley, 2012; Brockmann et al., 2016). Contractors then take responsibility for implementing innovation in the production, resembling a “relay race logic” (Kadefors et al., 2024, p. 23) of different innovation responsibilities within the project.

These traditional actors can be referred to as ‘internal knowledge resources’ within infrastructure and construction projects (Ozorhon et al., 2016). In contrast, other actors – often with less industry experience or with backgrounds in different sectors – can be regarded as ‘external knowledge resources’ (Ozorhon et al., 2016). Due to actors within the sector being constrained by existing processes, cultures, and

routines, several researchers have highlighted the critical importance of involving actors from outside the construction and infrastructure sector to succeed in construction innovation (e.g., Ozorhon, 2013; Ozorhon et al., 2016; Hu et al., 2022). These external resources bring new perspectives and experiences to projects (Ozorhon, 2013; Ozorhon et al., 2016), and their collaboration with internal resources remains vital for successful innovation (Hu et al., 2022).

Source

This dimension pertains to the origin of innovation and the characteristics of the innovation process, which can be categorized into two types: generation and adoption/adaptation (Damanpour & Wischnevsky, 2006).

Generation – refers to an internal process within the project, focused on development and commercialization, that leads to an innovation outcome novel to any organization or project (Damanpour & Schneider, 2009). This process typically begins with idea generation, followed by development and eventual implementation (Damanpour & Wischnevsky, 2006).

Adoption/adaptation – refers to an external process in which existing solutions are integrated in one of two ways: adoption or adaptation (Damanpour & Wischnevsky, 2006). *Adoption* implies replication of external innovation by incorporating new services, products, or technologies into the organization or project, essentially following a ‘copy-paste’ approach (Damanpour & Wischnevsky, 2006). In contrast, *adaptation* involves modifying or recombining external innovation or technologies to create something new or to apply them within a new context (Cantarelli & Genovese, 2021). For example, Bosch-Sijtsema et al. (2021) found in their study that existing technologies, primarily used for other purposes – such as BIM, sensors, and digital twins – were perceived as having potential for sustainability applications, including carbon reduction. This approach is often supported by external knowledge resources that "transfer technology from outside the construction industry" (Ozorhon et al., 2016, p. 4). In line with that, Ozorhon et al. (2013) emphasized the importance of creating forums for actors across the entire supply chain to share ideas and collaboratively address challenges.

In Figure 4, the adjusted framework related to innovation as a process is illustrated.

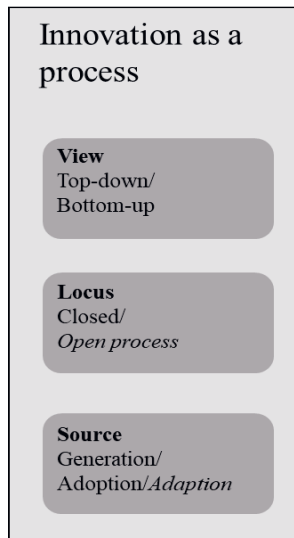


Figure 4: Adjusted framework: innovation as a process.

Procurement strategy

In this section, the context of public procurement will first be described, followed by a presentation of the two frameworks related to procurement strategy: the control mode framework, which outlines the three control modes, and the procurement framework, which presents how these control modes can be applied in the context of public procurement of engineering consultants. Lastly, previous research on the three control modes will be reviewed, with a particular focus on how they can be adapted to different contexts.

The public procurement context

Public procurement is the process by which public organizations, including public clients, acquire works, services, and goods (Upphandlingsmyndigheten, n.d.). This process is governed by the Public Procurement Act and applies to all European Union member states. Its primary objective is to ensure that public entities conduct their procurement activities through competitive bidding while simultaneously excluding suppliers with poor financial standing, a history of misconduct, or a

criminal record (*ibid*). This regulation helps to ensure that tax funds are used efficiently and that suppliers compete on equal terms.

In this thesis, the procurement strategies will relate to the three phases of the public procurement process: pre-tender, tender, and post-tender (McKevitt & Davis, 2015). In the pre-tender phase, the client develops the procurement strategy, which typically encompasses specifications, procurement procedures, selection and awarding criteria, reward systems, and performance evaluation, while also preparing the tender documents (Selviaridis et al., 2011).

In the tender phase, the tender is publicly announced to the market (McKevitt & Davis, 2015), with actions and interactions varying depending on the chosen procedure (Hoezen et al., 2010). At this phase, the contract is also awarded to the winning supplier (Directive 2014/24/EU).

In the post-tender phase, the client evaluates the contracted supplier's performance based on the agreed terms and manages any necessary adjustments (McKevitt & Davis, 2015). While private clients may continue refining specifications throughout the contract period (Selviaridis et al., 2011), public clients face restrictions on making changes (Volker, 2012; Arrowsmith, 2014), to prevent discrimination of other potential suppliers (Directive 2014/24/EU).

Control mode framework

Establishing control, both intra- and inter-organizational, is essential for every organization (Das & Teng, 2001). Ouchi (1979; 1980) developed a control framework based on organizational control, which distinguishes between three control modes (or systems) – process, output, and social (or clan) control. This control mode framework is widely recognized as the most commonly used framework (Cardinal et al., 2017), and has been extensively applied in procurement strategy studies within the construction and infrastructure sector (e.g., Järvenpää et al., 2022; Ning et al., 2023), although it was originally developed for intra-organizational purposes (Ouchi, 1979).

Organizational control is founded on the principle that a controller oversees the work of a controlee, whose interests typically differ – and often conflict – with those of the controller (Eisenhardt, 1985). In the inter-organizational context of this

thesis, the public client acts as the controller, while the engineering consultancy company functions as the controlee.

The three control modes are sometimes grouped into formal (output and process) and informal control (social) categories (Sitkin et al., 2020). This is because output and process control involve formal control methods, such as policies, rules, and procedures, that serve to specify, reward, and evaluate performance (Joslin and Müller, 2016), as well as distinct roles (Sitkin et al., 2020) between the public client and the engineering consultancy company. In contrast, social control represents informal control, where roles between the contracting parties are less distinct and more reliant on relational aspects and collaboration (Sitkin et al., 2020).

In output control, the public client focuses on specifying, rewarding, and evaluating the results, or output (Kirsch, 1996), usually in a quantitative manner (Sihag & Rijdsdijk, 2019). This control mode assumes that the public client relies on that the engineering consultant has the expertise to determine appropriate processes to achieve the desired outcomes (Aulakh & Gencturk, 2000; Sihag & Rijdsdijk, 2019). Therefore, the public client does not need to understand the specific activities required or how they should be carried out to perform output control effectively (Kirsch, 1996). Output control is sometimes described as the “invisible hand of market” (Gencturk & Aulakh, 1995, p. 758), as it allows the public client to avoid closely monitoring the engineering consultant’s work in detail (Kreutzer et al., 2015). This hands-off approach is efficient and less time-consuming for the public client than the other two control modes (Sihag & Rijdsdijk, 2019; Eriksson, 2024).

In process control, the public client focuses on more detailed specification, rewarding, and evaluation of the engineering consultant’s processes and behaviors (Kirsch, 1996). Unlike output control, process control requires the public client to understand not only the specific activities needed but also how these activities should be executed by the engineering consultant to ensure effective control (Eriksson, 2024). Consequently, process control is sometimes referred to as the “visible hand of management” (Gencturk & Aulakh, 1995, p. 758) due to its resource-intensive nature and closely monitoring.

Social control differs from the other two control modes in several ways, as it is an informal form of control (Sitkin et al., 2020) that also involves relational aspects (Sihag & Rijdsdijk, 2019). In social control, the public client’s focus is on developing

shared goals, values, and a common culture to foster collaboration through appropriate behaviors and outcomes (Das & Teng, 2001; Cardinal et al., 2017). These shared values and understandings guide the engineering consultant on what the public client considers acceptable or unacceptable, relying more on trust between the contracting parties than on direct monitoring (Kirsch et al., 2010), with self-control often exercised by the engineering consultant (Das & Teng, 2001). Due to its informal nature, social control is also the most adaptable control mode for public clients to use (Sitkin et al., 2020; Ning et al., 2023). In similarity to process control, this is a resource-intensive control modes as it requires the client to engage in collaboration during the contract execution (Eriksson, 2024).

Procurement framework

Eriksson (2006) and Eriksson and Laan (2007) developed a procurement framework based on the three control modes – output, process, and social control – specifically suited for procurement strategies when procuring contractors. According to Eisenhardt (1985), the primary aspects for a controller to achieve organizational control over the controlee include specifying, rewarding, and evaluating performance. In public procurement settings, the client also needs to obtain control in the tender-phase, through the selection of procurement procedure and awarding criteria (Lou et al., 2022). This thesis includes five specific procurement stages: specification, bid invitation, bid evaluation, reward system/type of compensation, and performance evaluation.

For each stage, one procurement alternative corresponds to each of the three control modes—output, process, and social control – as visualized in Table 1. The procurement framework will be explained in two steps, beginning with an overview of the five procurement stages (first column), followed by a detailed

Table 1: The procurement framework.

Procurement stages	Output control	Process control	Social control
Specification	Output-oriented	Process-oriented	Value-oriented
Bid invitation	Open bid procedure	Pre-qual./negotiation	Pre-qual./negotiation
Bid evaluation	Price	Best price/authority-based quality	Best price/quality - trust-based quality
Reward system	Fixed price	Time-and-materials	Including incentives
Performance evaluation	Output control by client	Process control by client	Self-control by service provider

description of the procurement alternatives within each stage that correspond to the three control modes (second to fourth column).

Five procurement stages

In the specification stage, the public client outlines the service requirements using a specific specification method (Axelsson & Wynstra, 2002), which defines who holds responsibility for the quality (Eriksson, 2006). This specification also serves as a foundation for evaluating performance during the performance evaluation stage in the post-tender phase (Tiwana & Keil, 2007). The bid invitation stage involves the client's selection of a procurement procedure, determining whether any interaction between the bidders and the client will occur, such as negotiation (Hoezen et al., 2010), and specifying the number of bidders permitted to participate (Eriksson, 2006). In the bid evaluation stage, the awarding criteria are established, meaning the client determines the extent to which price, cost, and/or quality will influence the selection of the winning bid (Eriksson, 2006). The reward system stage defines the terms of compensation, specifying how risks and responsibilities will be allocated between the contracting parties (Malatesta & Smith, 2011). In the final stage, performance evaluation, the evaluation of the engineering consultancy companies' service takes place, thus dealing with how well the specifications were met (Eriksson, 2006).

In the following three sections, the various procurement alternatives will be linked to the three control modes: output, process, and social control.

Procurement alternatives for output control

In output-oriented (also called functional) specifications, the public client defines the service in terms of the desired function or outcome, which the engineering consultant then interprets and translates into specific activities, processes and tasks (Axelsson & Wynstra, 2002; Lin et al., 2019). This approach assigns responsibility for both the output and quality to the engineering consultant, a responsibility formalized through both the specification and the reward system, in similarity to a design-build contract (Eriksson, 2006; Eriksson & Laan, 2007). However, as service outputs can be subject to multiple interpretations, aligning the client's and consultant's visions may prove challenging, especially when the service involves uncertainties and complexities (Axelsson & Wynstra, 2002).

Regarding the bid invitation stage, an open procedure invites a large number of bidders to compete, representing a short-term, transactional approach (Anderson & Oliver, 1987) associated with the market mode, or output control (Eriksson, 2006). Similarly, a short-term transactional approach focused solely on the (lowest) price in bid evaluation connects this procurement alternative to output control as well (Eriksson, 2006).

In terms of the reward system, the engineering consultant is typically compensated through a fixed-price contract (Eriksson, 2006). Fixed-price contracts incentivize the consultant to reduce costs and improve efficiency but make adaptations costly (Bajari & Tadelis, 2001), thus providing low incentives for adaptability within the engineering consultant (Williamson, 1985). Consequently, this procurement approach is usually applied to simpler services with low levels of uncertainty and complexity. Finally, the engineering consultant's performance is evaluated based on an inspection of the output, measured against the pre-defined, output-oriented specification (Sitkin et al., 2020).

Procurement alternatives for process control

In process-oriented specifications, the public client defines the process, including specific tasks, activities, and deliverables (Axelsson & Wynstra, 2002), thereby taking responsibility for the quality, in similarity to a design-bid-build contract (Eriksson, 2006). This approach assumes that carrying out the specified tasks and activities is both feasible and sufficient to achieve the desired outcome.

In the bid invitation stage, process control is supported by using pre-qualification or a negotiated procedure, where price and/or quality aspects of the bid can be negotiated. This approach aligns with process control because pre-qualification and negotiation involve a limited number of bidders (Eriksson, 2006), allowing for more in-depth bid negotiation (Hoezen et al., 2010) and reflecting a longer-term perspective (Anderson & Oliver, 1987). Furthermore, as the client assumes responsibility for quality (Eriksson, 2006), it is essential to thoroughly assess the engineering consultant's expertise and competence during the bid invitation stage (Anderson & Oliver, 1987). Process control is inherently linked to a long-term perspective, as it reduces the incentives to prioritize short-term gains in favor of sustained quality and performance (Anderson & Oliver, 1987). Similarly, selecting bids based on the best price-quality ratio is tied to process control, with quality parameters focusing on authority-based attributes (Eriksson & Laan, 2007), such as

the consultant's ability to manage time, cost, and quality (Kang et al., 2014). However, for a public client, these must focus on quality parameters beyond the requirements specified in the tender documents (Public Procurement Act).

Typically, the engineering consultant is compensated on a time-and-materials basis, covering costs related to the time worked (Eriksson, 2006). Time-and-materials contracts are commonly used for complex and uncertain services, as they allow for less rigid specifications compared to fixed-price contracts (Bajari & Tadelis, 2001). In the context of process control, they enable the client to provide closer guidance without transferring financial risk to the consultant (Eriksson, 2006). This creates strong incentives for adaptability within the engineering consultant (Williamson, 1985); however, public clients are restricted from making significant changes during the contract due to public procurement regulations (Volker, 2012). Finally, performance evaluation is conducted by the client, who closely monitors the engineering consultant's performance against the process-oriented specifications (Sitkin et al., 2020), ensuring alignment with the prescribed tasks and processes.

Procurement alternatives for social control

When the client is uncertain about both the output and the process, they may opt for a value-oriented (also called outcome-oriented) specification, which defines the value or need the service should fulfill (Axelsson & Wynstra, 2002). In this approach, detailed activities and deliverables are developed collaboratively (joint specification), and responsibility is shared between the client and consultant, in similarity to a partnering or early contractor involvement (ECI) contract (Eriksson, 2006).

In regards to bid invitation, employing pre-qualification and negotiation in this context supports a long-term perspective, as it involves a limited number of bidders (Eriksson, 2006) and allows for bid negotiation (Hoezen et al., 2010). Social control, which entails building collaborative relationships and investing socially in the partnership, is strengthened by long-term relationships (Aulakh & Gencturk, 2000). Negotiating with a selected group of bidders fosters these long-term relationships (Eriksson, 2006). Given the emphasis on a long-term outlook, using the best price-quality ratio in bid evaluation is associated with social control (Eriksson & Laan, 2007). These quality aspects rely on trust-based factors (Eriksson & Laan, 2007), including measures related to innovation capability (Lou et al., 2022), collaborative skills, and shared values (Eriksson, 2006). This is argued especially important when

uncertainties are high (Eriksson, 2024). In line with process control, a public client should also consider quality parameters that go beyond the requirements specified in the tender documents (Public Procurement Act).

Typically, the engineering consultant is compensated based on incurred costs through a time-and-materials contract (Eriksson, 2006). Time-and-materials contracts are favored for complex and uncertain services, as they require less precise specifications than fixed-price contracts and allow for greater adaptability, for both contractual parties, when adjustments are necessary (Bajari & Tadelis, 2001). These contracts are often combined with incentives, such as bonuses, though bonuses can be challenging to implement in engineering consultancy contracts (Eriksson & Kadefors, 2015). In cases where trust is high, the engineering consultant is evaluated based on self-control and alignment with the shared values of the contracting parties (Das & Teng, 2001).

Adapting control modes

In the following two sections, previous research on adapting control modes will be presented. Broadly, the adaptation of control modes can be categorized based on task characteristics and organizational goals (Eriksson, 2024). Therefore, the subsequent sections will present previous research related to these two distinctions. This distinction is necessary because different control modes are considered suitable for different situations and should therefore be adapted accordingly (Kivilä et al., 2017; Maqsoom et al., 2020). As argued by several researchers, the three control modes should be viewed as complements rather than substitutes, meaning that the controller cannot choose only one but instead employ a combination of two or more (Cardinal et al., 2017; Eriksson, 2024).

Based on task characteristics

Early studies describe two task characteristics influencing control modes: outcome measurability and knowledge of the transformation process (Ouchi, 1979, 1980). Subsequent research has introduced additional relevant characteristics, such as uncertainty (e.g., Yang et al., 2022; Ning et al., 2023) and complexity (e.g., Turner & Makhija, 2006; Eriksson, 2024).

