Successfully implementing innovations in public construction projects

- Determining the impact of a public project team's innovation capability -

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Utrecht, 15-06-23

FINAL VERSION

A Master's Thesis

Civil Engineering

University of Twente

In Fulfilment of the Requirements

For a Master's Degree in Construction Management and Engineering

June 2023

UNIVERSITY OF TWENTE.

Witteveen + Bos

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Abstract **–** The Dutch construction sector faces a need for more innovative public projects. Innovation often takes place on a project-level. However, it is unclear which specific abilities are needed by a project team to implement innovations in public projects successfully. By studying the literature on innovation capability, this study explores how the innovation implementation process of four Dutch public projects can be explained, and the success of implementing an innovation be improved. Through a qualitative case study, this research has found the relation between the presence of eighteen innovation abilities in project teams, and the success of an innovation's implementation in their project designs. The effect of these eighteen abilities on innovation implementation success is explored through a case comparison. The findings result in a framework for public project design teams to determine their innovation capability and lessons to improve future innovation implementation success. Important aspects in the implementation process, like stakeholder involvement and organisational support, can be attained using innovation abilities. This study has found that, through the presence of these abilities, a project team is more successful throughout this implementation process. Furthermore, the framework created to determine the presence of these abilities is a good method of determining possible missing abilities.

Keywords - Innovation capability, Dutch public sector, innovation implementation success, abilities

INTRODUCTION

Public organisations are instrumental in promoting, fostering, and creating the opportunity for implementing innovations (Edler et al., 2015). As the success of an innovation depends on the purposeful governance of innovation processes (Ansell & Torfing, 2014; Edler et al., 2015), this governance ecosystem is important to investigate. Innovative construction projects led by the public sector are characterised by a lack of an "innovate or die" culture (de Vries et al., 2016) and a lack of connection between performance and revenues (Gullmark, 2021). Furthermore, their nonprofit orientation and focus on achieving multiple goals (Piening, 2013), high media attention, risk aversion, and political inference (Sørensen & Torfing, 2017) in a multi-organisational setting create a plethora of conflicting stakeholders and conflicting project goals (Ozorhon, 2012; Ozorhon et al., 2016). This context's effect on the capability to implement innovations in public projects gave a starting point to multiple studies (Gullmark, 2021; Lewis et al., 2018; Trivellato et al., 2021). From these studies, innovation capability appeared to be a key factor enabling public organisations to create, handle, and execute innovative ideas consistently (Trivellato et al., 2021).

Innovation capability is defined as a collection of dynamic organisational and managerial capabilities that encourage ongoing innovation efforts and strategic changes (Gullmark, 2021; Schilke et al., 2018). Furthermore, a recent study has shown more insight into the innovation process of public agencies, describing abilities that could form a framework to incorporate innovation capability within a public agency (Bolier et al., 2023).

However, as the construction industry often produces unique projects, innovation must also develop at the project level (Dorée & de Ridder, 2003; Ninan et al., 2022). Little is known about the role of innovation capability in project-level innovation implementation. Currently, the Dutch construction industry is requiring a fast transition, spurred up by climate change, material shortage and an upcoming peak of assets that are in need of renovation (Landman, 2017; Rijkswaterstaat, 2013, 2022). A need for succesfull project-level innovation implementation has arisen. This development gives rise to the question: Which abilities are needed by Dutch public project teams to foster, harbour, and implement innovations on a project-level? Insight into the innovation capability of public projects teams, and its effect on the success of an innovation's implementation, is therefore needed. This research will attempt to close this knowledge gap. Project design collaborations with a public organisation and external consultants and architectural firms, who bring design experience for an innovation, are most interesting for this knowledge gap, for these collaborations bring a need for external knowledge management (Weissenberger-Eibl & Hampel, 2021). This study could promote public clients and their suppliers to push innovations in public projects more often (Clausen et al., 2020), as the lessons from this study should increase the success of innovation implementation. This research will attempt to address this knowledge gap in two ways.

First, building on the theoretical framework of Bolier et al. (2023) and other innovation literature, this study provides a framework to determine the innovation capability of a public client-led project team. Second, this study furthers the

understanding of the needed innovation abilities by a project team to implement innovations successfully during various stages in the design phase of Dutch public construction projects. Through a qualitative case study, this study hypothesizes that the presence of innovation abilities in public project teams contributes to the success of an innovation's implementation. The contribution of each ability in the innovation implementation process, and their relative importance in a public innovation implementation process is determined.

This paper is structured as follows. First, this paper discusses the theoretical background. Then, this paper describes which theories and tools are applied to identify and implement innovation capability in project teams. The third section explains which methods have been used to (1) determine the innovation capability of projects teams and (2) identify which abilities making up that innovation capability are most impactful to innovation implementation success. Finally, the closing sections are devoted to the discussion and conclusion.

THEORETICAL BACKGROUND

Innovation capability, a functional domain of dynamic capabilities (Gullmark, 2021; Schilke et al., 2018), refers to an organisation's ability to innovate consistently by identifying and capitalising on entrepreneurial opportunities. By transforming both the organisation itself and its ecosystem for mutual benefit. Innovation capability can therefore be defined as a set of conditions that support innovation or provide a supportive infrastructure (Aas & Breuning, 2017).

Several factors contribute to the development of innovation capability, including passionate and visionary leadership, a flexible organisational structure, and a focus on organisational learning (Gullmark, 2021; Lewis et al., 2018; Schneckenberg et al., 2015; Slater et al., 2014). In collaboration with and devised for public agencies, Bolier et al. (2023) categorised these abilities into a framework consisting of three types of *capabilities*: *absorptive*, *adoptive*, and *adaptive* capabilities.

Absorptive capability

The first of these capabilities is called *absorptive* capability. The concept of *absorptive* capability in the knowledge management capability context (Lichtenthaler & Lichtenthaler, 2009; Robertson et al., 2012) refers to an organisation's ability to leverage external knowledge through a combination of three distinct learning processes. These are exploratory learning, exploitative learning, and transformative learning, which complement and reinforce each other (Lane et al., 2006; Zahra et al., 2002). This involves a sequential process of acquiring new external knowledge, applying this knowledge, and retaining and maintaining it over time (Cohen & Levinthal, 1990; Wang & Ahmed, 2007; Zahra et al., 2002).