Output measurability refers to the public client's ability to articulate goals for the engineering consultancy service (Ouchi, 1979) and to measure its output in an objective and precise manner (Das & Teng, 2001). In an inter-organizational

context, such measurements are essential for the client to formulate specifications, draft contracts, and assess their fulfillment (Wuyts & Geykens, 2005), especially for public clients that cannot change these during the length of the contract (Uyarra et al., 2014). If outputs cannot be reliably observed or measured, it becomes challenging to determine and evaluate quality, and thus, output measurability would be considered low (Ouchi, 1979).

Knowledge of the transformation process has a less straightforward and somewhat ambiguous definition. According to Ouchi (1979), it is the degree to which the controller is able to specify how a task, e.g., activities and processes, can be specified in advance, a concept originally rooted in the empirical context of parts distribution. However, when applied to complex services, Kirsch (1996) argues that Ouchi's (1979) definition is not suitable, as service processes tend to be iterative and exploratory rather than linear, and the outcomes may not be clearly defined. Kirsch (1996) therefore proposes defining it as "how well the client understands the tasks" (p. 4). In alignment with research on complex professional services (e.g., Tiwana & Keil, 2007; Kirsch et al., 2010), this thesis adopts Kirsch's (1996) definition.

For a client to exercise process control, they must possess a high level of understanding of the tasks being performed, which is not a requirement to exercise output control (Kirsch, 1996; Kreutzer et al., 2015). In fact, when the public client has a thorough understanding of the tasks, it becomes challenging not to impose detailed process control (Tiwana & Keil, 2007). While the early work on control modes suggested that a high level of task understanding is not necessary for social control (Ouchi, 1979), later research challenges this view, arguing that task understanding remains important even in social control (Turner & Makhija, 2006; Eriksson, 2024).

Uncertainty reduces the ability to predetermine tasks and plan ahead, while simultaneously increasing risks (Eisenhardt, 1989). This makes uncertainty a particularly relevant task characteristic in project contexts (Lin et al., 2019), especially those involving engineering consultants (Ning et al., 2023). When uncertainty is high and unexpected changes occur, it becomes difficult for actors to predict outcomes, making it costly to allocate risk and responsibility to the supplier, which reduces the efficiency of output control (Stouthuysen et al., 2012; Eriksson, 2024). Additionally, under high uncertainty, clients face challenges in specifying tasks and evaluating results, complicating the use of process control (Maqsoom et

al., 2020; Yang et al., 2022). Consequently, when uncertainty is low, both output and process control are found to be efficient (Yang et al., 2022).

Notably, Ning et al. (2023) found that high uncertainty can also lead to an increased use of process control. They suggest that this finding may be context-specific to engineering consultancy services not restricted by the Public Procurement Act, which often require high levels of coordination and interaction between the client and the engineering consultant to effectively address task uncertainty (Ning et al., 2023). Furthermore, Ning et al. (2023) also observed an increased reliance on social control under high uncertainty, as it offers both flexibility and collaboration, which is supported by Eriksson (2024). Social control allows the involved parties to jointly manage disruptions and address unavoidable contractual uncertainties that emerge in inter-organizational relationships (Lou et al., 2022; Ning et al., 2023; Eriksson, 2024).

Previous research presents somewhat conflicting findings regarding the effects of complexity and the control modes best suited to handle it. When complexity is high, process control appears inefficient, according to Turner and Makhija (2006) and Sihag and Rijdsijk (2019). In contrast, Eisenhardt (1989) argues that process control is more appropriate than output control in such situations because output control places excessive risk on the supplier. Furthermore, Turner and Makhija (2006) and Eriksson (2024) found that social control is particularly effective under high complexity, especially when the client possesses a high understanding of the task. Similarly, Stouthuysen et al. (2012), in their study of inter-organizational relationships within various service industries, concluded that both process and social control are superior to output control when complexity is high.

Based on organizational goals

Previous research has examined how control modes influence organizational goals, such as sustainable development (Kivilä et al., 2017; Eriksson, 2024) and innovation (Lou et al., 2022; Järvenpää et al., 2024), thereby concluding how procurement strategies could be adapted to achieve these goals. A few studies indicate that output control can positively impact innovation (Cardinal, 2001; Järvenpää et al., 2024), whereas no studies suggest a solely positive effect of process control. In contrast, several studies emphasize that social control positively influences innovation (e.g., Caldwell et al., 2009; Lou et al., 2022).

Järvenpää et al. (2024) studied contractor contracts in infrastructure projects and concluded, based on interviews, that process control is perceived to negatively affect innovation, whereas output control is seen as enhancing innovation. However, findings related to social control were more ambiguous, as the public client often perceived innovation as the contractor's responsibility rather than a joint effort requiring collaboration. The study also highlighted that most decisions regarding control are made in the pre-tender phase, which is perceived to significantly limit adaptability in the post-tender phase and thus negatively impact innovation.

For studies reporting a positive effect of social control on innovation, Lou et al. (2022) quantitatively analyzed the impact of different combinations of supplier selection methods and control modes on incremental and radical innovation within manufacturing firms. They concluded that combining all three control modes can enhance incremental innovation, though social control is considered the most effective. In contrast, Lu et al. (2017) studied inter-organizational contexts in new product development and found that only social control positively influenced incremental innovation. Additionally, Lou et al. (2022) identified social control as the only mode that, when combined with innovation-oriented supplier selection, positively influenced radical innovation.

In a survey study combining procurement strategies (efficiency-seeking or innovation-seeking) and control modes, Kang et al. (2014) reported that social control is the most suitable mode when the procurement strategy is innovation-seeking. Similarly, Caldwell et al. (2009) investigated organizational control in complex infrastructure projects requiring innovation and concluded that social control – implemented through joint specification, pre-qualification, soft parameters in bid evaluation, and incentive-based payments – positively affects innovation.

Research highlights that different control modes may be more appropriate depending on whether the goals are short-term or long-term (Kivilä et al., 2017). It is found that process control is better suited than output control for achieving long-term goals, such as learning and innovation, while output control is more effective for achieving short-term goals, such as productivity and efficiency (Sihag & Rijdsdijk; 2019; Eriksson, 2024). Additionally, it has been concluded that social control is suitable for achieving both short-term and long-term goals (Sihag & Rijdsdijk; 2019; Eriksson, 2024).

In summary, if the client aims to achieve organizational goals requiring innovation, previous research suggests that social control is the most effective control mode, followed by process control. In contrast, output control appears to be the least favorable for these purposes.

Project management strategy

This section will first provide an overview of project management strategy research within the construction and infrastructure sector. Then the framework, based on the hard and soft paradigm will be introduced, which highlights six strategy aspects that public clients can consider when adapting their project management strategy. Finally, a review of previous research on the adaptation of project management strategies based on this framework will be presented.

Previous research in project management strategy

Project management is a key discipline in the construction and infrastructure sector and is therefore vital for public clients aiming to drive innovation aligned with organizational goals (Kivilä et al., 2017; Guerrero & Engström, 2024). Traditionally, project management in this field has been viewed more as a practical function than a strategic one (Shenhar & Dvir, 2007; Lenfle & Loch, 2010), often relying on a “one size fits all” model (Shenhar et al. 2001). Practices are typically based on standardized guidelines like the PMBOK® Guide (Project Management Institute, 2024), widely seen as promoting “best practices” but also criticized for overlooking research (Turner, 2022). From this perspective, project management is mainly about planning and executing a series of tasks (Shenhar & Dvir, 2007; Guerrero & Engström, 2024). However, such a practical approach is said to hinder innovation (Ivory, 2005) and is increasingly seen as unsuitable for the rising complexity of infrastructure projects (Atli & Krystallis, 2025).

In recent years, researchers have highlighted the need for a more strategic approach – also for clients – by adapting project management to the specific demands of real-world projects (Shenhar et al., 2001; Koppenjan et al., 2011) and aligning it with wider organizational goals (Shenhar & Dvir, 2007; Kivilä et al., 2017). Some scholars describe these adaptations as “project management strategies” (Anderson &

Merna, 2003; Arefazar et al., 2022; Boonstra & Reezigt, 2023), while others use terms like “project management approach” (Lalic et al., 2022; Guerrero & Engström, 2024), “management approach” (Koppenjan et al., 2011), or “project management practice” (Eriksson et al., 2017). For clarity, this thesis refers to all of these as project management strategies.

In line with this reasoning, during the last few decades a stream of research on project management strategies has focused on project typologies and contingencies (Boonstra & Reezigt, 2023; Loch et al., 2024). Some researchers include multiple categories in their frameworks (Shenhar, 2001; Boonstra & Reezigt, 2023), while others used analytical framework based on the hard and soft paradigms developed by Crawford and Pollack (2004). Subsequent studies have applied various frameworks including the contrasting hard and soft paradigms (Guerrero & Engström, 2024) or similar distinctions, such as control versus flexibility (Lenfle & Loch, 2010; Koppenjan et al., 2011) and traditional versus agile (Fernandez & Fernandez, 2016). These two-type classifications share significant similarities, with "hard," "control," and "traditional" approaches encompassing comparable elements, as well as "soft," "flexibility," and "agile." For clarity, this thesis will adopt the terms "hard" (encompassing control and traditional) and "soft" (encompassing flexibility and agility) project management.

Framework of hard and soft

The concepts of hard and soft arise from two fundamentally different paradigms, each grounded in distinct philosophical assumptions (Kuhn, 1962). The hard paradigm is based on realist and positivist views, emphasizing objective knowledge (Crawford & Pollack, 2004). On the contrary, the soft paradigm is rooted in relativist and interpretivist perspectives, focusing on intersubjective understanding (Crawford & Pollack, 2004).

In the construction and infrastructure sector, project management research (Locatelli et al., 2023) and much of its practice are primarily grounded in the hard paradigm (e.g., Cicmil and Hodgson, 2006; Eriksson et al., 2017), which are characterized by objectivity, efficiency, and linear problem-solving (Pollack, 2007). On the contrary, innovation projects and organizational change projects (including its project management), generally align with the soft paradigm (Crawford &

Pollack, 2004), which emphasizes subjectivity, stakeholder engagement, and iterative approaches to problem structuring (Pollack, 2007).

The hard and soft framework in this thesis builds on prior research in project and project management. It is organized around strategy aspects (shown in the left column of Table 2), which highlight key issues for analyzing practices linked to hard and soft project management (Eriksson et al., 2017; Guerrero & Engström, 2024). These aspects fall into three groups. The first includes goals, outputs, and success measures, tied to the hard paradigm (Pollack, 2007). The second covers the work process and participation of project members and actors, linked to both paradigms (Crawford & Pollack, 2004; Shenhar & Dvir, 2007). The third includes change and learning, associated with the soft paradigm (Crawford & Pollack, 2004; Pollack, 2007).

Paradigms extend beyond mere philosophical foundations (Pollack, 2007); they influence practice by shaping perceptions, defining what is valued, and establishing what is deemed valid and effective action. Though subtle, a paradigm's impact on practice is comprehensive, affecting what is done, how it is done, and why it is done (Pollack, 2007). Consequently, focusing only on practices (e.g., tools and techniques) – the "what" and "how" – is insufficient, as the purpose – the "why" – holds significant importance. Since, for example, soft practices can be used in both hard and soft purposes – depending on how the practitioner applies them – distinguishing between practices and purposes is important (Pollack, 2007). Even though the majority of empirical studies referring to hard and soft do not distinguish between practices and purposes in their frameworks and analyses (e.g., Eriksson et al., 2017; Guerrero & Engström, 2024), the framework in this thesis aligns with the argument made by Pollack (2007) and makes this distinction. Thus, for each of the strategy aspects, the literature was reviewed to identify associated practices and purposes linked to both the hard (second column) and soft (third column) paradigms, which together form the framework illustrated in Table 2. Thus, the project management strategy is formed by the choice of practices and purposes across different strategy aspects.

Table 2: The framework of hard and soft project management.

Aspect	Hard paradigm		Soft paradigm	
Goals, outputs and success measures	<p>Clear (often) SMART goals^a</p> <p>Defining short-term goals at the beginning^{a,k} in a non-participative manner^a</p> <p>Tangible outputs e.g., a road^c</p> <p>Using standardized, quantitative^a and isolated short-term measures e.g., time, cost and quality^f, defined at the beginning^g</p>	Practice	<p>Abstract goals^a</p> <p>Defining goals continuously in a participative manner.^a</p> <p>Intangible outputs e.g., long-term effects and values.^a</p> <p>Using measures suited for the specific project, process and context.^a</p>	Practice
	Striving for efficiency ^a , clearly defined scope, objectivity and simplicity ^{d,e} , and control ^c . Measure against pre-determined goals ^d	Purpose	<p>Valuing different interpretations^e, capture complexity^{a,b} and flexibility.^d</p> <p>Project execution contributes to organizational goals.^{fj} Measuring the impact (long-term) of the project^f or learning gained.^a</p>	Purpose
Work process and participation of project members and actors	<p>Linear and sequenced (often standardized) processes^h comprising the whole project from start to finish e.g., stage-gate^k</p> <p>Clearly defined roles, responsibilities and</p>	Practice	<p>Iterative processes^a</p> <p>Exploration of many different solutions.^b</p> <p>Process is suited for the specific project and continuously</p>	Practice

	<p>tasks from the beginning, e.g., WBS.^a Expert-led tasks.^g Non-participative execution (few actors).^a</p> <p>Project manager closely involved in the details.^f</p>		<p>evaluated.^b Activities emerge.ⁱ</p> <p>Joint planning and adjustments.^b Shared responsibilities between actors/members. Crossing professional boundaries.^a Many involved actors.^d</p>	
	<p>Assumes a plannable and stable environment.^a Striving for efficient problem-solving, thus optimizing the predetermined activities and solution.^{a,e} Assumes that project members are interchangeable.^a Project progress through completing the tasks.^h Command-and-control management style.^f</p>	Purpose	<p>Assumes a changing environment.^a Striving for problem structuring.^e Valuing different interpretations.^e Emphasize human relationships and self-organizing, e.g., project manager is a facilitator.^e Flexible management style.^c</p>	Purpose
Change and learning	<p>Make (concrete) changes when deviation from plan occurs.^c</p> <p>Learning through a sequential process of lessons learned.^c</p>	Practice	<p>Practices are inherent flexible.ⁱ</p> <p>Learning through an explorative process, including reflection and subsequent</p>	Practice

	Learning from past experiences/projects is used in the planning of future projects. ^{cf}		correction. ^b Learning is continuously affecting the ongoing project. ^{b,e}	
	To achieve predictability, plannability and rationality. ^{b,k} Changes are undesirable and should be avoided. ^d Continuous improvements in order to find best practice. ^f	Purpose	Openness to changes. ⁱ Changes adds value due to the potential of higher quality and increased client satisfaction. ^{b, d} An ongoing process of learning and unlearning. ^e Learning is emphasized, as it contributes to a wider understanding ^a adding of perspectives ^e	Purpose
Sources: Crawford & Pollack, 2004 ^a ; Eriksson et al., 2017 ^b ; Atkinson et al. 2006 ^c ; Koppenjan et al., 2011 ^d ; Pollack, 2007 ^e ; Shenhar & Dvir, 2007 ^f ; Lalic et al., 2022 ^g ; Conforto et al., 2014 ^h ; Lenfle & Loch, 2010 ⁱ ; Guerrero & Engström, 2023 ^j ; Gustavsson & Hallin 2014 ^k				

Adapting project management strategies

As project management in the construction and infrastructure sector is rooted in the hard paradigm research exploring project management strategies across the hard and soft paradigms continues to spark debate. Scholars question the sector’s reliance on the hard paradigm and promote alternative project management strategies (e.g., Koppenjan et al., 2011; Guerrero & Engström, 2024). Practices based on the hard paradigm, which emphasize control, are seen as more suitable for simple, straightforward projects (Koppenjan et al., 2011; Eriksson et al., 2017). In contrast, for complex, uncertain projects requiring innovation, soft paradigm approaches are considered better suited to managing adaptation and change (Koppenjan et al., 2011; Eriksson et al., 2017). Previous research stresses the value of incorporating

elements from both paradigms (e.g., Koppenjan et al., 2011; Eriksson et al., 2017; Guerrero & Engström, 2024), a concept described as “balance” (Guerrero & Engström, 2024).

Yet, what it means to balance between the hard and soft paradigms remains unclear. First, the definition of balance varies: some argue hard practices should be complemented by soft ones (Szentés & Eriksson, 2016; Eriksson et al., 2017), while others suggest combining of the two (Koppenjan et al., 2011; Guerrero & Engström, 2024). Second, despite Pollack’s (2007) distinction between practices and purposes, existing research rarely separates these clearly (e.g., Eriksson et al., 2017; Guerrero & Engström, 2024), leaving it uncertain whether the aim is to balance practices, purposes, and/or something else.

Despite the lack of clear definitions of what balance means within previous research, Eriksson et al. (2017) concluded that adopting a flexibility-focused approach (soft), characterized by explorative learning, collaboration, and adaptability, within a control-focused paradigm (hard) improved time performance in complex infrastructure projects. Research highlights the limitations of both hard and soft paradigms, advocating for using both to mitigate the risks of a one-sided focus (Koppenjan et al., 2011; Lalic et al., 2022).

Using both hard and soft practices and purposes remains challenging, particularly due to contextual constraints. For example, a project’s setup – shaped by senior officials, historical precedents, administrative decisions, and external factors – often limits managerial flexibility (Koppenjan et al., 2011). This tension is especially obvious when managers must stick to short-term benefits, such as meeting deadlines and budgets, with long-term benefits like promoting construction innovation (Guerrero & Engström, 2024). Guerrero and Engström (2024) further observed that in infrastructure project contexts the client often prioritizes hard practices, even in initiatives intended to encourage innovation, creating friction between conflicting goals. Finally, Szentés and Eriksson (2016) contribute to this discussion by arguing that the use of both hard and soft project management must be operationalized across multiple levels, both intra-organizational and inter-organizational.

Three

RESEARCH METHODS

This chapter outlines the research process and the methods employed in this study. It begins with an overview of the longitudinal case and the three sub-studies, followed by a description of the research process. Next, it details the collection of empirical material and the methods of analysis. Finally, it addresses the use of artificial intelligence and presents an evaluation of research quality.

A longitudinal case study

This thesis draws on a longitudinal single-case study of a public client, the STA, conducted from December 2019 to March 2024. In-depth single-case studies are often favored over multiple-case designs for exploring complex issues, as they provide deeper and more nuanced insights (Flyvbjerg, 2006) and may serve as “a very powerful example” (Siggelkow, 2007, p. 20).

Given the STA’s mission and scale, it qualifies as a critical favorable case (Flyvbjerg, 2006) for examining how a public infrastructure client promote innovation for the sustainability transition by adapting procurement and project management strategies during planning and design. This longitudinal case was intended to support analytical, not statistical, generalization – an approach common in qualitative case studies (Flyvbjerg, 2006). As the leading actor in Sweden’s infrastructure sector, the STA influences the broader industry, including smaller public clients and suppliers like engineering consultants. Additionally, many public clients outside Sweden share traits with the STA – such as the responsibility to promote innovation in line with sustainability goals, operating in a project-based manner, and being constrained

by public procurement regulations – suggesting that the findings may be applicable beyond the Swedish context.

Description of case organization

The STA was formed in 2010 through the merger of Sweden’s former road and railway administrations. It is among the largest government agencies in the country, employing around 10,500 and managing a 94 billion SEK budget, with 67 billion SEK spent on procuring goods and services from private firms (Trafikverket, 2025). The STA’s broad mandate covers long-term planning for all four transport modes – road, railway, air, and sea – as well as managing and procuring construction and maintenance for road and rail infrastructure. It is also responsible for scheduling train traffic and issuing driver's licenses. Figure 5 shows a simplified organizational chart of the STA.

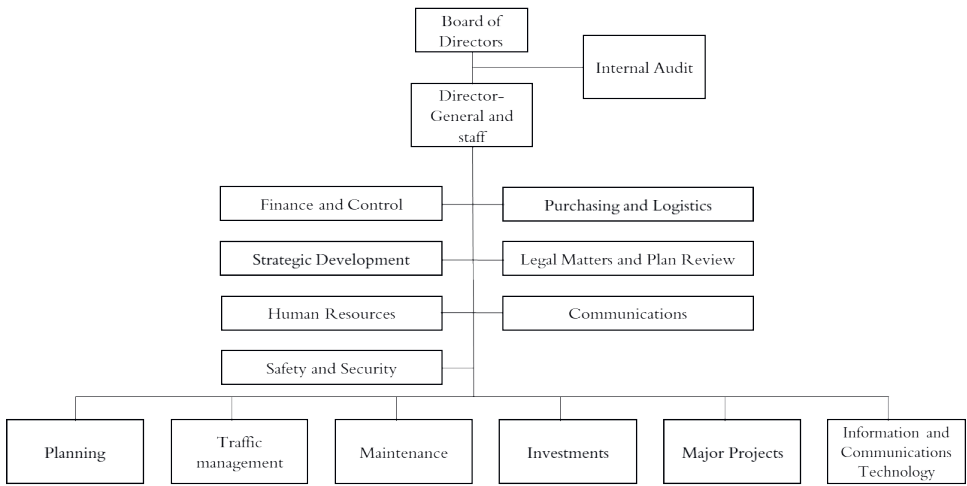


Figure 5: Organizational chart of the STA.

According to Sweden’s national climate goal, the country aims to achieve net-zero greenhouse gas emissions by 2045 at the latest. In addition, emissions from domestic transport (excluding aviation) are to be reduced by at least 70 percent by 2030 compared to 2010 levels (Trafikverket, 2025). As the owner of national transport infrastructure, the STA plays a key role in driving this sustainability transition, both

by reducing emissions from traffic and from its own infrastructure management activities, including construction, maintenance, and operations.

The STA has set a long-term climate goal of achieving climate neutrality in infrastructure management by 2040, based on a life cycle perspective (Trafikverket. 2025). In the annual report for 2024 figures show, emissions related to the construction, maintenance, and operation of road and railway infrastructure – covering both STA’s internal activities and work procured from suppliers – amounted to approximately 1.2 million tonnes of carbon dioxide equivalents (ibid). This figure stands in contrast to the 12.8 million tonnes generated by traffic-related emissions (ibid).

From a broader perspective, emissions generated by construction, maintenance, and operation of infrastructure are substantially lower than the emissions from the traffic using the infrastructure. In fact, new investments in roads and railways completed in 2024 resulted in a net increase in emissions from traffic by approximately 4,224 tons of carbon dioxide equivalents (ibid). This indicates that constructing new roads and railways not only contributes emissions during the project itself but also results in increased emissions once the infrastructure is in use – given current vehicle fuel types. To meet its climate targets related to construction, maintenance, and operation, the STA has implemented a range of measures. These include setting requirements and offering incentives for emission reductions in infrastructure design and construction, as well as initiating dedicated pilot projects to test and accelerate climate-friendly practices (ibid).

Due to its mission as a major public client, which includes striving to enhance productivity, innovation, and efficiency in related markets, several initiatives were launched. In 2009, the government requested the establishment of a "Productivity Committee" to evaluate how the STA should act to fulfill this mission. This effort resulted in recommendations (SOU 2012:39) emphasizing the use of public procurement as a policy tool. Subsequently, the STA's role as a client was defined as a "pure client" (Trafikanalys, 2017), leading to a strategic shift towards fixed-price engineering consultancy contracts and design-bid contractor contracts. This shift was based on the idea that maintaining distance from contracting parties would create room for supplier-led innovation.

In 2016, the Purchasing and Logistics Department formalized a new business strategy based on a fit-to-project approach, drawing on Eriksson and Hane (2014). This approach aligns with the procurement framework proposed by Eriksson (2006) and Eriksson and Laan (2007). The strategy provides an overarching framework for adapting procurement strategies tailored to individual projects. Since its launch, it has been revised several times, shifting away from standardized methods – like the heavy reliance on fixed-price contracts – toward more adaptive strategies based on task characteristics and organizational goals, using procurement as a strategic tool for innovation and development.

Each STA project begins with an internal order outlining long-term impact goals (e.g., improved accessibility and traffic safety) aligning with the STA’s mission and the scope needed to meet them (e.g., installing median barriers, wildlife fences, and a bridge). Before initiation, the internal client and project execution department agree on the scope, timeline and budget, formalizing the "iron triangle" early. Projects follow a linear stage-gate model with tollgates, divided into five phases: planning, design I (including physical planning), design II (detailed design work), production, and closing. Each project also includes a set of tasks and activities carried out throughout its duration.

Since the STA procures most work from private companies, project progress follows a “relay race logic” (Kadefors et al., 2024, p. 23), with tasks executed through successive contracts. In the planning and design, the engineering consultant’s role may be split: one may handle the road plan and another the contractor’s tender documents (as in Project B), or both may be handled within a single consultancy contract (as in Project A). The tender documents are prepared for either a design-bid-build contract – with detailed design (Project A) – or a design-build contract, with less detailed design (Project B).

Figure 6 illustrates Project A’s setup, showing how the STA’s infrastructure project links to multiple supplier contracts. The STA procures the road plan and tender documents from engineering consultants, then contracts production services from contractors. Supplier deliverables allow the client to advance to the next project phase. While the client prepares tender documents for the initial public procurement (PP) of the road plan, consultant outputs serve as input for later procurement stages.

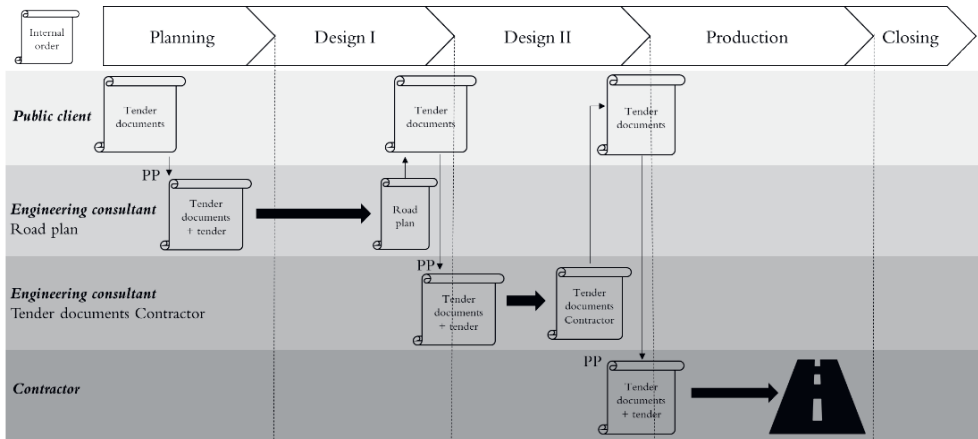


Figure 6: Illustration of the project process and the contracts procured by the public client.

Three sub-studies

In line with Yin (2009), the single-case study corresponds to an embedded case study design, incorporating three sub-studies. This embedded design provides researchers with the flexibility to modify or add sub-studies as the research progresses and new, interesting research questions emerge, rather than requiring a complete redesign of the study (Yin, 2009). As this thesis adopts an exploratory approach, and the research has largely been guided by my empirical interests and inspirations – further detailed in the section on the research process – this design facilitated the research process.

A common pitfall of this embedded case design is that researchers may overly focus on the sub-studies and fail to return to the larger case in their conclusions (Yin, 2009). To address this, this thesis aims to strengthen the connection to the larger case – the STA – ensuring that the findings from each of the three sub-studies are integrated into a comprehensive understanding, relating to all three fields of literature: procurement strategy, construction innovation, and project management strategy.

The first sub-study focused on how a public client adapts its procurement strategy, particularly in terms of the choice of control modes. To capture a broad perspective on the adaptation of procurement strategies within the STA, this included an interview study of the management level, encompassing managers who oversee

project managers for small-, medium-, and large-scale infrastructure projects, as well as those responsible for supervising purchasers. These managers are responsible for approving procurement strategy decisions and are involved in multiple procurements of engineering consultants, and thus considered suitable to interview.

The second sub-study examined a specific project, Project A, which is managed within the Investments business unit. This project was assigned a sustainability-related goal by the management level, aiming to reduce carbon emissions throughout the project – from the planning (road planning) through to construction.

The third sub-study centered on Project B, which is managed within the Major Projects business unit and is part of a program comprising seven projects. Project B is specifically highlighted in the Swedish National Plan for Transport Infrastructure, as proposed by the STA and approved by the government. This project was assigned a sustainability-related goal by the government through the National Plan to improve production efficiency and significantly reduce the climate impact of the production phase through innovation, digitalization, electrification, and automation.

Projects A and B (see Table 3) are specially designated pilot projects within their respective business units, each with similar goals and expectation of promoting innovation towards the sustainability transition. Thus, they serve as two distinct sub-cases within the broader case of the STA and were primarily selected due to their explicit sustainability-related goals and the STA's expectations, which align with the focus of this thesis – promoting construction innovation towards the sustainability transition. These two sub-cases serve as favorable critical cases (Flyvbjerg, 2006) for exploring how a public client promotes innovation to achieve long-term benefits through the adaptation of procurement and project management strategies. As the largest public client in the Swedish construction and infrastructure sector, the STA has initiated pilot projects explicitly designed to promote innovation supporting the sustainability transition. This makes these two sub-cases critical for understanding innovation promotion within the sector and for studying how such efforts can influence broader sectoral practices.

Table 3: Outline of the two projects in focus.

	Project A	Project B
Est. project budget	40 million EUR	160 million EUR
Est. engineering contract value	1.8 million EUR	5 million EUR
Scope of the engineering construct	Road plan, tender documents for the contractor and construction site monitoring.	Tender documents for the contractor and investigation of innovation within the construction project.
Scope of the project (major parts)	2+1 lane (widening of existing road) Median barriers Bridges Bicycle and pedestrian path Wildlife fence	Motorway (widening of existing road) Intersections Median barriers Bridges Bicycle and pedestrian path Wildlife fence
Sustainability-related goal (as expressed in the specification to the engineering consultant [svenska: uppdragsbeskrivning])	"The project aims to reduce carbon dioxide emissions by 50% [compared to a standard value from 2015] during the road planning, procurement, and production phases" (p. 9).	"Innovation goals for the production phase [svenska: entreprenad]: * No local greenhouse gas emissions from machinery and vehicles * At least 50% of the total energy use for vehicles and machinery must consist of electricity from renewable energy sources * Materials used in the project (concrete/cement, steel, and asphalt paving) must meet or exceed Trafikverket's current climate requirements for investment measures <50 million SEK for the year 2030 and beyond (see TDOK 2015:0480) * 100% of the crushed material must come from contracts within the program * Fewer than 4 accidents per million hours worked" (p. 6).

Thus, these sub-cases allow for analytical generalization: in the context of promoting construction innovation for the sustainability transition, if barriers and shortcomings are identified in these projects, it is likely that similar issues are/will be present in other projects too. Similarly, any successes achieved in these projects may offer insights and practices that other projects could adopt. Consequently, studying these sub-cases provides a rich source of information, offering valuable insights into the phenomena studied.

In addition to Projects A and B involving the same client – the STA – both projects also engaged the same engineering consultancy company. However, only a few professionals participated in both projects on either side. Due to the innovation-related focus of both projects, certain professionals were intentionally engaged based on their innovation expertise, as required by the client. Some of these individuals were employed by other divisions within the engineering consultancy company, while others represented various sub-consultants. In Project B, one such professional was also part of the client organization.

These individuals brought experience in project management, leading or facilitating innovation processes, or working in innovation-related roles within sectors such as other governmental agencies, the automotive industry, construction equipment, or various technology companies. In this thesis, such individuals are referred to as *external knowledge resources*. In contrast to internal knowledge resources, external knowledge resources have little or no experience working within the construction and infrastructure sector (Ozorhon et al., 2016), and are therefore less constrained by existing processes, organizational culture, and routines (Duan et al., 2023).

The three sub-studies partially overlapped in time, as illustrated in Table 4. As shown, sub-study 2 included a break, dividing it into two parts (2.1 and 2.2), each with distinct focuses and utilizing different frameworks. Sub-study 2.1 resulted in Paper 2, while sub-study 2.2, in combination with sub-study 3, contributed to the development of Paper 4.

In sub-study 1, the control modes framework (Ouchi, 1979, 1980) and the procurement strategy framework (Eriksson, 2006; Eriksson & Laan, 2007) were further developed and applied to analyze how a public client adapts its procurement strategy, specifically in terms of choice of control modes. In Sub-study 2.1, the same theoretical frameworks applied in Sub-study 1 were extended by incorporating the concept of adaptability (Williamson, 1985) to explore how the public client adapt procurement strategies to promote innovation with long-term benefits. As discussed in Paper 2, this sub-study analyzed the choice of control modes and the incentives for adaptability they create for engineering consultants, particularly in relation to carbon reduction.

In sub-study 3, the innovation framework developed by Crossan and Apaydin (2010) and Cantarelli and Genovese (2021) was further refined and applied to assess

the perceptions of innovation outcomes and processes among three key project actors: the public client, engineering consultants, and sub-consultants. This analysis resulted in Paper 3. Subsequently, sub-studies 2.2 and 3 were integrated, and the framework of hard and soft project management was employed to explore how the public client adapts project management strategies to promote innovation, leading to the development of Paper 4.

Table 4: Outline of the three sub-studies.

Sub-study	Type of study	Data collection	Frameworks used	Appended paper	RQ
1	Interview study: Management level	May–August 2020	Control modes (Ouchi, 1979; 1980). Procurement strategy (Eriksson, 2006; Eriksson and Laan, 2007).	Paper 1	2
2	Sub-case: Project A	2.1 November 2020–October 2021 2.2: April–June 2024	2.1: Control modes (Ouchi, 1979; 1980). Procurement strategy (Eriksson, 2006; Eriksson and Laan, 2007). High- and low-powered incentives (Williamson, 1985). 2.2: Framework of hard and soft (Crawford and Pollack, 2004; Pollack, 2007).	Paper 2 (2.1) Paper 4 (2.2)	1-3
3	Sub-case: Project B	January 2023–June 2024	Innovation framework (Crossan and Apaydin, 2010; Cantarelli and Genovese, 2021). Framework of hard and soft (Crawford and Pollack, 2004; Pollack, 2007).	Paper 3 and 4	1-3

The sub-studies aimed to contribute to three construction management – related fields of literature: construction innovation, procurement strategy, and project management strategy in different ways. Collectively, these studies contribute to understanding how a public infrastructure client promotes innovation towards the sustainability transition through adaptation of procurement and project management strategies in planning and design of infrastructure. Specifically, they investigate how procurement and project management strategies are adapted in the procurement of engineering consultants. Through the three sub-studies, different aspects of the overarching problem presented in this thesis are addressed, ultimately contributing to all three key fields of literature – construction innovation, procurement strategy, and project management strategy – as illustrated in red in Figure 7.