Empirical research has highlighted the crucial role of *absorptive* capabilities in enhancing inter-organisational learning and performance (Lane et al., 2001). Inter-organisational trust enables the different actors to share and understand knowledge. Lane et al. (2006) have further developed a model that underscores how *absorptive* capability can generate new knowledge and commercial outputs that ultimately influence the overall performance of firms. *Absorptive* capability can foster learning and innovation, which drives project and portfolio performance in research and development (Cohen & Levinthal, 1990).

In conclusion, *absorptive* capability of a project team comprises the abilities to recognise the existence of new (external) knowledge, the capability mobilise this new knowledge in the project team, and to convince other stakeholders that this knowledge's value and importance exists (Lane et al., 2001). *Absorptive* capability is therefore often linked to the initiation of the innovation process.

Adoptive capability

Absorptive capability on its own is not enough to produce value through innovation. The knowledge acquired and assimilated by having an *absorptive* capability also must be realised through the adoption of an innovation by the actors involved (Zahra & George, 2002). *Adoptive* capability refers to the ability to understand the significance and potential impact of an innovation and make informed decisions about its implementation, while also effectively managing the implementation process with these insights in mind (Bolier et al., 2023).

Governments and companies have realised that, for an innovation to be successful, it is not enough to have good new ideas. It must foremost be adopted by the market (Brem & Viardot, 2015). The "market" or buyers, in this case the public client, will need to be convinced an innovation's value is worth the risk. An *adoptive* capability provides methods to overcome this uncertainty concerning value recuperation and successful implementation, among other innovation barriers, in the public client projects. Some of these innovation barriers include the culture of risk aversion, the delivery pressures of construction projects, the resistance from specific actors, and the political climate surrounding public client projects (Cinar et al., 2019; Lewis et al., 2018; Mulgan & Albury, 2003). In practise, this means providing insight into the value the innovation might bring to their specific project, being able to identify and predict certain risks, and creating an ecosystem in which the innovation barriers can be overcome (Van Oorschot et al., 2020). Flexible organisational leadership, practical experience and the creation of support and momentum can all aid in the creation of capability (Gullmark, 2021; Slaughter, 2000). *Adoptive* capability is therefore often linked to the implementation phase in the innovation process (Slaughter, 2000).

Adaptive capability

Adaptive capability refers to an organisation's ability to respond and adapt to changes in the environment, such as new technologies or market trends. Chakravarthy (1982) distinguishes *adaptive* capability from adaptation, where *adaptive* capability focuses more on effective search and balancing exploration and exploitation strategies on an

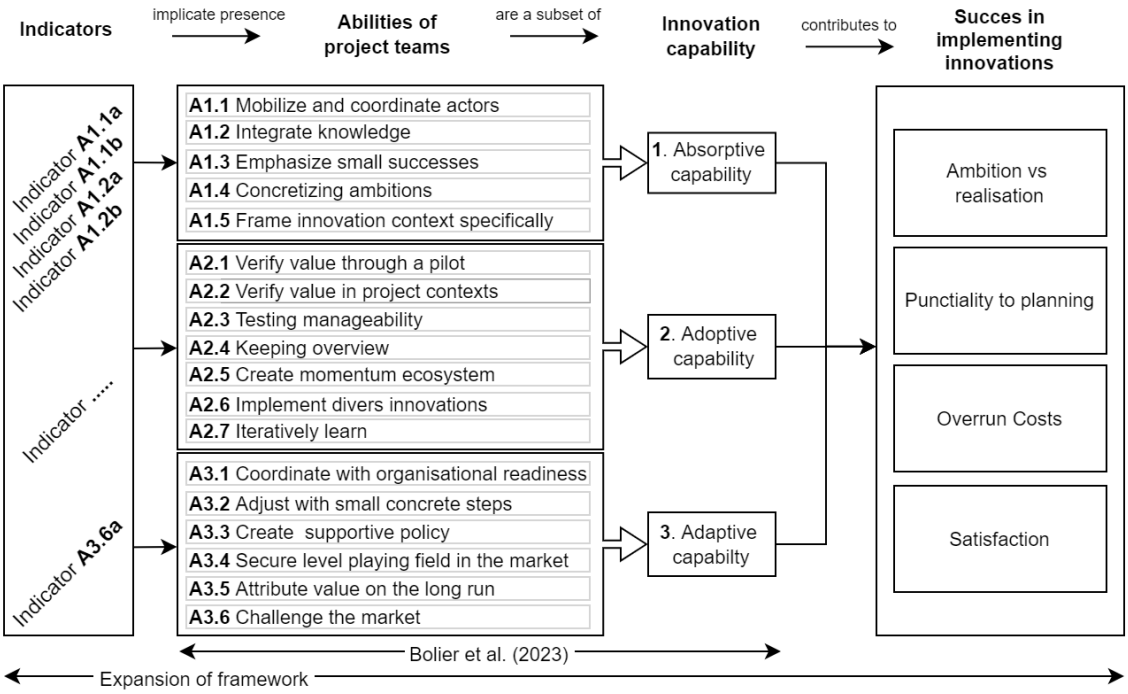

Figure 1 Suggested framework: Measuring the capabilities of public client-led project teams.

organisational level (Wang & Ahmed, 2007). These strategies can be manifested through organisational strategic flexibility and in the balance of applying resources.

Several factors can influence a construction organisation's *adaptive* capability. These include the availability of resources such as funding, skilled labour, and technology, as well as the firm's organisational culture and leadership (Aagaard, 2012). An organisation that is open to trying new things and taking risks may be more adaptive than one that is more risk averse. Additionally, the ability to gather and analyse data swiftly, as well as the presence of strong networks and partnerships, can also contribute to *adaptive* capability. This is in line with the theory of small wins, where small changes and wins can enable an organisation to implement change on a larger scale (Termeer & Metze, 2019). These theories and other theories will be used in the creation of the expanded framework.

The *adaptive* capability is linked to the adaptation of an organisation to take in an innovation in standard practice (van de Ven, 2017). Therefore, the *adaptive* capability is linked to the institutionalisation phase of the innovation implementation process.

Suggested framework (to build upon)

Bolier et al. (2023) subdivided the three capabilities (i.e., *absorptive*, *adoptive*, and *adaptive*) into 18 innovation abilities that support the innovation implementation process. Figure 1 displays the 18 abilities and their corresponding capability. A method of determining the presence of these abilities has yet to be created for the scope, as Bolier et al. (2023) initially designed their framework to discuss an entire public agency, instead of a project team under their supervision. Their abilities are therefore broadly stated.