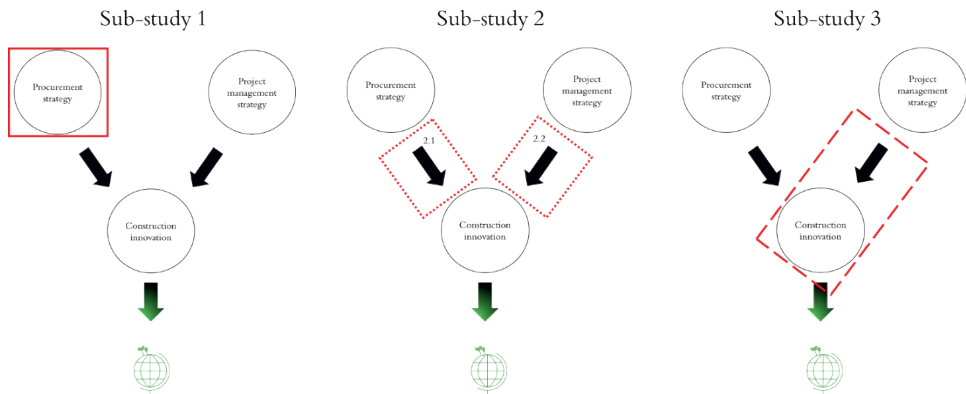


Figure 7: Outline of how the three sub-studies relate to the three fields of literature.

Each of the three sub-studies following a structured process: starting with a review of relevant literature, followed by planning the study, collecting empirical material, analyzing the material, and finally writing the paper. For the second and third studies, this process was repeated a second time as they resulted in two papers each. Although this description suggests a linear process, the actual workflow was more iterative, involving frequent movement back and forth between different stages.

Although the focus of these three sub-studies has been on the STA, collection of empirical material in all three sub-studies also included representatives from engineering consultants to capture their perspectives on the topics studied. This approach allowed for understanding both the perspective of the innovation promoter and that of the actor intended to be promoted. In sub-study 1, managers from six different engineering consultant companies were interviewed. In sub-study 2 and 3, respondents from the contracted engineering consultant company (as well as from their sub-consultants) were interviewed and participated in observed meetings.

The research process

My PhD journey began in the fall of 2019. At the start of my PhD studies, I conducted a literature review, resulting in a report on the current scientific knowledge regarding the public procurement of engineering consultancy services within the construction and infrastructure sector. This offered an initial understanding on the field of literature related to procurement strategies. Since then, I have continued conducting literature searches, exploring the fields of construction innovation and project management strategy, which helped shape the understanding of different analytical frameworks and understanding of previous research. The literature review primarily included scientific articles, but also incorporated conference proceedings, government documents (from the Swedish government and STA), websites, and agency reports.

Before beginning my doctoral studies, I worked as a purchaser at the STA. Additionally, both prior to and during my PhD studies, I also gained extensive experience in procurement strategy development (based on the same procurement framework included in this thesis). This practical background provided me with a deep understanding of public procurement regulations as well as the procurement framework (Eriksson, 2006; Eriksson & Laan, 2007), the project-based nature of the construction and infrastructure sector in which these practices are situated. Since the procurement framework, based on studies of contractors (Eriksson, 2006; Eriksson & Laan, 2007), is also utilized within the STA for procuring engineering consultants, I was already familiar with its application. However, I recognized a practical need to develop a framework better suited for the procurement of engineering consultants and I also believed it could be useful to understand a public client's adaptation of procurement strategies. Consequently, further developing the procurement framework and applying it in the first two papers felt like a natural choice.

During sub-study 2, I encountered the concept of innovation and explored how procurement strategies could be adapted to promote innovation toward specific goals. Through this process, I realized that innovation is a multidimensional and complex concept, which led to the third sub-study. This third sub-study initially explored how various project actors (i.e., public client, engineering consultant and sub-consultant) perceive innovation. Additionally, further developing an innovation framework that public clients could utilize in decision-making and

discussions with various project actors was another key motivation behind the design of this sub-study.

Throughout my doctoral research – across the three sub-studies – as well as in my role as a procurement strategist, I encountered a significant practical challenge for public clients, as outlined in the introduction to this thesis. Specifically, I reflected on that in order for public clients to effectively promote innovation towards the sustainability transition, focusing solely on procurement strategies might not be sufficient, as project management strategies also influence the promotion of innovation. Upon identifying this issue, I was introduced to the framework of hard and soft project management, which I found to be a valuable tool for further exploring this problem. Consequently, I recognized the need to investigate public clients' adaptation of project management strategies and their role in promoting construction innovation toward sustainability transition, integrating insights from both Project A and Project B in the process.

Thus, my research process has been emergent, partly driven by my interest in developing and adapting frameworks for practical application within public clients. Additionally, the research process has been motivated by a desire to explore new and relevant challenges, contributing to a deeper understanding of these issues. Throughout this process, different frameworks have been perceived useful in gaining further insights within the different sub-studies. In doing so, my research not only provides practical contributions but also raises awareness among scholars about existing challenges in practice that require further understanding and diverse research approaches. As a result, this thesis connects three distinct yet interrelated fields within construction management research: construction innovation, procurement strategy, and project management strategy.

Collection of empirical material

The collection of empirical material began in 2020 and was ended in 2024. The empirical material was gathered using a combination of methods, including observations, interviews, and document studies, which will be further described below.

Overall presentation of the collection of empirical material

In total, 160 hours of observations were conducted in sub-study 2 and 3. A detailed breakdown of the observations is provided for each of the two sub-studies below. These were documented in notes, with each observed meeting written in a separate Word document. These notes included the meeting title, the attendees, and the duration of the meeting. Additionally, as much of the discussions as possible was written down, with each speaker identified by their initials. While I was able to capture the topics discussed and most of what was said, direct quotations were not possible to capture. All observations were also documented in an Excel spreadsheet to systematically track key details, including the date of each observation, the number of observations conducted, their duration, whether they were held online or in person, the attendees, and other relevant information.

The empirical material from the interviews was gathered in alignment with the framework relevant to each appended paper, which structured the semi-structured interview questions. Before each interview round, the formulation was tested the formulation of some questions by consulting various project managers, purchasers, and specialists within the STA to ensure that the questions were understood as intended based on the frameworks. Minor adjustments were made following these tests. Additionally, slight modifications were made to the interview questions after conducting a few interviews, and in some interview rounds, one or two questions were added to the interview guide due to interesting aspects raised in early interviews. Follow-up questions were frequently used to deepen the responses to the predetermined questions.

Separate interview guides were developed for client and engineering consultant respondents. While most questions remained the same, some were slightly reformulated to capture their distinct perspectives – for instance, distinguishing between the innovation promoter and the one being promoted. Furthermore, certain questions varied to explore internal processes and templates specific to the client and engineering consultant organizations.

In total, 65 interviews, with 66 respondents, were conducted across the three sub-studies, amounting to approximately 87 hours. Of these, 2 interviews were conducted in person, while the remaining 62 were conducted via online platforms such as Skype. A detailed breakdown of the interviews is provided for each sub-study below. The respondents represented both the STA, with their organizational

affiliations marked in grey and illustrated in Figure 8, and various engineering consultancy companies. The majority of client respondents are affiliated with the project-executing departments – Investments and Major Projects – as well as the procurement-related department of Purchasing and Logistics. Thus, in relation to promoting construction innovation through adapting procurement and project management strategies, these departments are the most influential within the STA. With the exception of seven interviews conducted during the second round of sub-studies 2 and 3 – which were led by the co-author of Paper 4 – I conducted all interviews. These seven interviews were led by my co-author due to my prior interactions with the respondents – either because I had previously conducted interviews with them or was already familiar with them from other occasions. However, for these seven interviews, I was present, took notes, and asked follow-up questions. All interviews were recorded and transcribed by me. This approach allowed me to focus on the conversations without needing to take extensive notes during the interviews. Additionally, transcribing the interviews myself facilitated the analysis, as it enabled me to engage deeply with the material, not only during the interviews but also during transcription. Although the transcription process was time-consuming, it significantly helped me familiarize myself with the empirical material.

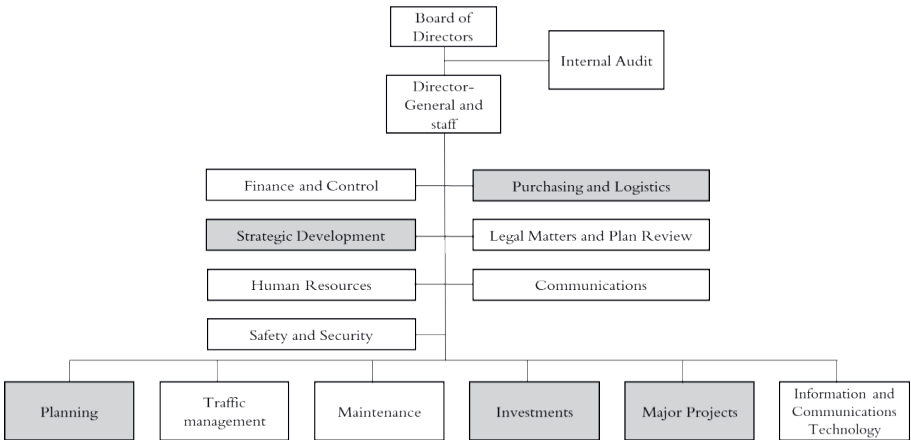


Figure 8: Organizational affiliation of respondents.

Collection of empirical material in sub-study 1

Interviews were conducted with 14 respondents, including managers from the client organization (departments: Procurement and Logistics, Investments, and Major Projects) and representatives from various engineering consultancy companies, as shown in Table 5. To study the choice of control modes based on task characteristics, it was essential to gain a comprehensive understanding of this phenomenon. Therefore, respondents were selected at the management level, as these respondents were involved in multiple engineering consultancy contracts.

It was also important to include perspectives from the other contracting party, gathering insights from various engineering consultancy companies, including both larger multidisciplinary companies and smaller companies with a specialized focus on the construction and infrastructure sector.

Table 5: List of the 14 respondents - sub-study 1.

Organization	Professional role	Sub-study	Lenght (min)
<i>Interviews conducted 2020</i>			
Public client	Client manager	1	80
Public client	Client manager	1	70
Public client	Client manager	1	75
Public client	Client manager	1	85
Public client	Client manager	1	75
Public client	Client manager	1	75
Public client	Client manager	1	45
Public client	Client manager	1	90
Engineering consultancy company Larger	Engineering manager	1	80
Engineering consultancy company Larger	Engineering manager	1	80
Engineering consultancy company Smaller	Engineering manager	1	75
Engineering consultancy company Larger	Engineering manager	1	80
Engineering consultancy company Larger	Engineering manager	1	80
Engineering consultancy company Smaller	Engineering manager	1	70
			1060

Below are examples of questions asked to the respondents:

- Describe an ordinary consultancy assignment [Svenska: konsultuppdrag] within the STA.
- Client: What do you procure from the engineering consultancy companies?
- Engineering consultant: What do you sell to the STA?
- How do the task characteristics [Svenska: projektförutsättningarna] look like in consultancy assignments within physical planning and design, respectively?

- Client: What do you as a client regard when choosing...
 - ...how to specify?
 - ...reward system?
 - ...how to evaluate?

Collection of empirical material in sub-study 2

In this sub-study, the collection of empirical material included observations, interviews, and document analysis. In total, I conducted approximately 40 hours of observations across multiple sessions, during online settings. Observations started during the pre-tender phase, focusing on meetings where the client's project team engaged in market dialogues with potential engineering consultancy companies, discussed procurement strategies, and prepared tender documents. These observations provided insights into how different engineering consultancy companies perceived various procurement strategies and captured the internal discussions within the public client as they discussed and decided upon how to adapt the procurement strategy, as well as aspects related to project management strategy. In the post-tender phase, when the contract was signed, the observations continued in meetings attended by both the client and the winning engineering consultant.

Two rounds of interviews were conducted, as shown in Table 6. The first round took place during the tender phase in 2021, after the preparatory work for the tender had been completed, totaling 16 interviews. These interviews focused on the public procurement of engineering consultancy services aimed at promoting innovation towards carbon reduction, with particular attention given to the choice of control modes. To gain relevant insights, it was essential to include project team members from the client organization who were involved in decisions related to procurement strategy and tender document preparation. Respondents included purchasers and procurement strategists from the Purchasing and Logistics department, as well as a unit manager, project manager, project engineer, and various technical specialists, within different disciplines, from the Investment department. To gain insights from the perspective of the winning engineering consultant, interviews were conducted with members of the consultancy's bidding and project teams primarily represented by members of their project management team led by their project manager.

Below are examples of questions asked to the respondents:

- Describe the uncertainties and complexity in this consultancy assignment.
- Client: How would you describe your understanding of the tasks and activities the engineering consultants need to carry out?
- Engineering consultant: Based on the tender documents, how would you describe the client's understanding of the tasks and activities you need to carry out?
- Client: What degrees of freedom have you provided for the engineering consultants in this assignment?
- Engineering consultant: How does the reward system affect your prerequisites to reach the carbon reduction goals?

The second round of interviews within Project A was conducted in 2024, comprising a total of 8 interviews (including one respondent representing both Project A and Project B, marked with ★). These interviews aimed to provide insights into adapting project management strategy to promote innovation. Therefore, it was essential to interview the internal client responsible for evaluating project execution, who belongs to the Planning department. Additionally, interviews were conducted with the purchaser from the Purchasing and Logistics department, as well as the project manager, unit manager, and climate expert from the Investment department. To capture the perspective of the engineering consultancy company, interviews were conducted with internal knowledge resources, such as the project manager and the discipline lead for climate. Additionally, it was considered important to include the external knowledge resource, the discipline lead for innovation, who has expertise in innovation processes. Apart from the purchaser, the professionals in other roles had changed between the first and second rounds of interviews.

Below are examples of questions asked to the respondents:

- What aspects that you associate with a good project and good project management do you think are present in this project?
- This project is an innovation pilot, what does that mean for you?
- Are there any other goals that conflict with the goals associated with the sustainability-related goals? If yes, which and how?

- Describe how you have worked with exploring and developing different solution.

Table 6: List of the 24 respondents - sub-study 2.

Organization	Professional role	Sub-study	Lenght (min)
<i>Interviews conducted 2021</i>			
Public client	Project manager	2.1	125
Public client	Project engineer	2.1	105
Public client	Purchaser	2.1	125
Public client	Innovation strategist	2.1	60
Public client	Unit manager	2.1	45
Public client	Specialist environment	2.1	110
Public client	Specialist bridge construction	2.1	110
Public client	Specialist road design	2.1	110
Public client	Specialist road equipment	2.1	45
Public client	Specialist geotechnics	2.1	75
Engineering consultancy firm	Bid manager	2.1	90
Engineering consultancy firm	Project manger	2.1	90
Engineering consultancy firm	Design manager	2.1	90
Engineering consultancy firm	Climate coordinator	2.1	80
Engineering consultancy firm	Plan coordinator	2.1	80
Engineering consultancy firm	Function coordinator	2.1	75
<i>Interviews conducted 2024</i>			
Public client	Project manager	2.2	100
Public client	Purchaser	2.2	90
Public client	Climate expert	2.2	90
Public client	Unit manager	2.2	60
Public client	Internal client	2.2	90
Engineering consultancy firm	Project manager	2.2	120
Engineering consultancy firm	Discipline lead Innovation	2.2	90
Engineering consultancy firm	Discipline lead climate*	2.2	100
			2155

Collection of empirical material in sub-study 3

The collection of empirical material began in January 2023 with the observation of the start-up meeting for the contract, where representatives from the public client, the engineering consultant, and different sub-consultants were present. These initial observations served multiple purposes. Beyond gathering initial insights, the observations helped decide upon the focus of the study and determine the appropriate framework to apply. Additionally, they facilitated introductions to key

professionals who would later participate in interviews. This early engagement was important to building relationships and establishing trust, which proved crucial for conducting in-depth interviews in the later stages of the collection of empirical material.

In total, observations were conducted over multiple sessions spanning 1.5 years, amounting to approximately 120 hours. These observations included both physical and online meetings. The discussions during the observed meetings followed the specific meeting agendas, which were set by project members from either the client or the engineering consultant, not by me. The unstructured nature of the observations allowed them to be used flexibly, for various analytical purposes by shifting between different analytical lenses. For instance, a single observation could yield insights into both the actors' perceptions of innovation outcomes and processes, and how their practices and purposes related to the hard and soft paradigms, simply by applying different analytical perspectives. The observation notes were mainly used to complement the depth of interview material by adding breadth to the understanding, also putting aspects mentioned in the interviews in a real-life setting.

The first interview round of two was conducted in 2023, totaling 18 interviews, as illustrated in Table 7. The initial interviews included respondents from various departments within the client organization to capture a comprehensive understanding of the expectations surrounding the project, in terms of innovation outcomes and processes. This involved interviews with managers from the Major Projects department, as well as strategists from several departments (Major Projects, Planning, and Strategic Development). Further interviews were conducted with project team members, including a purchaser from the Purchasing and Logistics department, and a project manager, design manager, and project manager innovation from the Major Projects department.

To capture the perspective of the engineering consultancy company, interviews were held with their project manager, design manager, and two discipline leads. Additionally, to gain insights from the external knowledge resources involved by the engineering consultant, interviews were conducted with representatives from the sub-consultants (also called innovation consultant). The interviews included the discipline lead for innovation, who managed the entire innovation team of 10-12 professionals, as well as discipline leads specializing in electrification, digitalization,

and automation. The discipline lead for innovation has expertise in developing and managing innovation processes, while the other members of the innovation team have experience working within various innovation processes. These disciplines extend beyond the traditional scope of engineering consultancy contracts within infrastructure projects. These three focus areas – electrification, digitalization, and automation – were designated by the government in the National Plan for Infrastructure as key facilitators for innovation and progress toward the sustainability transition in Project B, making them central to the focus of the engineering contract as well.

Below are examples of questions asked to the respondents:

- What are the innovations within [name of the consultancy contract] and [name of the contractor contract] supposed to contribute to?
- Which roles and actors work with innovation and development within the assignment?
- How does the work related to innovation and development look like within the assignment?
- What are the consultants supposed to deliver?
- Describe some of the innovations you think the [name of the engineering contract] will result in.
- How do these innovations distinguish from the current practice?

The second round of interviews, conducted in 2024, aligned with sub-study 2's second interview round and included 9 interviews (excluding one with the respondent representing both Project A and B), as shown in Table 7. This round sought to explore how actors engage in project management to jointly promote innovation for the sustainability transition. As in sub-study 2, the internal client responsible for evaluating project execution – part of the Planning Department – was interviewed. Additional interviews included the purchaser from the Purchasing and Logistics Department, and the project manager, department manager, and climate expert from the Major Projects Department. To reflect the engineering consultancy's perspective, interviews were conducted with their project manager, design manager, deputy design manager, and discipline lead for climate. An interview was also held with the discipline lead for innovation, an external knowledge resource with expertise in innovation processes. The design manager and deputy design manager were interviewed together, as the former was new to the role while the latter had been involved since the beginning. Several respondents

were interviewed in both rounds, including the client’s project manager, department manager, discipline lead for climate, and discipline lead for innovation. The questions asked to the respondents are the same as in the second interview round in sub-study 2.

Table 7: List of the 28 respondents – sub-study 3.

Organization	Professional role	Sub-study	Length (min)
<i>Interviews conducted 2023</i>			
Public client	Department manager	3	50
Public client	Program manager	3	50
Public client	Staff manager	3	70
Public client	Innovation strategist	3	60
Public client	Electrification strategist	3	40
Public client	Digitalisation strategist	3	55
Public client	Purchaser	3	55
Public client	Project manager innovation	3	80
Public client	Project manager	3	80
Public client	Design manager	3	85
Engineering consultancy firm	Project manager	3	70
Engineering consultancy firm	Design manager	3	60
Engineering consultancy firm	Discipline lead climate	3	45
Engineering consultancy firm	Discipline lead bridge construction	3	30
Sub-consultant	Discipline lead innovation	3	80
Sub-consultant	Discipline lead electrification	3	55
Sub-consultant	Discipline lead automation	3	85
Sub-consultant	Discipline lead digitalization	3	50
<i>Interviews conducted 2024</i>			
Public client	Project manager	3	90
Public client	Purchaser	3	90
Public client	Climate expert	3	90
Public client	Department manager	3	80
Public client	Internal client	3	90
Public client	Project manager Innovation	3	100
Engineering consultancy firm	Project manager	3	130
Engineering consultancy firm	Design manager and deputy	3	115
Sub-consultant	Discipline lead Innovation	3	90
			1975

Analysis of empirical material

The analysis of the empirical material was tied to each of the four appended papers, with a separate coding and analysis process conducted for each. Thus, more details are found in each paper.

Overall presentation of the analysis

For Papers 1–3, empirical material intentionally collected for earlier papers were not specifically reused in the analysis of the paper at hand due to it belonging to different sub-studies. However, as a qualitative researcher, the analysis for each paper inherently included insights gained from the earlier papers, even though interview transcripts were only intentionally incorporated into the coding process for a single paper. For Paper 4, parts of the interview transcripts from earlier interview rounds, as well as the observation notes, were revisited primarily to gain a deeper understanding.

The analysis processes for all four papers began during the observations and interviews, as discussions contributed to initial reflections on the topics studied. As I transcribed the interviews, I became increasingly familiar with the empirical material. To facilitate analysis, the transcripts were color-coded to distinguish who said what. I then read through the transcripts, extracting relevant citations and pasting them into a structured Word document, organized with headings and subheadings based on the framework relevant to each paper.

For Papers 2 and 3, observation notes were also color-coded to indicate the specific meeting from which each note originated. Since the notes included the initials of speakers, I was able to code them into the same large Word document alongside the interview citations. This allowed me to distinguish between statements made during interviews and discussions that took place during observations, while also identifying who contributed to each. In many cases, the notes captured dialogues between multiple professionals, which were coded together.

As I became more familiar with the material and refined my interpretation of the empirical material, citations and notes were reorganized under different headings, forming themes. I also revisited transcripts and notes multiple times to ensure coherence in my interpretations. This initial coding process was conducted in a similar manner across all four papers. After this point, the analysis process differed between the papers. However, due to significant similarities between Paper 1 and Paper 2, as well as between Paper 3 and Paper 4, the following sections will be structured accordingly. The chapter will conclude with the overall analysis for this thesis.

Analysis in Paper 1 and 2

In Papers 1 and 2, the analysis followed a similar structure, beginning with the development of conceptual frameworks that were then illustrated using the empirical material from the case studies (Siggelkow, 2007). A flexible pattern-matching approach was employed to test the frameworks, balancing rigor with adaptability (Bouncken et al., 2021). Each of the analysis processes, started with manually coding the interview transcripts and observation notes (the latter used only in Paper 2), into the analytical frameworks, as illustrated in Table 8. The abbreviations used in the table are as follows: STA refers to a client respondent, and ECC stands for an engineering consultancy company respondent.

Table 8: Illustration of coding in Paper 2.

	Output control	Process control	Social control
Specification	“It is pretty clear what we should do. How we do it is up to us” (ECCm).	“In general, our regulation is very detailed. We have a lot of requirements” (STAd).	“It is good that we can adapt depending on what is actually demanded” (ECCo).
Bid invitation/evaluation	“We could not find what exactly to negotiate, and thus we chose not to.” (STAA).	“Are we able to put requirements on the ECCs to have competence within production?” (STAA).	“We would like them to present their organization and what way of working they intend to use in order to reach the carbon reduction goal.” (STAb).
Reward system	“I think we would have been very uncertain and very unwilling to submit a bid if it had been a fixed-price, due to there being a lot of uncertainties along the road.” (ECCk).	“I think it [time-and-materials] was a pre-requisite for us to submit a good bid and for us to jointly reach the [reduction] goal.” (ECCk).	“It would be nice if you could get a part of the carbon reduction as a bonus.” (ECC1).

The empirical material can be described as empirical patterns of perceptions regarding the client's adaptation of procurement strategies, based on task characteristics (Paper 1) and the promotion of innovation for long-term impact (Paper 2). These patterns were then compared to the frameworks and their theoretical predictions to identify matches (similarities) and mismatches (differences) between the empirical material and the frameworks. For example, mismatches were identified between their choice of control modes and the selection that the framework would suggest as the most suitable (which are further illustrated by Tables in Paper 1 and 2). When matches or mismatches were identified, their underlying causes were examined to deepen the understanding of the studied phenomena (Eisenhardt, 1989). Comparisons within the empirical material – such

as between different actors – were conducted to gain deeper insights into the phenomena.

Thus, I applied the further developed frameworks – namely, the control modes and procurement frameworks related to Paper 1, as well as the procurement framework and classification framework (as visualized in Paper 2 and in the chapter summarizing the appended papers) – when structuring and analyzing the empirical material for Papers 1 and 2. In the analysis related to Paper 2, I also revisited the tender documents multiple times to validate aspects mentioned during observations and interviews.

The analysis process involved iterative engagement with the literature, moving back and forth between literature and the empirical material to deepen understanding. Throughout the analysis, I discussed the findings with my co-authors to validate interpretations. Additionally, I sought feedback from practitioners to further ensure the validity of the findings. The analysis and interpretations were refined continuously until each paper was completed.

Analysis in Paper 3 and 4

The analysis of these papers followed an approach inspired by thematic analysis (Braun & Clarke, 2006), allowing new themes to emerge alongside those structured by analytical frameworks, as shown in Table 9 from Paper 3. This ensured that both predefined categories and new themes were captured, enabling a more nuanced understanding. During coding, sub-headings (themes) were continually added to a large Word document to structure and refine the analysis. Comparisons across empirical material – such as between actors or roles – were made to deepen understanding. For Papers 3 and 4, tender documents were revisited multiple times. These outlined contract scope, requirements, and legal terms, offering important insights into procurement and project management strategies and complementing data from observations and interviews.

For Paper 3, findings were discussed in meetings with co-authors to deepen interpretation and enhance credibility, refining the analysis until the paper was completed. In Paper 4, the co-author attended all interviews, and we held several meetings to cross-check finding to strengthen credibility. Since the co-author knew only one respondent from a previous study, while I was familiar with most, this

dynamic supported a more nuanced interpretation. Additionally, the fact that I approached the collaboration from a procurement perspective, while the co-author brought a project management perspective, further supported triangulation by incorporating diverse viewpoints.

Table 9: Example of coding in Paper 3.

Innovation as a process			
Dimension	Category	Themes	Illustrating quotes/descriptions
View	Top-down	Client	"We should have an innovative production that is a design-build, where the engineering consultant contract's focus is to create possibilities in the production to implement innovations." (C)
		Consultant	"We build something that give us the possibility to face complex problems, that our industry faces. We have the possibility to enter a space where others haven't yet entered." (IC)
	Bottom-up	Dedicated time for innovation work	"It is added to the work breakdown structure that everyone works with innovation." (EC)
Locus	Closed process	Innovation consultant work solely/lack of transparency	"Within the engineering consultant, we haven't worked with innovation at all." (EC)
	Open process	Collaboration with other actors based on the benefits	"It should be the innovation goals that decides which actors to talk to, not the other way around." (C)
		Collaboration with existing actors in the industry	"Not just talk to the contractors, but also the construction vehicle suppliers." (EC)
		Collaboration with new actors outside the industry	"In order to have automated construction vehicles that talk to each other, we need an extended communication and technical solution for communication on site. Thus, we need actors related to that kind of solutions." (C)
	Lack of understanding: innovation consultant vs client/engineering consultant	"The innovation group within the engineering consultant speaks a totally different language than the technical group within the consultant." (C)	
Source	Generation	Idea generation sessions	An idea generation workshop was observed.
	Adoption	Implementing innovations from other construction projects	In another project within the STA, algae in noise barriers that are able to handle both high levels of particles and noise from the road are used. "Variations of that [algae in noise barriers] I think we will see [in this project]." (C)
	Adaption	Implementing innovations from other industries	"We work with these things [digital models] within all industries, but all industries need their own adapted ones. You develop a model for a certain purpose." (IC)

C = Client

EC = Engineering consultant

IC = Innovation consultant

The analysis also included iterative engagement with the literature, moving between theoretical and empirical material to deepen understanding. Findings and paper drafts were discussed with other researchers to gain alternative perspectives, and select respondents were consulted to enhance the credibility of the results. The

analysis and interpretations were refined throughout the process until each paper was finalized.

Analysis in this thesis

This thesis integrates findings from four appended papers into a cohesive argument to examine how a public infrastructure client promotes innovation for the sustainability transition by adapting procurement and project management strategies. The analysis draws on four key frameworks: control modes, procurement, innovation, and hard and soft. It also incorporates perspectives from three literature fields: construction innovation, procurement strategy, and project management strategy.

Each appended paper contributes to the thesis's overall purpose. While all papers address the research questions and provide context, their specific contributions differ. Table 4 above outlines how each paper aligns with the thesis purpose and research questions, primarily through the frameworks employed. However, given the integrative nature of this thesis and qualitative research, insights from other papers are also included where relevant – either consciously or unconsciously.

Although the empirical material includes views from engineering consultants and sub-consultants, the analysis is intentionally centered on the public client's perspective as the promoter of innovation. This focus enables a clearer understanding of how public clients adapt their strategies. Still, insights from consultants are incorporated to reflect how innovation as well as these strategies are perceived by those affected, adding depth to the analysis of innovation promotion.

The use of artificial intelligence

As English is not my first language, I used an AI tool, ChatGPT, to improve the language in my thesis for three main purposes. First, to enhance the quality of my written English, I asked ChatGPT questions like, "Could you help me write this in proper academic English?" I would write a few sentences, copy them into ChatGPT, and then incorporate the improved version it provided into my thesis, as illustrated in Figure 9. I carefully reviewed the suggestions to ensure I understood all the words and that key terms were not replaced or altered; if needed, I made adjustments (as illustrated in the final sentence of this paragraph). Second, for Paper

4, I used ChatGPT to translate Swedish interview quotes into English by asking, “Could you help me translate this from Swedish to English?” An example of this process is illustrated in Figure 10. Third, I used ChatGPT to generate inspiration for the thesis title. I asked it to suggest possible titles, as shown in Figure 11, and then iteratively refined the options based on its suggestions. *In the end* (Ultimately), I chose a title that was a combination of some of the suggestions I received.

As English is not my mother tongue, I used an AI (artificial intelligence) tool, ChatGPT to improve the language. I used it for mainly three reasons. First, to improve my English in the written text, where I asked ChatGPT this question: “could you help me write this in proper academic english?” Then I wrote a text in the thesis, usually of a few sentences, that I copied and pasted in ChatGPT, then ChatGPT provided a response in improved English that I copied into the thesis. Then I read the text to make sure I understood all words and that the tool did not replace important terms, otherwise I replaced them with another words. Second, in Paper 4, I also used it for translating Swedish quotes from the interviews into English, by asking ChatGPT this question: could you help me translate this from swedish to english?, as illustrated in Figure x. Third, I also used ChatGPT to suggest some titles for the thesis that I could use as an inspiration. In Figure x, there is an illustration of the first suggestions I got and then I continued asking for adjustments on the suggestion I liked the best. In the end, I decided upon a title that was a mix of some of the suggestions I got.

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Figure 9: Example of language improvements by ChatGPT.

could you help me translate this from swedish to english?

Of course! Please provide the Swedish text, and I'll translate it into English for you.

det är oftast en kostnadsmässig försämring på kort sikt medan det ger oss en förbättring på lång sikt.

The translation of the sentence is:
"It is often a short-term cost disadvantage, while it provides us with a long-term improvement."

Figure 11: Example of ChatGPT assisting in translating from Swedish to English.

could you please help me with suggesting a 5 titles based on this suggestion?

Sure! Could you provide the suggestion or context you'd like the titles to be based on?

ADAPTING PROCUREMENT AND PROJECT MANAGEMENT STRATEGIES:
A public client's efforts to promote innovation

Here are five suggested titles based on your topic:

1. **Driving Innovation Through Procurement and Project Management: A Public Client's Strategic Approach**
2. **Fostering Innovation in Public Projects: Adapting Procurement and Management Tactics**
3. **Innovative Outcomes Through Strategic Procurement: Lessons from a Public Client**
4. **Revolutionizing Public Sector Innovation: Aligning Procurement and Project Management Strategies**
5. **Breaking Barriers to Innovation: A Public Client's Journey in Procurement and Project Management**

Let me know if you'd like me to refine these further!

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Figure 10: ChatGPT used for inspirations to the title of the thesis.

Research quality

The quality of qualitative research is typically judged by its trustworthiness, which includes credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1989). To strengthen *credibility*, multiple methods were used to gather empirical material, allowing triangulation and a broader understanding of the phenomena (Alvesson & Sköldbberg, 2018). This thesis also applied four frameworks (i.e., innovation framework, control modes framework, procurement framework and framework of hard and soft) to the data, expanding insight and enhancing the credibility of the analysis (Patton, 1999). As a result, interpretations drew on various sources – validating aspects through consistency (Papers 1 and 2) and enabling deeper understanding (Papers 3 and 4).

While pursuing my doctoral studies, I also worked as a procurement strategist, supporting project managers and purchasers in adapting procurement strategies. This dual role allowed me to apply research insights to practice while using practical experiences to deepen contextual understanding and credibility. My background as a purchaser and strategist added valuable real-world experience, enriching the research's relevance and depth. Peer debriefing was conducted by discussing findings with researchers and practitioners.