To identify a certain innovation ability in a project team setting, and thus to determine whether a project team has one or more of the capabilities, this research will identify indicators for each ability. Figure 1 summarises this process; indicators taken from literature in this study implicate the presence of abilities. The presence of abilities in a project team adds up to of one of three capabilities. These capabilities hypothetically cause more successful implementation of innovations.

To reiterate and conclude: This study builds upon the findings of Bolier et al (2023), who hypothesised that the abilities of have a positive influence on innovation implementation success. By expanding on this framework, this study tests the validity of this hypothesis, and determine the influence of each of the abilities and corresponding capabilities. To achieve this, indicators will need to be made.

RESEARCH APPROACH

This section discusses the approach of this research, which is divided into four parts. First, the suggested framework is expanded to handle the scope. Second, the selected cases for the empirical study are discussed. Third, this study conducted in-depth interviews in which the presence and practical implication of theoretically derived indicators and corresponding abilities are discussed. In five empirical cases, the effect of their presence on the success of the innovation implementation process is discussed. Fourth, the method of analysing and validating the collected data is expanded upon.

Expansion of the framework

In the suggested framework, the abilities of project teams add up to a project team's innovation capability. However, to test for their presence, they will first need to be operationalised for

Table 1 *Overview of cases*

	Public agency	Phase of the project	Interviewed team members	Innovation	Project size, # individuals aiding in the design	Implementation success
Case 1	Municipal	Sketch design	Project manager client Project manager consultant Innovation expert client Innovation expert consultant	Creation of a concept design for circular area development	Client (3-7), Innovation consultant (3-4),	*Low*
Case 2	National	Sketch design	Project manager consultant Technical manager consultant Innovation expert consultant	Use of a material passport, use of local materials, reduced emission building design	Client (>10), Engineering firm(s) (>50), Architect (>10)	*Neutral*
Case 3	Municipal	Preliminary design	Project manager consultant Innovation expert client Innovation expert consultant	Reuse of locally harvested pavement materials in area development project	Client (3), Consultant (2), Architect (2)	*Low*
Case 4	Municipal	Entire Design phase	Project manager client Technical manager contractor Innovation manager consultant	Use of more sustainable road construction material	Client (3), Innovation Consultant (3), Contractor (1), Architect (2)	*High*
Vali-Dation	Water board	Preliminary design	Project manager consultant Technical manager consultant Innovation manager consultant	Use of a circular shadow design to aid in decision-making and design optimisation	Client (>20), Engineering consultant (>20)	*Neutral*

the study's scope. This study determined indicators for each ability from literature, for a public project team setting. These indicators needed to provide a practical application of the ability, as those could be recognised by (interviewed) project teams.

First, literature from the initial source (Bolier et al., 2023) was examined to more extensively describe the abilities stated in that paper. Second, a discussion was held with the author of Bolier et al. (2023), to determine the goals of each ability more concretely. This discussion creates a more descriptive and broad statement about the goals of those abilities, and why that goal would add to the success of innovation implementation. It furthermore provides a connection with the *absorptive*, *adoptive*, or *adaptive* capabilities, suitable for a qualitative, exploratory study. Summarised lessons and (practical) suggestions from different articles, books and papers formed the basis of the indicators. This resulted in an extensive research effort, involving the analysis of 39 scientific papers and books to identify indicators that signify the presence of innovation abilities.

Case selection

In the investigation's framework on the innovation capability of project teams in public client spatial development projects, five cases have been studied and analysed. The initial selection criteria were:

- The project has completed the sketch design phase in the design process
- A sufficient database on the project was available
- An ambition to implement innovation(s) needed to be shown at the start of the project
- The project had to be tendered by a public client, who needs to be represented in a multi-organisational design team

To apply this research in various contexts, and test the framework in multiple scenarios, a purposive sampling approach was used. Cases were selected based on their (difference in) project size, public agency type, ambition to use innovations and self-proclaimed success in implementing this innovation. These criteria were chosen to be able to determine the level of innovation implementation success, and to be able to validate the empirical results. Initially, four cases were selected. These four cases provided this research with a possibility for an in-depth case analysis and a comparative analysis. Table 1 provides a detailed overview of these four cases, and displays a fifth *validation case*. The *validation case* was interviewed after the results were analysed and was used to validate findings.

Data collection

For each case, three to four project team members were interviewed to determine the presence of the 18 innovation abilities in their project team. The project team members interviewed needed to have an overview of the difficulties of the innovation's implementation in question (Ozorhon et al., 2016), the functional and managerial capabilities of the team members (Cinar et al., 2019; Lewis et al., 2018), and the ecosystem of actors surrounding the project. Therefore, both the project managers of the public client and of the organisation proposing an innovation were interviewed. These individuals were working for the consultancy, engineering or contractor firms who won the public tender. Innovation experts in the team were interviewed for their practical knowledge of the innovation in the project. The three to four individuals provided a comprehensive insight into the project(team).

The abilities and indicators were discussed in qualitative interviews. To streamline the process, stimulus texts were used as clues, in the shape of index cards displaying one ability and the corresponding indicators (Törrönen, 2002). As there were over 40 indicators to discuss, often not all present in the specific project team, a method of quickly selecting present indicators was needed. Using index cards, the interviewee could quickly respond to indicators they recognised, and extrapolate on how these indicators presented themselves in their specific context. A qualitative score stating the presence of indicators was discussed with each indicator. Here, the interviewee would state the indicator to be a "fully present", "partially present" or "no presence" (or "I do not know"). Each interview was recorded, and the response to each

indicator was summarised and coded. This resulted in 16 audio recordings, between 45 and 95 minutes each.

Through a collection of answers, the presence of the corresponding abilities per case could be determined. The ability was marked as fully present if the median of interviewees stated at least one indicator was "fully present". If an indicator only had a "partially present", the corresponding ability was marked with little presence. As different interviewees would sometimes give different answers, case documentation would be used to validate the answers. The best supported answer would then be chosen. Finally, a summary was made of the corresponding anecdotes given per discussed indicator.