Being an industrial PhD, however, involved the risk of losing a critical perspective on the STA. To address this, I regularly engaged with supervisors and ensured each paper had at least one co-author unaffiliated with the STA. Additionally, the research colleagues within the LTU and the multidisciplinary research network ProcSIBE (Procurement for Sustainable Innovation in the Built Environment) provided a forum for discussing STA-related research from multiple perspectives. ProcSIBE, which focuses on various procurement aspects of the STA, includes LTU and four other Swedish universities: KTH, Chalmers, LTH, and Karlstad University.

As this thesis examines how construction innovation can support the sustainability transition – which demands radical, systemic shifts in existing processes and routines (Winch et al., 2023) – my role as an internal rather than external knowledge resource may have made it harder to critically challenge the status quo (Wilden et al., 2023). However, observing meetings and engaging with external knowledge resources in the third sub-study helped renew my perspective. These interactions

made me aware of assumptions I had taken for granted and how my view is shaped by factors like my experience in the construction and infrastructure sector. I also used member-checking with respondents both inside and outside the sector to test my interpretations and enhance credibility (Symon & Cassell, 2012).

Transferability was enhanced by providing thick descriptions that help other researchers understand the context and judge the relevance of findings in other settings (Symon & Cassell, 2012). This research, based on a longitudinal case study with one interview study and two sub-cases, produced rich empirical material on the phenomena (Siggelkow, 2007). All four appended papers include thick descriptions supported by illustrative quotes. However, space constraints in scientific articles limit how much case detail can be included. A monograph would have allowed for more extensive descriptions and further improved transferability.

Dependability was ensured by recording and transcribing all interviews, enabling the findings to be verified (Symon & Cassell, 2012). Both the appended papers and the thesis underwent multiple revisions, with earlier drafts documenting the research process. In Papers 3 and 4, interpretations were occasionally validated with respondents during and/or after interviews.

Confirmability was supported by clearly indicating the sources of empirical material – interviews, observations, or documents – and identifying the actor (e.g., client or consultant). While transforming large volumes of material into concise findings remains a challenge, the inclusion of illustrative quotes in the findings chapters and coding examples enhances both thick description and confirmability (Siggelkow, 2007).

SUMMARY OF APPENDED PAPERS

In this chapter, the four appended papers are summarized. Each summary includes the purpose of the paper, a description of the framework developed and applied, the methods used, and the key findings and contributions. In the end of this chapter the author's contribution are outlined.

Paper 1

Public procurement of engineering services: the influence of task characteristics on organisational control

The purpose was to investigate organizational control in public procurement of engineering services, by answering two research questions:

- (1) How may a public client choose control modes in the procurement of engineering services?
- (2) How do the task characteristics of engineering services influence the public client's choice of control modes?

This paper draws on organizational control theory (Ouchi, 1979, 1980) and the procurement framework developed by Eriksson (2006) and Eriksson and Laan (2007). Two frameworks were further developed: first, the control framework (Ouchi, 1979), which was extended by incorporating *uncertainty* as a third task characteristic, alongside *knowledge of the transformation process* and *output measurability*, as shown in Figure 12.

	High	Low
Output Measurability	Output or Process control	Process or Social control
Knowledge of the Transformation	Process or Output control	Output or Social control
Uncertainty	Social control	Process or Output control

Figure 12: The further developed control framework

Second, the procurement framework originally designed for contractor procurement, was adapted to suit the context of engineering consultant procurement (Eriksson, 2006; Eriksson & Laan, 2007), as shown in Table 10.

Table 10: The further developed procurement framework for engineering consultants

Procurement stages	Output control	Process control	Social control
Specification	Output-oriented	Process-oriented	Value-oriented
Reward system	Fixed price	Time-and-materials	Including incentives
Performance evaluation	Output control by client	Process control by client	Self-control by service provider

Findings showed that although the public client acknowledged uncertainty as a crucial task characteristic in adapting its procurement strategy, similar strategies were considered suitable for projects with both high and low uncertainty, focusing primarily on process and output control. Engineering consultants reported that these procurement strategies limited creativity, increased financial risks, and created unclear responsibilities. Rather than acknowledging and managing uncertainty through the adaptation of procurement strategies (i.e., social control), findings indicated that the public client attempted to reduce it by providing detailed specifications, including calculable assumptions (i.e., process control). By doing so, the public client did not fully utilize the advisory expertise of engineering consultants, instead focusing on detailed control and procuring tangible deliverables.

Several key contributions from this paper guided the continuous research process. First, it established a foundation for understanding control modes and procurement strategies, as well as prior research on the procurement of engineering consultants and other complex services, contributing to a deeper understanding used in the subsequent papers. Second, the study highlighted an interesting aspect: a public client procuring what is considered a complex knowledge service (van Nordenflycht, 2010) while being perceived as having a greater understanding of the procured tasks than the engineering consultants delivering the service. This led to a

further investigation of how public clients may adapt a procurement strategy in the procurement of engineering services focusing on carbon reduction, also requiring innovation innovation, were existing understanding needs to be questioned, as investigated in Paper 2.

Third, the findings related to that uncertainty was reduced rather than managed and jointly explored between the client and the engineering consultant, which was an interesting insight. This led to the further development of the procurement framework in Paper 2, incorporating adaptability as a key concept, as it was considered crucial for handling uncertainty. It also directed attention toward the adaptation of procurement strategies in Paper 2, focusing on a project with inherently high uncertainty due to its sustainability-related goals. Additionally, the way uncertainty was handled laid the foundation for Paper 4, to explore potential reasons behind reducing uncertainty rather than engaging in joint exploration.

Paper 2

Adaptability in Public Procurement of Engineering Services Promoting Carbon Reduction: An Organizational Control Perspective

The purpose was to investigate how public clients may choose control modes and what incentives for adaptability their choice creates for service providers in the procurement of engineering services focusing on carbon reduction.

Building on Paper 1, this paper also drew on organizational control theory (Ouchi, 1979, 1980) and the procurement framework developed by Eriksson (2006) and Eriksson and Laan (2007), while additionally incorporating adaptability as a concept (Williamson, 1985). Findings indicated that creating incentives for adaptability was crucial when adapting procurement strategies to promote innovation aimed at reducing carbon emissions. Although the Public Procurement Act limited changes to specifications (Volker, 2012), making process-oriented specifications less effective for public clients, findings showed that such specifications were used and included rather detailed technical requirements. Additionally, the study highlighted that adaptability provided by a public client was essential for promoting carbon reduction, as it encouraged engineering consultants to select more skilled personnel

and adopt iterative, innovative working processes. The findings also showed how the client and the engineering consultant formed mirroring organizations, where experts in, for instance, road design and geotechnics were present on both sides of the contract – the client representative setting requirements and assessing the work, and the engineering consultant representative executing the work. This dynamic was particularly interesting, as it further reinforced the detailed process control exercised by the client, even though innovation was considered needed.

Several key contributions from this paper guided the ongoing research process. First, the use of process-oriented specifications and detailed technical requirements was notable. Especially since, during dialogue meetings between the client and various engineering consultancy companies before the tender was announced, these technical requirements were identified as obstacles to innovation and achieving the sustainability-related goals. This insight was particularly interesting. Building on the findings from Paper 1 regarding how uncertainty was reduced, the inclusion of technical requirements – despite their perceived hindrance to innovation and carbon reduction – contributed to the foundation for Paper 4. This further exploration aimed to identify potential reasons behind setting requirements that were perceived as barriers to innovation and carbon reduction rather than reformulating them (e.g., as value-oriented specifications) or removing them altogether. Second, findings indicated that the client and the engineering consultants perceived innovation differently. For instance, some engineering consultants highlighted during the dialogue meetings that, when comparing carbon emissions from road construction with those from traffic once the road was completed, the majority of emissions were attributed to traffic. Therefore, they argued that focusing on reducing traffic-related carbon emissions would have a greater overall impact. However, the client did not find this perspective particularly interesting. This insight led to the need for understanding different perceptions of innovation, related to different innovation dimensions, which was further explored in Paper 3.

Paper 3

Innovation outcomes and processes in the planning and design phase of a public infrastructure project

The purpose was to explore how the public client, the engineering consultant and the sub-consultant perceive and address innovation outcomes and processes in the planning and design of infrastructure projects.

This paper drew on a multidimensional innovation framework based on a literature review by Cantarelli and Genovese (2021), which was built on Crossan and Apaydin (2010). The findings illustrated that innovation outcomes, in terms of product and process innovation resulting from the engineering consultant's work in planning and design, were often overlooked by the client. Instead, the client focused solely on innovation outcomes in the production of the road. Findings highlighted the importance of incorporating the perceptions of engineering consultants, as they could act as both generators and implementers of innovation. As implementers, they held untapped potential for enhancing innovation in construction projects. For instance, the engineering consultant's exploration of goals and solutions, delivery of higher design quality, or management of complex data could potentially benefit not only the specific project (i.e., short-term) but also future construction projects (i.e., long-term).

By acknowledging the multidimensionality of innovation, the findings indicated that public clients could benefit from involving external knowledge resources, particularly those specializing in innovation. This was found important for both innovation outcomes and processes, as these professionals tended to focus more on radical innovation, emphasize long-term benefits, and adapt technologies developed in other sectors – contributions essential for the sector's role in the sustainability transition. In contrast, the public client and engineering consultants (i.e., the internal knowledge resources) were found to be more restricted by existing processes and best practices, leading them to focus on incremental innovation, short-term benefits, and adopting innovation from other infrastructure projects.

However, findings showed that the public client struggled to utilize the expertise of the external knowledge resources, either due to a lack of understanding (described as 'speaking different languages') or an undervaluation of their

perspectives. Instead, weak collaboration was observed between internal and external knowledge resources, along with a lack of shared understanding and trust. Additionally, findings suggested that to fully utilize the expertise of both engineering consultants and sub-consultants in planning and design, both procurement strategies and project management strategies needed to be flexible, especially for public clients restricted by the Public Procurement Act.

Findings also showed that the project, while labeled as a business project with innovation expectations, was ultimately managed as a project tied to standard processes rather than an innovation project free to explore new approaches without restrictions from established procedures. This approach appeared to make the client less open to risk and hesitant to explore more radical innovation. As a result, the client was less receptive to being challenged by the perspectives of the sub-consultants.

Mainly two key contributions from this paper guided the ongoing research process. First, the contrasting perceptions between internal and external knowledge resources were evident throughout most observations and interviews. External knowledge resources prioritized innovation outcomes and processes, aligning more closely with what previous research suggested was necessary for the sustainability transition. However, their perspectives were often misunderstood or resisted by internal knowledge resources, including the client. This contrast was found to be particularly interesting and needed further exploration. Along with insights from Papers 1 and 2, these findings contributed to the design of Paper 4. Second, in addition to shaping the research problem of this thesis, the study highlighted the interconnection between procurement and project management strategies in promoting construction innovation.

Paper 4

Sustainability transition stuck in the project management paradigm?

– Exploring project management in two Swedish infrastructure projects assigned to drive innovation

The purpose was to increase the understanding of how actors engage in project management aimed at jointly driving innovation in support of the sustainability transition in infrastructure projects.

This paper drew on a framework of project management practices and purposes related to the hard and soft paradigms, inspired by Crawford and Pollack (2004) and Pollack (2007) to analyze how balance between hard and soft project management is navigated in infrastructure projects and what challenges arise from different client and engineering consultant perspectives. As previously noted, the phenomenon explored in this paper was inspired by insights from earlier papers, where handling of uncertainties and innovation were, from my perspective, described in unconventional ways. Using a framework with two contrasting paradigms offered valuable insights into the complexity and challenges the public client faces in promoting innovation toward the sustainability transition.

This paper concluded that although a balance between hard and soft project management was observed, the client (and the engineering consultant) struggled to provide flexibility, involve external knowledge, and drive innovation – hindering efforts to promote innovation for the sustainability transition. Most practices, interpreted as hard, described by the client and the engineering consultant were those generally applied in similar projects. These practices consisted of tasks and activities that were rather isolated from one another and tied to different disciplines within the projects, such as geotechnics, road design, and bridge construction. Together, they formed a list of activities and tasks that needed to be completed for the project to progress. However, since the projects were pilot initiatives, it was regarded as important to add some soft practices as well. Thus, the list of hard practices was complemented by soft practices, which were also expected to be carried out. The project management strategies were interpreted as aligning with the hard paradigm, meaning that the balance involved combining or

complementing hard practices with soft ones – but strictly in line with a hard purpose. The findings also showed that practices associated with one of the paradigms could be used for either hard or soft purposes, depending on the practitioner’s underlying intent.

The external knowledge resources criticized the project management strategy, as they perceived the focus on elements such as efficient problem-solving, plannability, and control as a barrier for the actors in contributing to the sustainability transition. Thus, the study illustrated a public client that remains stuck in the hard paradigm, raising questions about its ability to meet expectations of promoting innovation for the sustainability transition through its project management strategies.

The three external knowledge resources among the respondents were interpreted as describing the project management in ways aligned with the soft paradigm, contrasting with others whose views reflected the hard paradigm. Observing this tension in meetings and comparing interview responses expressed key challenges the public client faced in promoting innovation for the sustainability transition:

1. Predefining concrete goals
2. Predefining concrete solutions
3. An isolated view
4. A short-term focus

The findings also showed that the first two challenges affect the engineering consultant’s work, as these predefinitions are included in the specifications provided by the client and are therefore part of the client’s procurement strategy. From an inter-organizational perspective – and considering the complexity of these projects – it is noteworthy that engineering consultants are procured but not involved in exploring goals and solutions. The third challenge is tied to the client’s perception that the project can and should be divided into multiple parts – such as disciplines, tasks, and activities – and that what should be changed or learned (and what should not) can be clearly defined from the outset. This approach was seen as problematic for effectively exploring the problem and for enabling the innovation team to make a meaningful impact toward the STA’s zero-emission goal for 2045. Additionally, the client’s short-term focus on time, cost, and scope was perceived as a barrier to achieving this long-term goal.

Findings also show that the client’s mission-related organizational goals – such as improved traffic safety and increased accessibility – were translated into concrete, standardized solutions (i.e., scope), such as wildlife fences and median barriers, before the projects began, as normally within the client. In the projects studied, the aim was to identify new, innovative standardized solutions – comparable to wildlife fences and median barriers used in standard practice projects – to achieve sustainability-related goals. This reflects a predefined vision of what should be learned and changed.

Additionally, both projects were designated as pilot initiatives, yet the sustainability-related goals were defined only after the decision had been made to proceed with the projects and the scope had already been established. For example, constructing a concrete bridge for wildlife – commonly used to improve traffic safety – and upgrading the road to allow higher speed limits – a typical measure to enhance accessibility – were included in the project scope. However, both measures risk increasing carbon emissions, as concrete has a high climate footprint and higher speeds generally result in increased traffic emissions, thus contrasting with the sustainability-goal of the project. One of the external knowledge resources within the engineering consultancy therefore proposed rethinking all three goals – accessibility, traffic safety, and sustainability – together, in order to develop a deeper understanding of the problem and identify new measures that could align with all goals, as that would have more impact on the goal of zero green gas emissions by 2045. However, redefining the existing scope, such as the inclusion of a wildlife bridge or increasing speed limits, was not considered an option by the client.

As the fourth and final paper in this thesis, it made one key contribution to the overall work. It provided insights into why public clients struggle to promote innovation toward the sustainability transition, despite facing political and societal pressure to do so. Simply assigning pilot projects or introducing new practices – such as sustainability-related goals, innovation expertise, or innovation processes – was found to have limited impact. The core challenges appear to lie in the public client’s continued reliance on the hard paradigm. To enable greater flexibility, involve multiple actors, manage complexity, and effectively promote innovation, public clients must first unlearn the hard paradigm. Therefore, researchers play an important role in deepening understanding among practitioners, rather than offering concrete recommendations for new “best practices.” Thus, it is my intention that this thesis contributes insights aligned with that purpose.

Contribution of authors

The author contributions for each of the four appended papers are outlined in Table 11. For the first three papers, Granheimer developed the manuscripts in collaboration with her supervisors, while the fourth paper was co-authored with a researcher affiliated with the same department at Luleå University of Technology.

Table 11: Contributions of the authors to the four papers.

Paper	Order of authors	Author's contribution
1	Granheimer, K. Karrbom Gustavsson, T. Eriksson, P. E.	The three authors jointly developed the focus of the paper. Granheimer was responsible for collecting, coding, and analyzing the empirical material as well as writing of the paper. The co-authors attended one interview each, assisted in the development of the theoretical frameworks, discussed the findings and edited the paper.
2	Granheimer, K. Eriksson, P. E. Karrbom Gustavsson, T.	The three authors jointly developed the focus of the paper. Granheimer was responsible for collecting, coding, and analyzing the empirical material, as well as writing the paper. Most of the interviews were conducted in collaboration with another PhD student, Jacob Guerrero, and a researcher, Susanne Engström, with the interviews divided into two parts. The co-authors contributed to the development of the theoretical frameworks, engaged in discussions of the findings, and edited the paper.
3	Granheimer, K. Eriksson, P. E. Hedgren, E.	Granheimer was the lead author, responsible for developing the focus of the paper, collecting, coding, and analyzing the empirical material, and writing the paper. The co-authors contributed to shaping the paper's focus, each attended one interview, assisted in the development of the analytical framework, engaged in discussions on the analysis with Granheimer, and contributed to editing the paper.
4	Granheimer, K. Engström, S.	Granheimer was the lead author. Granheimer and Engström jointly developed the focus of the paper and collected the empirical material. The transcriptions and coding were carried out by Granheimer, and the analysis were discussed with Engström. Granheimer was responsible for writing the paper, while Engström contributed through editing.