One extra card was made to determine the success of the innovation implementation process. Construction success is often defined by multiple factors. This research concludes the success of the implementation process (up to the point of the interviews) based on the indicators of "overrun cost", "punctuality to the project planning", "initial ambition versus realisation" and "team member satisfaction" (all due to the process of innovation implementation) (Chan & Chan, 2004; Silva & Warnakulasooriya, 2017). As construction success has always been an abstract concept, making evaluation difficult (Silva & Warnakulasooriya, 2017), the overall level of success will be determined qualitatively based on these factors.

Both the presence of indicators from the interviews and the level of success were validated using over 24 documents, such as tender documents, project schedules, organisational charts, design proposals, and action plans.

Data analysis

To analyse gathered data from case documents and interviews, this research has used a technique from Miles & Huberman (1994), called a case-ordered predictor matrix. The cases were ordered based on variations in outcomes (of success). Cross-case matrices are a useful tool for analysing the relationships between different variables. A case-ordered predictor matrix organises cases and data into two distinct components:

1. The main antecedent variables that are believed to be key factors influencing, being the innovation abilities of the project team.
2. The main outcome or criterion variables, overall success of the innovation implementation in the project.

In the analysis, the individual abilities can be reviewed in unison and in collaboration. By sorting on implementation success factors, "missing" abilities can be spotted in the cross-case matrix in cases that scored lower or higher. Based on the results, the focus of the analysis shifted to explain why certain abilities had an impact of the innovation implementation process. If such a causal reason was found in the anecdotal explanations of the interviewees of a certain case, other cases were used to confirm or dis-confirm the emerging findings. Quotes were extracted that described how the innovative activities of individuals or innovation-stimulating organisational tools, processes, structures, and routines caused the focal public client project teams to become (less) successful in innovation implementation.

To further confirm the findings from the data analysis made using the first four cases, a validation case was examined. In this validation case, the important "predictor" abilities discovered through the first four cases were compared to the abilities causing a (lack of) success in the validation case. As they were consistent, the findings from the initial study seem to reflect other (future) cases as well.

RESULTS

The results section is subdivided into four sections. First, the operationalisation of innovation abilities is discussed. Secondly, the effect of the innovation abilities on the innovation implementation process is discussed. Thirdly, the contribution of the abilities to the success of innovation implementation is analysed. Finally, these empirical results are corroborated by a validation case.

Indicators of innovation abilities – expanding the framework

Appendix A provides an operationalised interpretation of innovation abilities, which enables their presence in a project team to be tested through interviews. The table outlines the specific indicators that a project team recognises in their implementation process to demonstrate their innovation abilities. Importantly, this framework gives a project team options to what end they wish to fulfil the ability.

Appendix A shows that certain abilities like **A1.4** were not only referenced more often by literature, but could also be attained using a wider range of indicators. Important to notice is that similar indicators are useful in achieving multiple different abilities. For example, "The use of the innovation is framed to be a necessity with the (to be convinced) audience" is an indicator of ability **A1.5**. It was stated to be a method to increase *absorptive* capability by at least three sources and is connected to the goal of ability **A1.5**. A similar indicator can be seen corresponding to ability **A3.4**, where "the use of the innovation is 'felt' as mandatory by client-side employees".

The findings of this theoretical research filled out the framework displayed in Figure 1. Each ability now carries at least one indicator, indicating its presence in a public project team setting.

The effect of the abilities on the innovation implementation process

Without going deep into the qualitative side of the empirical results, Table 2 displays the presence of each ability in the four initial cases. Table 2 is sorted based on the qualitative average of the success factors determined by the researcher, called overall success. A higher number of present abilities can be seen to correlate with an overall higher success rate of innovation implementation. However, just counting the number of fully present abilities does not account for the smaller differences in the success of innovation implementation in the different cases.

Table 2 Case-ordered predictor matrix: The presence of the 18 abilities in each of the cases, ordered based on overall success.

						Absorptive					Adoptive							Adaptive					
Case	**Ambi-tion**	**Punct-uality**	**Overrun costs**	**Satis-faction**	**Overall Success**	**A1.1**	**A1.2**	**A1.3**	**A1.4**	**A1.5**	**A2.1**	**A2.2**	**A2.3**	**A2.4**	**A2.5**	**A2.6**	**A2.7**	**A3.1**	**A3.2**	**A3.3**	**A3.4**	**A3.5**	**A3.6**
Case 4	*Realised*	*Punctual*	*Slightly*	*High*	*High*	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓	✓	✓✓	✓	✓✓	✓✓	✓✓
Case 2	*Lessened*	*Punctual*	*Slightly*	*High*	*Neutral*	✓✓	✓✓	✓	✓✓	✓	✓	✓✓	-	✓	-	-	✓✓	-	✓	-	✓✓	✓✓	✓✓
Case 1	*Lessened*	*Halted*	*Slightly*	*High*	*Low*	✓✓	✓✓	✓✓	✓	✓✓	✓	✓	-	-	-	-	✓	✓✓	✓	-	✓✓	✓	✓✓
Case 3	*Lessened*	*Extended*	*Firmly*	*Neutral*	*Low*	✓	✓	-	✓	✓	-	✓✓	-	✓	-	-	✓	✓	✓	-	✓	✓	-
Vali-dation	*Realised*	*Extended*	*Slightly*	*Neutral*	*Neutral*	✓	✓	✓	✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	-	✓✓	-	✓	-	✓✓	✓	-

- No presence of the ability: no presence of indicators

✓ Little presence of the ability: Low presence of (one of the) indicators

✓✓ Fully present of the ability: at least one fully present indicator

Therefore, the following sections will discuss the findings concerning the impact of each ability in the suggested framework as applied to the cases in more detail. Each ability and its impact on the innovation implementation process will be discussed in order of the abilities. This will answer the question of *how* the presence or absence of innovation abilities interacts with the innovation implementation process. The interaction of the abilities in each case will be discussed through this itemised path. The contribution of the innovation abilities to innovation implementation success is discussed afterwards. Finaly, the results will be corroborated using a validation case.

Absorptive abilities

The analysis of the four cases revealed a high level of *absorptive* abilities in three of them. The presence of *absorptive* abilities was attributed to the involvement of multiple individuals who were willing to experiment and innovate. Early involvement of important stakeholders in the design process laid a solid foundation for the project, and the necessary skills to achieve a high *absorptive* capability were acquired through this collaborative effort.

> *"If you want to implement an innovation, you have to have guts. Then you have to dare. You have to dare to take the gamble. If that is not there, the will to do something unknown, then the project is not going to succeed." (Project manager client, Case 4)*

The early involvement of important actors (**A1.1**), and their input, seemed to play a large role in the early phases of the design process. Decisions needed to be made in order the further the design and implementation of the innovation. These decisions can only be made when the needed knowledge about the innovation can be shared within the project team. Recognising value and making knowledge context-specific and applicable in the team (**A1.2**) played a large role in this process. The key actors need to be convinced of taking the risk, which is why early involvement and constructive knowledge sharing was needed. *Case 3* did not involve the relevant actors needed to implement the innovation in the early phases of design and did not involve client-side actors with relevant prior knowledge. The project-team could not convince decision-makers of using the innovation in their context (**A1.1, A1.2**), and did not show the possibilities of its use (**A1.5**). The trust deteriorated between the client and the design consultant proposing the innovation over time and slowed the project down considerably. Setting interim targets, project progression, and an individual taking responsibility for the innovation implementation (**A1.3** & **A1.4**) could have positively influenced and enthused important actors, according to the project manager (consultant) and the sustainability expert of the public client. The project team of *Case 3* comprised around 5 individuals, which were not all on board with the (rather vague) ambitions set for the project. These lacking *absorptive* abilities in *Case 3* were said to slow the project considerably (displayed in Table 2 as an extended punctuality), and reduced trust in the innovation and between the individual team members (supportive of the neutral satisfaction in Table 2).

Case 1 experienced delays in the project design despite having almost all the *absorptive* abilities outlined in Table 2. Notably, stating concrete ambitions (**A1.4)** was found to be a necessary ability for the project, being of little presence in this case. The goals set for the project were relatively vague, among which were sustainability ambitions that could only be achieved through implementing sustainability innovations. Partly due to the focus lying on innovation implementation, further requirements for the area, such as housing, businesses, or budgeting were poorly defined. This resulted in a lack of specific targets for the design process, rendering the proposed designs untestable and unapprovable. This ultimately led to the indefinite halt of the project.

Both *Case 2* and *Case 4* scored relatively high in their absorptive capability, and crucially, showed a convincing presence in ability **A1.1** and **A1.4**. *Case 4* succeeded relatively smoothly in their implementation of multiple innovations. The interviewees gave the following reasons for their high absorptive capability: They involved both the internal stakeholders at the client side, the external stakeholders of the area and the future contractor, very early in their design process. This reduced possible resistance from these stakeholders, according to the innovation expert (contractor).

> *"You need someone inside the college (municipal board), who is looking out for the interests and success of the project's innovation implementation." (Project manager client, Case 1)*

The team got these actors involved, which helped in getting momentum for the project (**A2.5)** and necessitated the creation of progress rapports (**A1.3**) to keep these stakeholders up to

date. Similarly, *Case 2* involved multiple stakeholders from the area to comply with their demands. They also linked their ambitions to a certain certificate, creating a list of measurable goals and steps to attain these goals (**A1.4**). Both cases had less resistance to implementing their respective innovations due to the support of important actors, who were actively involved in the project's design. These actors understood the need for innovation implementation since the ambitions were made concrete and could only be achieved by breaking tradition and implementing new ideas in the design. *Case 2* & *4* tested their designs on the set goals and continued only if they passed them.

Adoptive abilities

Only *Case 4* had a high presence of *adoptive* abilities. Looking at Table 2, a lower presence in other cases correlates with the reduction in ambitions in the final design, compared to the initial ambition. According to multiple interviewees from every case, implementing an innovation requires the taking of risks. According to the contractor-side project managers of both *Case 3* and *Case 4*, the risk-averse nature of public employees and their organisation hindered innovation implementation. For example, in *Case 3*, the department of asset management in the client organisation hindered the innovation implementation. This department was uncertain that they would get the necessary budget to manage the innovation as it would differ from their regular budget calculations.

All cases tried to mitigate the (perceived) risk of the innovations but handled it differently. As seen in Table 2, *Cases 1,2,* and *3* had little to no presence of **A2.1**. These cases had few project team members with practical pilot experience concerning the innovation, on both the design consultant and client side. The consultant of *Case 3* knew how to implement the innovation; however, no concrete steps could be assigned using experience to support their innovation implementation process (**A2.1, A1.5)**. Not all actors (within or outside the project team) could therefore be convinced by the consultant to use the innovation, such that the client is trying to hire an external party to validate the necessary steps and contracts needed to carry out the design proposal. This lack of trust, partly due to a lack of pilot-gained experience, was solved in *Case 4* by including the contractor in the project team. They created a "Bouwteam" (see Chao-Duivis, 2012), where the contractor's experience with the innovation was used to build trust and mitigate perceived risk.

> *"As we currently don't have the time, we should have involved the market sooner (to overcome unknowns about the innovation)" (Project manager consultant, Case 3)*

Case 2 addressed risk and uncertainty by focusing on ability **A2.2**. The project-team meticulously calculated the advantages and costs of each innovation aspect. This extensive insight into the effects and properties in their context relieved the need for specific pilot insight and experience. The importance of determining the value of the innovation (**A2.2**) was mentioned in all (partially) successful cases. This importance was especially evident though *Case 1*. The team's lack of value determination (**A2.2**) in the innovation halted the design process, as no indication could be made of the price or value of the different proposals. Therefore, no decision could be made on the best course of action.

The ability to have a high manageability and create momentum (**A2.3** & **A2.5**) were only present in *Case 4*. All interviewees in *Case 4* agreed that their project design could proceed swiftly due to the high executive capacity of the project team (**A2.3**). The project director had a large executive capacity and network in the client organisation, and was highly involved, which is why decisions about clashing forces could be made quickly. This is in line with ability A2.5, as the project manager was able to leverage his network to influence the municipal board directly to gain support.

> *"I'm glad I have put so much pressure on him (the deciding actor), in order to for him to tell me "Let's just do it". He would not have given a 'yes' to someone else, only to me. Since he trusted me." (Project manager client, Case 4)*

This network of influence in the client organisation resulted in a larger supporting base for the project. *Case 4* was also the only case which made a public announcement in the media and involved these public stakeholders early in the project (**A2.5**). This made sure politicians could not back down on their ambitions and reduced possible setbacks.