DISCUSSION

This chapter provides a discussion of findings from the four appended papers, related to the three research questions that this thesis aims to answer. First, the answer to RQ1 is discussed, describing the challenges the public client faces in promoting construction innovation. Based on the answer to RQ1, the subsequent two research questions are discussed describing how the public client adapt its procurement strategies and project management strategies.

Challenges in promoting innovation

This section intends to discuss and answer the first research question:

RQ1: What challenges does a public client face in promoting innovation towards the sustainability transition in planning and design of new infrastructure?

Construction innovation literature discusses that both innovation outcomes and processes are necessary for the construction sector to contribute to the sustainability transition (Cantarelli & Genovese, 2021; Larsson et al., 2022). Given the dimensions and categories in the innovation framework, some are identified in previous literature (e.g., Bosch-Sijtsema et al., 2021; Lenderink et al., 2022) as particularly important for construction innovation to support this transition.

New processes and products

In line with Lenderink et al. (2022), findings from Papers 2 and 3 show that the public client considers both product and process innovations important for reaching

the sustainability-related goals. For product innovation, the client's technical regulations impose strict design boundaries. Papers 2 and 4 show that both the client and the engineering consultant acknowledge these requirements hinder innovation and are insufficient to meet sustainability goals (see Table 3). Despite this, technical requirements remain in the specifications, with changes handled individually through a standardized dispensation process after the contract is signed. Responding only to concrete issues aligns with the hard paradigm (Lenfle & Loch, 2010), but this is ill-suited to public procurement, as major changes cannot be made once the contract is signed (Volker, 2012).

For process innovation, Project B's sustainability-related goals focus primarily on the production phase. As a result, the engineering consultant's proposed alternatives – including those from internal and external innovation experts – are not prioritized, even though they may better support national climate goals. Since prior research has largely focused on contractors (e.g., Lenderink et al., 2022; Larsson et al., 2022), process innovation during the design phase remains underexplored. By narrowly emphasizing selected innovations, the client reinforces sector norms and excludes alternative perspectives – consistent with the hard paradigm (Crawford & Pollack, 2004), where solutions are predetermined by the client instead of being collaboratively developed. This hinders the client from utilizing the engineering consultant's perspective, as well as from applying learning gained within the project to influence its development.

Radical innovation

In line with Lenderink et al. (2022), the public client identifies radical innovation as essential for achieving carbon reduction aligned with the sustainability-related goals (see Table 3) and proposes several such innovations, including automated construction equipment and digital twins, as highlighted in Papers 3 and 4. However, the findings show that implementing these client-suggested radical innovations faces challenges linked to the adherence to a standardized, linear stage-gate process, which limits exploratory efforts (Eriksson et al., 2017), and to a continued focus on short-term success metrics – time, cost, and scope (Guerrero & Engström, 2024). Even though Lenderink et al. (2022) report successful implementation of isolated radical innovations – such as material replacements in movable bridges – the findings show that many of the suggested radical innovations in this study would require the involvement of multiple actors and disciplines, as well as changes to standardized practices across various parts of the project.

However, since these developments were managed within an isolated structure – confined to the innovation discipline or team and separated from other disciplines – the external knowledge resources struggled to implement the necessary changes. These three aspects were critically addressed by the external knowledge resources in Paper 4.

Additionally, Papers 3 and 4 show the client has even greater difficulty supporting radical innovations proposed by external knowledge resources, such as iterative design models or organizational learning processes. These challenges may result from the need for actors to shift roles (e.g., consultants acting as both creators and implementers) and the necessity of embedding innovation both within the project and across organizations (Linderoth, 2010). Though not prioritized by the client, these innovations are seen by external experts as valuable for achieving national climate goals. Realizing this would require expanding sustainability-related goals beyond production and embracing long-term impact.

Because the client narrowly defined and procured specific innovation, aligned with a clearly predefined scope, this reflected a hard purpose (Pollack, 2007), limiting openness to innovation aligned with soft purposes (Shenhar & Dvir, 2007). These findings reinforce the broader challenge of promoting innovation that supports the sustainability transition. In both cases, the client struggles to collaborate effectively with external knowledge resources, despite research stressing the importance of involving actors free from sector constraints (Hu et al., 2022; Duan et al., 2023). This disconnect reflects a broader conflict between hard and soft purposes – mirroring the clash between hard and soft paradigms.

Internal and external drivers

In line with previous research, findings from Paper 3 show that both internal drivers, such as adapting procurement strategies, and external drivers, such as governmental decisions in the National Plan, are used to promote innovation, in line with previous research (Ozorhon & Oral, 2017; Cantarelli & Genovese, 2021). Findings show that the National Plan helped establish a shared goal within the project, serving as motivation for both innovation outcomes and processes. Although the National Plan was determined by the government, the client itself formulated the goals related to sustainability in the proposal document to the plan. However, this driver, which focused exclusively on the production process, was criticized by the engineering consultants for narrowing the scope of innovation, overlooking their

expertise, and failing to address the broader needs of the sustainability transition within the sector.

Long-term benefits

Researchers emphasize that innovation targeting long-term benefits – especially those addressing the full lifecycle of infrastructure assets – is essential for the sustainability transition, rather than focusing solely on the production (Larsson & Larsson, 2018; Lenderink et al., 2022). Findings show that, due to the focus on production, the constructed asset itself was deprioritized by the client, which is in line with previous research (Larsson et al., 2022). The findings also show two additional perspectives to long-term benefits beyond lifecycle considerations.

First, Papers 2 and 4 show that designing roads to reduce traffic emissions – by focusing on road use – could significantly contribute to Sweden’s climate goals, which is also in line with the figures presented from the STA’s annual report (see section: Description of case organization). While aligned with the national objective of zero greenhouse gas emissions by 2045, this was not seen as fitting within the client’s project-specific sustainability-related goal of reducing emissions by 50% during planning, procurement, and production. As a result, broader impacts beyond the project were not prioritized, despite aligning with the national climate goals.

Second, findings from Papers 3 and 4 points to the value of learning as a prerequisite for future development. Thus, if the client’s suppliers possess knowledge and insights into the complexity of promoting construction innovation toward the sustainability transition, the client will be better positioned to procure and apply these insights in future projects. Yet this was not prioritized, as it fell outside the narrowly defined sustainability-related goals.

It is notable that the client consistently prioritized short-term concerns over long-term considerations across all these perspectives above, despite its formal mission to own and maintain the road network (i.e., the asset), reduce traffic emissions in line with national climate goals, and promote innovation and development among sector suppliers. These findings illustrate, in line with earlier studies (Ozorhon et al., 2016; Larsson et al., 2022), the dominance of a narrow focus on predefined project goals and the ‘iron triangle’ of time, cost, and scope – characteristics associated with the hard paradigm (Koppenjan et al., 2011). In contrast, the engineering consultants’ perspectives aligned with prior research suggesting they are

more inclined to promote innovation with long-term impact than the client (Rose et al., 2019). As long as project success continues to be measured by adherence to predefined time, cost, and scope parameters, the client is unlikely to shift toward a long-term perspective.

Open process

Findings from Papers 2–4 show that the client acknowledges the importance of engaging several actor including external knowledge resources – both within the client organization (only in Project B) and within the engineering consultancy – who possess innovation expertise and experience from other sectors, which aligns with previous research (Ozorhon et al., 2013; 2016). However, questions remain regarding how external knowledge resources – such as companies and professionals specializing in innovation, digitalization, electrification, and automation – can be effectively involved. These actors may not fit within the pre-set five-phase stage-gate project process (as illustrated in Figure 6) or the standard contracts for engineering consultants and contractors. Thus, in line with Linderoth (2010), implementing certain innovation outcomes may require project actors to change roles and involve new actors. For instance, future roads could be constructed by a tech company in collaboration with a construction equipment supplier, rather than a traditional contractor. Such a shift may require the client to first procure problem structuring – an intangible outcome that involves multiple actors to enhance understanding – in line with a soft purpose (Pollack, 2007). Subsequently, the client would need to procure the required function, whether a road or another solution(s), from actors best suited to deliver that function. However, an open process is not solely about contractual engagement; it must also ensure that the contracted actors and resources are given the opportunity to create impact and contribute to meaningful change – that is, to enable genuine involvement.

Adaptation

Findings from Paper 3 illustrate that the client acknowledges the importance of adapting technologies related to digitalization, electrification, and automation in road production, thereby recognizing several aspects previously identified in research as having potential to contribute to the sustainability transition (Bosch-Sijtsema et al., 2021). However, in similarity to its challenges in promoting radical innovation, the client struggles to promote this adaptation of technologies. This difficulty, as discussed in Paper 4, was considered to be linked to adherence to a standardized linear stage-gate process, the measurement of success according to the

'iron triangle,' and the isolation of disciplines, as well as the underlying hard purpose.

Furthermore, the client pre-determines and selects only a few technologies, aligning with the simplification related to the hard paradigm (Eriksson et al., 2017). In contrast, as suggested by external knowledge resources, the client could instead focus on broader sustainability transition goals (such as the national climate goals), allowing project actors to explore and identify potential technologies that could be adapted to achieve these goals, which is more in line with the soft paradigm (Shenhar & Dvir, 2007).

Procurement strategies promoting innovation

This section intends to discuss and answer the first research question:

RQ2: How does a public infrastructure client adapt its procurement strategies to promote innovation towards the sustainability transition, in planning and design of new infrastructure?

Findings from Paper 2 show that both within the client organization and during market dialogue meetings – where client representatives and engineering consultants from multiple companies participated – various procurement alternatives related to specifications, bid invitations, bid evaluations, and reward systems (see Table 1) were discussed prior to finalizing the procurement strategy. Additionally, the general topic of providing incentives for engineering consultants was actively considered in the pre-tender phase. Thus, illustrating the client making intentional choices of procurement alternatives within the procurement strategy.

Previous research highlights that social control is the most effective control mode for handling uncertainties (Yang et al., 2022), promoting innovation (Lou et al., 2022), and for achieving sustainability goals (Kivilä et al., 2017; Eriksson, 2024), as it provides flexibility and collaboration. Even though, process control is also reported efficient (Ning et al., 2023). Findings from Papers 1 and 2, show that, apart from within the bid evaluation, the public client's overall procurement strategy

predominantly relies on a combination of process and output control, with process control being the most dominant.

The choice of process control in the specification is notable for two main reasons. First, even though process control is argued to provide adaptability (similar to flexibility) (Williamson, 1985), this is not applicable for a public client restricted from making substantial changes to specifications and contractual terms during the contract's duration (Volker, 2012; Arrowsmith, 2014). Second, process control is not argued to facilitate collaboration (Eriksson, 2006; Eriksson & Laan, 2007). Instead, the public client's reliance on process control suggests a lack of recognition or valuation of the engineering consultant's perspective and expertise, despite the inter-organizational nature of the relationship. This is in line with a study on contractors (Järvenpää et al., 2024). However, the findings align with Ning et al. (2023), who emphasize that process control supports coordination and interaction between clients and engineering consultants, making it suitable for managing high uncertainty. Yet, process control depends on distinct roles between the public client and the engineering consultancy company, along with the client's close monitoring (Kirsch, 1996), whereas social control involves less distinct roles and relies more on relational aspects, such as trust, emphasizing collaboration (Sitkin et al., 2020).

As a result, process and social control appear to facilitate different types of collaboration, distinguishing between coordination and interactions focused on directing and monitoring (i.e., process control) versus those aimed at fostering collaboration based on trust (i.e., social control). As bringing in diverse perspectives is essential for promoting construction innovation (Rose & Manley, 2012; Hedborg Bengtsson et al., 2018) and supporting the sustainability transition (Keusters et al., 2022), collaboration and flexibility through social control would likely be more effective in achieving that. In contrast, a public client relying on process control primarily reinforces the client's perspective, limiting broader collaborative engagement and adding of other actors' perspectives. Thus, public clients risk hindering innovation by discouraging engineering consultants from proposing new solutions and limiting input from actors outside the sector, even though they are argued crucial for radical innovation and adopting innovation from outside the sector (Ozorhon et al., 2016; Hu et al., 2022). Ultimately, this may prevent public clients from fulfilling their expected role in promoting innovation toward the sustainability transition, resulting in taxpayer money spent on innovation initiatives having limited impact.

Tiwana and Keil (2007) concluded that clients with a high level of understanding of the tasks – i.e., knowledge of the transformation process – often struggle to avoid imposing detailed control through process control. The findings indicate that the client similarly struggles to refrain from imposing detailed control, both when the perceived understanding of the task is high (Paper 1) and when it is low (Paper 2). This emphasis on detailed control reflects characteristics associated with the hard paradigm (Crawford & Pollack, 2004) and aligns with a command-and-control management style (Shenhar & Dvir, 2007).

Adding findings from Paper 4 to this discussion highlights that, within the specification and performance evaluation stages, the process control executed by the public client is closely linked to hard practices. These practices include aspects like dividing tasks into distinct discipline areas (e.g., road design and bridge construction), imposing linear processes through time and cost management, and, requiring tangible deliverables (Crawford & Pollack, 2004; Pollack, 2007; Shenhar & Dvir, 2007), which are imposed by the client on the engineering consultants, through the specification. Thus, the findings illustrate that procurement and project management strategies are closely intertwined. Therefore, the hard paradigm, which dominates project management within the construction and infrastructure sector, appears to have shaped not only project management in practice (Eriksson et al., 2017) but also influence how procurement strategies are adapted by public clients. Thus, findings from Papers 1 and 2 show that adapting procurement strategies in the context of construction and infrastructure projects does not occur in isolation.

Project management strategies promoting innovation

This section intends to discuss and answer the third research question:

RQ3: How does a public infrastructure client adapt its project management strategies to promote innovation towards the sustainability transition, in planning and design of new infrastructure?

Findings from Paper 4 show that the project management strategy originates from a hard purpose and incorporates both hard and soft practices, in line with previous research (Eriksson et al., 2017). These include hard practices usually used in similar projects, which can be called 'standard', such as measuring project success based on the 'iron triangle' and adhering to a linear stage-gate process (Crawford & Pollack, 2004). Additionally, practices interpreted as hard (e.g., establishing an innovation discipline with innovation experts and implementing an innovation plan) and soft (e.g., iterative processes and innovation workshops) were layered onto the existing list of practices, added by the client to support the sustainability-related goals, creating a more extensive list of tasks to complete.

This approach aligns with the hard paradigm, which views projects as sequences of predefined tasks and activities that must be completed for the project to progress (Shenhar & Dvir, 2007; Guerrero & Engström, 2024). In line with the PMBOK Guide (Project Management Institute, 2024), the standard hard practices appear to be treated as "best practices" for managing projects, following a "one size fits all" approach (Shenhar, 2001, p. 394). These practices were not found to be questioned or intentionally reconsidered within the client organization, particularly among the internal knowledge resources. Instead, findings from Papers 3 and 4 suggest that while some hard practices, such as the linear design process and the focus on the 'iron triangle', were challenged by external knowledge resources, representing both actors (client and engineering consultant), they were not substantially re-evaluated by the client and were largely deemed non-feasible to change.

Thus, findings from Papers 3 and 4 indicate that the client's project management strategy consists of a combination of non-intentional hard practices, adopted as "best practices," and additional intentional hard and soft practices introduced specifically to align with the sustainability-related goals. Additionally, findings from Paper 4 show that the client adopted a hard purpose, despite this purpose being contrasted and challenged by the external knowledge resources interpreted as adopting a soft purpose. Thus, both the non-intentional and intentional choices of practices appeared to be driven by factors such as efficiency, problem-solving, plannability, non-participation, and an aversion to change – aligning with characteristics of a hard purpose (e.g., Crawford & Pollack, 2004; Guerrero & Engström, 2024).

Findings from Papers 3 and 4 illustrate that due to the client adapted its project management strategy based on a project view aligned with the hard paradigm, the

client was found to have a natural incentive to push the project forward. Thereby expecting the engineering consultant to complete predefined tasks and activities toward predetermined goals – most of them defined by the client – within the project phase, allowing for progression to the subsequent production phase (as illustrated in Figure 6). Thus, illustrating the “relay race logic” (Kadefors et al., 2024, p. 23) of contracted suppliers. Consequently, the client approached inter-organizational collaboration with the engineering consultant from a non-participative approach, where few additional perspectives or suggestions from the engineering consultants were valued – an approach not considered conducive to promoting construction innovation (Koppenjan et al., 2011; Keusters et al., 2022).

Additionally, the project as well as the innovation work was managed in a linear and pre-planned manner, despite previous research emphasizing the need for iterative and explorative processes in engineering consultancy work, (Mitchell et al., 2011; Benabdellah et al., 2020) and innovation promotion (Eriksson et al., 2017; Keusters et al., 2022). As a result, the client’s adaptation of project management strategies appears to neither support the planning and design work within the engineering consultancy nor facilitate the innovation efforts necessary to achieve the sustainability transition. Thus, multiple aspects in the findings demonstrate that the client’s project management strategies not only involve intra-organizational control but also influence the adaptation of the inter-organizational control imposed on engineering consultants. This further strengthens Kivilä et al.’s (2017) argument that research should acknowledge inter-organizational aspects of control in infrastructure projects, as project management and procurement are found intertwined.