The ability to keep an overview of developments (**A2.4**) was not fully present in any of the cases. According to multiple interviewees, a project's design phase is divided in three phases for a reason, as it is difficult to divide the process into multiple smaller steps. Implementing innovations was done simultaneously with all other aspects of the project. Moreover, there was a lack of frequent and thorough risk analysis to anticipate and plan for potential course changes.

> *"I think it is important to do a comprehensive risk analysis, and it is often forgotten. Adjustment directions are usually not determined." (Technical manager consultant, Case 4)*

Permission to alter course from higher management could often only be received after a concrete and examined alternative. As these indicators were not fully present, the connection between success and presence of ability **A2.4** could not be determined.

The ability to implement diverse innovations (**A2.6**) was largely coupled to gaining organisational support to try to learn from more risk-taking actions, according to multiple interviewees. In *Case 2*, the high state of managerial pressure, and a push to reduce risk-taking ideas, caused the more difficult ambitions to be easily let go. Presenting something uncertain and perceived as risky to management was not possible, thus only risk-averse parts of the innovation could persist. *Case 1, 2,* and *3* also all stated a clear lack of public entrepreneurs (someone in service of the public client, willing to take a risk, think outside the box, and take responsibility for possible failures) in their project team. Moreover, *Case 4*

mentioned that this role is deemed critical when the organisation itself is not highly innovatively routinised (see Gullmark, 2021). *Case 4* had two public entrepreneurs present in their project team. As the only case with fully achieved ambitions, the results support this statement. Meetings about the innovation with diverse disciplines on the client side were not often done in the four cases.

An iterative working method (**A2.7**) was implemented in *Case 1* and *2*. This did allow them the possibility to iteratively learn, however, did not immediately include the objections of (external) stakeholders. *Case 2* and *4*, importantly, focussed on these objections in their innovation implementation process, which improved the support for the innovation and design's progression.

Adaptive abilities

The *adaptive* abilities focus mostly on the public client organisation of the project, and its willingness to support and coordinate the innovation implementation process and the project team.

All public organisations said that they were willing to try to start adapting towards this "innovative" new standard (**A3.1**), however, not all gave this practical backing. In *Cases 1,3* and *4*, this organisational backing took shape through the hiring of "innovative" consultants, getting them to help in creating innovative solutions to their ambitions. However, each of these project teams still noticed that the public organisation's employees did not feel like innovative behaviour was rewarded (similar to the reluctance of the asset management department in the previous section). This lack of practical backing caused delays through the thwarting actions of departments in these public organisations.

Ability **A3.2** showed little presence in the less successful cases.

> *"Certain standards could not be adjusted in time because politicians would not cooperate quickly enough. People are not supported, and do not talk to the boss." (Project manager client, Case 4).*

> *"The deciding committee just decides what they like best, and does not listen to their subordinates about what is best for innovation implementation or achieving their innovative goals." (Innovation expert consultant, Case 2)*

Creating a coalition of innovation-supportive actors with public employees (**A3.2**) seemed difficult, as it rarely felt in their best interest to do so. Implementing innovation might impact their budget or time, which was undesirable (*Case 3, project manager consultant & Sustainability expert client*). Often only the less influential actors in the project team were pushing the innovative agenda, making it difficult to find organisational support (*Cases 1,2,* and *3*). Seeking a supportive and influential project team member was deemed to be important (see **A2.5**). Altering the traditional operating procedure and handbooks within client organisations was stated to be an almost impossible task for the project teams. Unsurprisingly, policy creation or operation procedure alteration (**A3.3**) was also felt to be out of reach in most cases. *Case 4* did use a "Bouwteam" which reduced the lifetime insurance risk for implementing the innovation somewhat.

Each case at least tried to secure a level playing field for the market (**A3.4**). *Case 4* was tendered based on the ability to show an innovative approach and based on quality instead of price. *Case 2* implemented the use of certifications, through which its use of innovations was made mandatory. *Case 3* wanted to implement the use of innovations in their tender, however, were willing to let go of that requirement if no easy to execute proposal came along. This was mainly caused by a lack of a coalition for the use of the innovation within the project team, stated the interviewees.

For the cases that could concretely state their ambitions (**A1.4**), the long-term value resulting from innovation implementation (**A3.5**) could be determined. This required identifying the factors that define value. Only *Cases 2 and 4* assessed long-term value, and they received organisational support and extra budget because of their ability to do so. Long-term value did need to be transposed into organisational planning, where future costs or benefits needed to be adjusted throughout the organisations involved.

Multiple interviewees further determined that, for innovation to be a success, an equal footing in the project team is required (**A3.6**).

> *There must be equal levels of knowledge between the client and the contractor/consultant. That way you can have equal conversations, and you can discuss options, and build trust" . . . If there is no innovation knowledge at the client, the contractor can tell you anything. This creates unnecessary risks. Little knowledge was present (at the client) but had been hired well (externally). (Project manager client, Case 4)*

Challenging the market necessitated a level of knowledge from the client, or a willingness to trust the design team. A feeling of necessity to reach the relevant ambitions would also suffice. *Case 3* showed that an absence of **A3.6** caused delays due to mistrust, and extra costs due to the hiring of external knowledge to validate design suggestions. The other project teams collaborated more deeply on the innovation and could more successfully propose innovation aspects.

Innovation abilities' contribution to innovation implementation success

The *absorptive* abilities concern themselves with establishing a solid foundation for the implementation process. The *absorptive* abilities have shown to attribute to establishing the initiation of innovation implementation. A low or lacking presence of these abilities was said to impact the satisfaction of the team members in the process through a lack of trust and increased stakeholder resistance. Furthermore, lacking *absorptive* abilities reduced punctuality in the project schedule (often through delays). Especially abilities **A1.1, A1.2, A1.4** and **A1.5** were discussed to be instrumental. Due to their presence, the project involved the key actors, had a clear ambition, and acquired support for the innovation in their specific context. In cases where some of these abilities were less present, the success of the innovation implementation process was indeed lower. These four absorptive abilities therefore seem to contribute to innovation implementation.