CONCLUSIONS

This chapter concludes this thesis by providing a summary of its major findings, followed by a discussion of its theoretical and practical contributions. Lastly limitations of the research as well as suggestions for future research are presented.

Fulfilling the purpose

The purpose of this thesis was to increase the understanding of how a public infrastructure client promotes innovation towards the sustainability transition through adaptation of procurement and project management strategies in planning and design of new infrastructure.

By integrating frameworks and prior research from construction innovation, procurement strategy, and project management strategy with findings from a critical favorable case (Flyvbjerg, 2006), involving Sweden's largest public infrastructure client, several conclusions emerge. The public client faces pressure from both national and EU levels to support the sustainability transition through innovation. While the client recognizes that a range of innovation outcomes and processes must be considered – and that procurement strategies are key to guiding consultants – the study shows that, despite explicit expectations, the client struggles to effectively promote innovation in practice.

A central difficulty lies in the client's tendency to treat innovation as a goal rather than a way to explore and achieve sustainability-related goals. Rather than starting by exploring and understanding the sustainability-related goal and investigating what innovation outcomes and processes could contribute to it, the client defines,

specifies, and procures particular innovation outcomes and processes from the engineering consultant. Notably, the study also finds that the client struggles even to promote the predefined innovation effectively.

These difficulties stem from the client being stuck in the hard paradigm, which emphasizes plannability, simplicity, control, objectivity, efficiency, and problem-solving (Crawford & Pollack, 2004; Pollack, 2007). As this paradigm dominates the client organization, it heavily influences the way procurement and project management strategies are adapted. While there is recognition within the organization that procurement strategies should include incentives and flexibility to encourage innovation from engineering consultants, such adaptations are limited to specific areas – mainly how contracts are awarded (bid evaluation). Most other decisions across the procurement and project management strategies continue to reflect the hard paradigm. Therefore, even if an engineering consultant is selected based on their ability to promote innovation, the broader strategic context may still hinder or complicate innovation efforts.

Since the hard and soft paradigms are contrasting (Pollack, 2007), continued reliance on the hard paradigm prevents the realization of values aligned with the soft paradigm. By incorporating the perspectives of external knowledge resources, this study highlights the importance for public clients to begin “unlearning” the hard paradigm to enable adoption of the soft paradigm. The soft paradigm is better suited to managing complexity, focusing on values and abstract goals, fostering exploration, involving diverse perspectives, promoting flexibility, and facilitating a deeper understanding of problems (Crawford & Pollack, 2004; Pollack, 2007), thus elements in line with what is suggested needed to handle complexities (Sabini et al., 2019; Atli & Krystallis, 2025), and thus to support the sustainability transition.

This thesis further concludes that procurement strategies are deeply intertwined with project management strategies. This interdependence underscores the need for construction management research and practice to acknowledge and address both together. For public clients to effectively use public procurement as a strategic tool for the sustainability transition, focusing solely on procurement strategies is insufficient – project management strategies must also be developed in parallel to ensure intentional decision-making and a coherent strategic direction.

Theoretical implications

Although promoting innovation is considered crucial for public clients in the construction and infrastructure sector to drive the expected sustainability transition (European Commission, 2022), procurement and project management strategies represent two practically interconnected but previously separated forms of governance in research (Kivilä et al., 2017). By integrating frameworks and previous research from three construction management-related fields – construction innovation, procurement strategy, and project management strategy – and by focusing on the promotion of innovation in the planning and design where it is particularly important (Rose & Manley, 2012; Hu et al., 2022), yet involving a rather neglected actor in previous research, the engineering consultant (Eriksson & Kadefors, 2015; Guerrero & Engström, 2024), this thesis contributes to research within each of these fields individually as well as at their intersection.

Contributing to research on *construction innovation* (e.g., Ozorhon et al., 2016; Cantarelli & Genovese, 2021), by acknowledging innovation being a multidimensional concept including both innovation outcomes and processes (Crossan & Apaydin, 2010), this thesis provides valuable insights into the challenges of promoting different innovation outcomes and processes, offering a more nuanced understanding of promoting construction innovation toward the sustainability transition in planning and design of new infrastructure. By incorporating the perspectives of external knowledge resources (Ozorhon et al., 2016) with specific innovation expertise, this thesis offers valuable insights into how perceptions of innovation differ between internal and external knowledge resources. The external knowledge resources' perspectives aligned more closely with what innovation outcomes and processes are needed to support the sustainability transition. As a result, existing innovation frameworks (e.g., Cantarelli & Genovese, 2021; Larsson et al., 2022) would benefit from including internal and external knowledge resources as a distinct dimension within innovation as a process – particularly when studying innovation aimed at advancing sustainability. Additionally, recognizing that long-term effects may also relate to the traffic using the road is suggested as an important consideration – particularly in studies focused on sustainability.

Contributing to research on *procurement strategy* (e.g., Ning et al., 2023; Järvenpää et al., 2024), this thesis concludes that the hard paradigm influences how control modes are chosen and thus how the procurement strategy is adapted to promote

innovation towards the sustainability transition, in planning and design of new infrastructure. This provides valuable insights into potential reasons why public clients in the construction and infrastructure sector prioritize detailed specifications and close monitoring when promoting construction innovation, as concluded by previous research (Järvenpää et al., 2024). Additionally, this thesis shows that even though uncertainty and complexity are perceived as high – which would typically suggest the use of social control due to difficulties in defining the scope (Yang et al., 2022; Eriksson, 2024) – the public client addresses this by explicitly defining the scope, thereby reducing uncertainty and complexity in order to apply process control. This finding demonstrates that public clients, through their procurement strategies, actively influence task characteristics (e.g., uncertainty and complexity), reflecting a preference for certain control modes, which contributes to research on procurement strategies (e.g., Ning et al., 2023; Järvenpää et al., 2024).

Contributing to research on *project management strategy*, this thesis demonstrates that, although the term 'project management strategy' is not frequently used in previous literature, scholars have emphasized the importance of tailoring project management to the characteristics of the project (e.g., Koppenjan et al., 2011; Eriksson et al., 2017), as well as indicating its potential for strategic impact (Rokio et al., 2024). This thesis offers insights into the strategic significance of project management within construction management for supporting organizational goals aligned with the sustainability transition. Furthermore, if research on project management strategy in the construction and infrastructure sector is to adequately address inter-organizational dynamics, a sole focus on intra-organizational control or governance – such as the relationships between sponsors, project managers, and project teams, or between program and project levels – will be insufficient.

Finally, contributing to *construction management* research (Kivilä et al., 2017), this thesis demonstrates that as three related fields of literature – construction innovation, procurement strategy, and project management strategy – are empirically intertwined, acknowledging their common ground would facilitate a deeper understanding of how public clients can promote innovation toward the sustainability transition also within research. Therefore, in line with recommendations for researchers to produce practically relevant studies, which results practitioners can use in their decision-making (Söderlund, 2023), this thesis contributes important insights for researchers within construction management (e.g., Lenderink et al., 2022; Nilsson Vestola et al., 2024).

Practical implications

By conducting a single case study of Sweden's largest infrastructure client, this thesis provides valuable insights for public clients across the European Union, who face similar expectations of promoting innovation toward the sustainability transition through public procurement (European Commission, 2022). The findings suggest that solely focusing on adapting procurement strategies is unlikely to be sufficient, due to the project-based context. As the entire construction and infrastructure sector is rooted in the hard paradigm (Lenfle & Loch, 2010), this paradigm significantly influences both how project management and procurement strategies are adapted.

Empirical material gathered from professionals across various departments within the public client organization, as well as within the engineering consultant organization, shows that the dominance of the hard paradigm is deeply embedded at multiple organizational levels. In fact, the thesis indicates that the hard paradigm extends beyond project management and permeates the broader organizational and sectoral framework. This has implications not only for promoting innovation toward the sustainability transition, but also for consultant assignments in general within the sector.

Firstly, a substantial part of the engineering assignment involves investigations, particularly those related to physical planning, as claimed by previous research (Witzell, 2019). As physical planning is regulated by law and forms part of a democratic process that public clients must adhere to in order to obtain permits for land expropriation (e.g., for constructing a new road), managing such investigations through a hard paradigm approach is not only inefficient but also risks clashing with democratic principles. These investigations require the careful consideration of multiple aspects and the balancing of competing values – such as those of landowners or the protection of sensitive animal habitats – against the public interest of increased accessibility. As this thesis shows that the clients aim to reduce uncertainty and complexity, both in standard assignments (Paper 1) and in those aiming to promote innovation (Paper 2-4), striving instead for linearity and problem-solving within strict time and budget constraints, there is a risk that the investigative work becomes neither exploratory nor genuinely investigative. Consequently, public values may be deprioritized in favor of project progress.

Secondly, this underscores the substantial challenge of promoting innovation, as the hard paradigm emphasize aspects that tend to hinder innovation rather than promote. Consequently, substantial changes and critical reflection are required at multiple levels – not only within the client organization and the engineering consultancy, but also at the political level – in order to address this entrenched paradigm. Without such changes, ambitious innovation efforts are likely to yield limited impacts in driving the sustainability transition. Below, the implications for various actors and roles are discussed.

At the political level, in order to enable public clients to effectively promote innovation that supports the sustainability transition, this (i.e., sustainability transition) objective must be explicitly included in their mission – alongside other overarching goals such as accessibility and traffic safety. Since the sustainability transition involves shifting from the current system to a fundamentally different one, sustainability-related goals need to be discussed and weighed in relation to other goals so they can influence decisions about whether to build new roads or consider alternative measures. This is especially important given that carbon emissions from traffic using the infrastructure are substantially higher than building new, and that constructing new roads and railways not only generates emissions during the project itself but also leads to increased emissions once the infrastructure is in use. Additionally, it would be necessary to allocate dedicated funding over multiple years specifically for exploratory or innovation projects. Expecting such initiatives to be carried out within the scope of ordinary projects and standard budgets is insufficient. Furthermore, the political level must acknowledge the inherent complexity and uncertainty associated with infrastructure projects in general – and with innovation-oriented projects in particular – and consider how these factors affect the accuracy of the client’s cost forecasts. While the public clients operate with public funds, expecting cost estimates for complex and uncertain projects to align precisely with actual outcomes is unrealistic.

At the organizational level, this means that sustainability-related goals must be weighed against other overarching goals, allowing them to influence not only how something is built, but also what is built and not. This is particularly important because emissions from traffic are significantly higher than those from construction, operations, and maintenance, even though there is an increasing number of electric vehicles. It also implies that the organization must learn to manage projects in relation to abstract, long-term goals or values – such as accessibility, traffic safety,

and sustainability – that can be addressed through both intangible outputs (e.g., lowering speed limits, increasing travels with public transport) and tangible ones (e.g., constructing a new roundabout), rather than focusing solely on tangible ones. Furthermore, the organization must actively engage with external knowledge resources.

For manager, this means when assigning pilot projects, they should be designed and evaluated in alignment with their intended purpose – fostering learning on a specific issue from a long-term perspective – rather than adhering strictly to standard processes and short-term success measures like those defined by the ‘iron triangle’. Project teams must feel trusted and supported in their exploratory work, but in success and failure. As shown in this thesis, if teams are forced to follow the same processes as traditional projects, assessed solely by the ‘iron triangle’ or constrained by standard regulations, innovation will be significantly limited.

For purchasers, this means using their expertise in the Public Procurement Act and their understanding of current supplier markets to facilitate flexibility and collaboration in the relationship with the suppliers. This approach enables the integration of new perspectives that can influence the direction of the project. Additionally, the thesis highlights the need to move beyond a predefined set of suppliers, ensuring that new actors are engaged and new supplier markets are explored. This, in turn, could foster learning and supports project progress.

For project managers, this means critically questioning and reflecting on the hard paradigm and their role in infrastructure projects. They may evaluate the practices and purposes they use, consider alternative methods, and assess their potential consequences. Also, reflect upon how the practices used, fit into an inter-organizational context. Emphasis should be placed on making intentional decisions regarding project management strategies, rather than defaulting to "best practices," to better align with the Sweden’s climate policy goal. However, this will be a challenging task, as their experience of project management is grounded, more or less, solely within the hard paradigm.

For strategists, this means recognizing project management as a strategic function and understanding that procurement and project management strategies are deeply interconnected. To achieve Sweden’s climate policy goals, strategists must support both management-level decision-makers and the operational project team in

developing a deeper understanding of intentional choices related to both procurement and project management, as well as their potential consequences.

Lastly, for engineering consultants, this implies the need to critically question and reflect on the dominance of the hard paradigm and its role in infrastructure projects. This involves evaluating the practices and purposes they adopt, considering alternative approaches, and assessing their potential consequences. It also includes engaging in collaboration with external knowledge resources to broaden perspectives and enhance problem-structuring abilities. Given that working with public clients is constrained by the tender documents and specifications formulated by the client – reflecting the client’s understanding and assumptions – engineering consultants must actively engage with clients to help broaden their perspective. Potential limitations embedded in these documents should be identified and addressed during the tender phase, but also in interactions with the client not directly related to a specific procurement.

Limitations and suggestions for future research

As the case organization in this thesis is the largest in Sweden, achieving analytical generalization to smaller public clients, such as municipalities, may be challenging. While these smaller entities also face expectations to promote innovation toward the sustainability transition (European Commission, 2022), they likely operate within a different context. Furthermore, as the empirical material included in this thesis was rich – comprising hours of observations and interviews – providing a nuanced description of this material was challenging. At the same time, it allowed for thick descriptions of issues that were repeatedly mentioned across multiple observations and interviews.

Another limitation of this thesis is that the author, along with the co-authors of the appended papers, are all part of the construction and infrastructure sector, which is largely rooted in the hard paradigm (Gustavsson & Hallin, 2014). Supporting the sustainability transition requires questioning the entire system. Therefore, future research – particularly in the study of promoting innovation for the sustainability transition – should involve practitioners and researchers from other empirical fields where alternative approaches are applied, in order to incorporate diverse perspectives, question the status quo and broaden the understanding of promoting innovation. Furthermore, the study cannot provide insights from the production

on the planning and design, as the projects are ongoing, which constitutes a limitation.

Additionally, as this thesis highlights the practical value of integrating insights from three fields of literature into a joint discussion, it further emphasizes the need for continued interdisciplinary dialogue. In particular, more research is needed that connects procurement and project management. This aligns with the expectations placed on public infrastructure clients to promote innovation and development through public procurement (European Commission, 2022) within a project-based context, as well as with the broader emphasis in project and project management studies on producing research that supports managerial decision-making and offers practical relevance (Söderlund, 2023). Rather than proposing straightforward recommendations such as 'best practices', this research should elaborate on complexities and focus on increasing practitioners' understanding.

Since traffic emissions account for the majority of emissions related to road infrastructure – at least in Sweden – and this issue was raised by engineering consultants but not prioritized by public clients, further research is needed to understand how future infrastructure projects aligned with the sustainability transition could be designed and what complexities they would face. Specifically, there is a need to explore how intangible outputs, such as increased public transport usage or reduced travel demand, can be incorporated into public infrastructure projects. Project management – at least within a public infrastructure client – is not about building roads and railways, but rather about creating value and public benefit for citizens and businesses. The road or railway in itself has no intrinsic purpose; rather, it serves as a means to an end, such as improving accessibility, enhancing traffic safety, and enabling sustainable travel. As the sustainability transition may conflict with the construction of new infrastructure – since it contributes to increased carbon emissions during construction, operation, maintenance, and from resulting traffic – it does not inherently conflict with other societal goals. In line with previous research discussing increased complexity of public values within public construction clients (Kuitert et al., 2019; 2023), project and project management literature need to further explore project management within public infrastructure client organizations from the perspective of achieving societal value and benefits. This could also offer valuable insights for planning research that examines the competing values faced by private consultants performing work within the public sector (Witzell et al., 2019; Linovski, 2024).

Furthermore, since engineering consultants are typically involved in only one part of the client's project – usually at the beginning – the two actors operate with different time perspectives. Public infrastructure clients, who often assume long-

term ownership of the completed road or railway, and therefore should adopt a significantly longer time horizon, even though this thesis as well as previous research (Rose et al., 2019) rather show the opposite. These differing temporal perspectives may influence how each actor perceives and approaches project management. Future research would benefit from exploring how such variations in time horizons shape inter-organizational collaboration, decision-making, and project outcomes. This is especially relevant in regard to the sustainability transition, whose time horizon extends beyond individual projects.

As this thesis shows, external knowledge resources play an important role in enabling public clients to promote innovation toward the sustainability transition, due to their outsider perspectives. More research is needed on involving (potential) external knowledge resources – both those with experience in the field and those not yet engaged in such projects, such as tech companies and construction equipment manufacturers with expertise in digitalization. Engaging multiple actors, for instance through focus groups, could provide valuable insights into the complexities and barriers within the current system.

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