Most *adoptive* abilities only seemed to be fully present in the highly successful *Case 4*. A public entrepreneur advocating the innovation's use, and a method to display the value of the innovation were the most important indicators mentioned by the interviewees. The adoptive abilities are especially important to maintain the initial ambition of the project and to realise the innovation implementation in the design. Risks and uncertainties pop up during the design process, which needs to be managed and addressed. Interviewees stated that abilities **A2.1, A2.2, A2.3, A2.5** and **A2.6** proved instrumental in tackling these aspects. Due to their presence, the project team could clearly state the value of the innovation in the project. Furthermore, the project team that had these abilities could acquire organisational and public support more easily, which allowed them to implement the innovation into their design. In cases where some of these abilities were less present, the success of the innovation implementation process was indeed lower. These five adoptive abilities therefore seem to contribute to the success of innovation implementation.

The adaptive abilities manifested themselves through gathering organisational support from the public client and its staff. The abilities can be used to institutionalise innovations in an organisation. Reduced presence of these abilities caused a need for finding solutions to acquire this support. However, the interviewees often felt the abilities used to acquire organisational support were out of their reach. It could be said that this lack of support slows the design process down, as it was deemed necessary for decision-making. Only ability **A3.6** was mentioned to contribute actively to the success of the innovation implementation, as its presence solidified innovative propositions as reliable. *Case 3*, the sole case not able to challenge the market, suffered in their expenses and planning's punctuality due to its absence.

These results indicate that the contribution of the innovation abilities lies in the advancement of the innovation implementation process. Through the presence of abilities in a project team, multiple important factors concerning innovation implementation are improved. Factors like decision-making, value-recognition, internal and external collaboration, stakeholder management, and risk management were all mentioned by interviewees. Especially abilities **A1.1, A1.2, A1.4, A1.5, A2.1, A2.2, A2.3, A2.5, A2.6** and **A3.6** were (1) mentioned to contribute actively to the implementation process, and (2) missing in less successful cases. This indicates their need for a successful innovation implementation in public projects.

Corroboration of results

After these results were in, a *validation case* was conducted to corroborate the previously stated results. An analysis of the case's *absorptive* and *adoptive* capabilities showed that their scores were not particularly low compared to previous cases. Yet, significant obstacles were encountered during the innovation implementation process. Upon closer examination of Table 2, it was found that the validation case had a lessened presence of six previously determined key abilities: **A1.1, A1.2, A1.4, A2.1**, **A2.6** and **A3.6**. Their lessened presence should indicate the possibility for decreased success, which is in line with the score given in Table 2. This corroborates the findings of the previous section.

The impact of some of the individual abilities can be validated as well. While this *validation case* initially experienced success, the innovation implementation in the design stagnated and the team members grew less satisfied in the process over time. Notably, the "missing" key abilities were linked by the fact that the project was initially led by a public entrepreneur who was willing to take on responsibility and risk to implement ambitious innovations. With this individual in charge, the right actors were involved, the innovation's implementation in the project ran smoothly, and risks were properly managed on the client side. However, after a few months, this individual left the project team. His replacement lacked knowledge of the innovation and was not willing to serve as a public entrepreneur. The team thereafter lost cohesion and trust (especially in the design consultant).

> *"He [project manager] talked about great ambitions and made sure budget was found through subsidies. [Project manager] was the real driver of the project. When he left, it was a large blow to the progress of the project and the innovation's implementation." (Technical manager consultant, Validation case)*

According to the interviewees, the departure of this individual reduced the team's ability to concretise goals, since no one wanted to bear the responsibility of their achievement (**A1.4**). Furthermore, it removed the individual with the most knowledge about the innovation on the client side (**A1.2**, **A2.1, A3.2** & **A3.6**). Moreover, the team lost their public entrepreneur (**A2.6**), felt a reduction in trust in the project team's abilities (**A1.3**) and halted internal collaboration (to implement the innovation) (**A2.6**). The removal of this key individual created a loss of the presence of five significant abilities previously present and reduced the presence of three others. This shift caused the implementation process to be immediately halted until some of these abilities could be regained.

DISCUSSION

This chapter discusses the results presented in this study by first discussing the framework presented in Appendix A as a method to determine a project team's innovation capability. Afterwards, the relation between the presence and the success of innovation implementation is explored further, through a discussion of the most important findings. Finally, the chapter concludes by providing insight into managerial implications.

Innovation capability framework

This study provides a framework to determine the innovation capability of a public client-led project team. Through Appendix A, this research contributes to the findings of Bolier et al. (2023) to determine the required abilities of a public construction agency for innovation implementation. As stated

by Gullmark (2021), a one-size-fits-all approach must be avoided. This study therefore attained multiple indicators to gain innovation abilities. The literature study resulted in more indicators for *absorptive* and *adoptive* capability, for a project team setting. As the *adaptive* capability is aimed at organisational change and culture for innovation (Van de Ven, 1999), abilities in a project team are more difficultly attained. Lichtenthaler & Lichtenthaler (2009) further mentioned the need for a knowledge management capacity, where, from a dynamic capability perspective, a need arises for a client firm to manage its knowledge base dynamically. This need for managerial guidance towards knowledge and innovation implementation means that, from a project level perspective, there is less to be done to increase adaptive capability. Thus, there are fewer indicators found for the *adaptive* capability and the corresponding abilities (**A3.1**-**A3.6**).

The limited impact of adaptive abilities in a project team setting was corroborated by the case study, in which the adaptive abilities where more difficult to attain. This does not mean that a project team does not need *adaptive capability*, however the interviewees indicated that the adaptive indicators where mostly dependent on the client organisation. In a project team setting, the initiation and implementation phases are more likely to be influenced. The suggested framework in Figure 1 should therefore focus on the attainable abilities, being the *absorptive* and *adoptive* abilities to improve the success of implementing innovations.

These abilities were further shown to be different in their effect on the implementation process, and their influence on actual success. For example, concretizing goals (**A1.4**) and the ability to implement diverse innovations and learn from common mistakes (**A2.6**) were assessed as necessary in to continue the innovation implementation process and to succeed. However, the ability to emphasize small successes was hardly mentioned to be of importance. This suggests that there are significant differences in the level of contribution each ability could provide, not discussed by Bolier et al. (2023).

An adapted version of the suggested framework is presented in Appendix B. The goal of the framework aims to aid project teams in acquiring abilities to succeed in innovation implementation. As each ability was found to impact the innovation's implementation process differently, this study suggests that a weight is added to signify their relative importance. The weight could further expand on the limited role of adaptive abilities in a project team setting. By setting abilities **A1.3, A2.4, A2.7, A3.1, A3.2, A3.3, A3.4** and **A3.5** lower than the others, the findings of this research could be incorporated into the framework. However, the method and restricted number of cases in this study were not enough to determine these weights quantitively. A detailed expansion of this framework is therefore a suggestion for future research.

Understanding innovation capability in project settings

The second objective of this study was to further the understanding on how innovation capability of public project teams affects the success of innovation implementation in the design phase of public projects. Regardless of external factors that affect project success, the major elements of influence of the project team's innovation capability on the success of innovation implementation are the following.

Supporting previous research (Gullmark, 2021; Ozorhon & Oral, 2017), project-related factors play a large role in the success of innovation implementation. In a project team setting, abilities concerning themselves with public entrepreneurs, employee empowerment and personal responsibility to implement and guide innovations, are playing an instrumental role on project-level innovation. Gullmark (2021) also noticed these abilities and called them "low-routinised innovation capability". This study found that these abilities can be attained by a project team and should therefore be a focus point for aspiring innovative project teams. In support of the findings of Nam & Tatum (1997), someone with a respectable power in the public organisation, with technical competency and resources, is needed to implement innovations successfully. In contradiction to Nam & Tatum, projects seemed to need a someone with a strong personality, willing to push the innovation's agenda, overcoming backlash. Through, for example, this public entrepreneur, clear progress rapports, public announcements in the media and other aspects, the innovation could gain the support necessary for its implementation. Especially when public organisations themselves do not have a high *adaptive* capability to support their employees in the innovation implementation process.

The impact of *absorptive* abilities on innovation implementation success concerned the important actors, like public client management or residents of the area. Involving them early on, to make concrete ambitions for the project and framing the innovation's use in their context (**A1.1, A1.4, A1.5**) creates an imperative supportive base that is needed in implementing an innovation in a project (Poister, 2010). This could be attributed to interdependency. Interdependency is a key construct in construction projects, where actors are dependent on each other's resources and power (Leijten, 2017). The results show that this interdependency should embraced, involving relevant stakeholders as early as possible, to obtain their support. The dialogue with different stakeholders (through *absorptive* abilities) resulted in the active involvement of these stakeholders behind a driving objective (Nonaka & Toyama, 2005) and provided a method of establishing the value of the innovation.

Furthermore, the presence of *absorptive* abilities is shown to result in a high satisfaction of team members in the implementation process. Even in implementation failure, the team felt more positive about the outcome, even if that outcome came later or diminished in value. The interviewees in high satisfaction cases stated that they had learned a lot, which they valued highly.

In line with recent research by Van Oorschot et al. (2020) and Brem & Viardot (2015), the actual implementation of innovations in a specific project's design was largely defined by the *adoptive* capability of the project team. Its presence

assisted in overcoming many of the innovation barriers in public projects (Cinar et al., 2019; Lewis et al., 2018; Mulgan & Albury, 2003). Providing insight into the value of an innovation was needed to overcome the risk-averse nature of the public clients, by both providing experience and value insight on the innovation's use. This substantiates previous findings, stating the lack of clear benefits as the main barrier to innovation adoption (Ozorhon et al., 2016). Including a contractor with this experience improves both these abilities, which could be seen as an enabling factor for innovation, as described in Ozorhon et al. (2016). Delivery pressures and administrative burdens (Mulgan & Albury, 2003) could be resolved by having a solid insight into the manageability of the innovation, through *adoptive* capabilities.

A final lesson from the interviews was that the routines and culture of the client organisation were mostly seen as a barrier, not a tool for innovation implementation (Schilke et al., 2018). This can be attributed to the low *adaptive* capabilities (Gullmark, 2021) of the participating public organisations, which provide little top-down support to innovation implementation in projects. However, a change of team members more in support of the innovation or by adapting the properties of the innovation could be done to increase the *adaptive* capability of the project team, and possibly increase innovation implementation success, according to Robertson et al. (2012).

Managerial implications

These insights offer important implications for practitioners. This study calls for a more systematic approach to the innovation implementation process. By acquiring the innovation abilities in your project design team, the process could be more successful.

Project teams are advised to go through the framework if their goal is to implement innovations in their project. Before starting the design process, a project team should go through each ability, and discuss how they will fulfil each of them. Their focus should lie with the *absorptive* and *adoptive* abilities, as their absence had the most effect on innovation implementation success. Implementing the indicators in their team should increase their success chance.

Given that stakeholder management plays a large role in the innovation implementation process, gaining abilities concerning themselves with stakeholder management should be a priority. Through *absorptive* abilities, involve important actors and implement external knowledge through the building of trust and the provision of experience. Give individuals in the project team the responsibility of achieving innovative goals. Finally, look for support and momentum in the client organisation for the use of your innovation. Look for public entrepreneurs willing to be the face of the innovation implementation process.

It seems that the innovation abilities should be gained early in the design process, as their supplementation later in the process comes with a cost of time and loss of ambition realisation.

CONCLUSION

The goal of this research is to further and deepen the understanding of innovation capability in a project team setting, and determining how the innovation capability of a public project team could increase the success of an innovation's implementation. This study hypothesised that innovation abilities, a subset of innovation capability, present in a public project team would contribute to more success in implementing innovations in that project.

This study found that the innovation implementation process in projects is dependent on many factors. Risks to its implementation need to be explored and considered. The project team needs to be able to show the value an innovation might bring in the short or long term. The innovation needs to be connected to concrete ambitions and framed to be a project-specific solution to those ambitions. Furthermore, key stakeholders need to be on board and kept in the loop during the design process. This research has shown that these factors and more can be dealt with more successfully if innovation abilities are present in a project team. Innovation implementation success is dependent on the innovation implementation process proceeding well. Innovative ambitions and their implementation can strand on a multitude of factors in a project, as previous studies have so often proved. This research demonstrates that a project team with more innovative abilities has a foundation of overcoming these difficulties, and of finding support for its implementation.

Through the creation of a framework, the presence of innovation abilities of a project team could be tested, and its positive effect on innovation implementation success was qualitatively confirmed. Public project teams, willing to improve their innovation implementation success in public projects can therefore be advised to pursue innovation capability, through acquiring the abilities presented in this study. *Absorptive* and *adoptive* abilities were found to be especially useful in the project context, as they were both attainable and impactful..

Future research

This explorative research examined four cases in the context of the Dutch public spatial development sector in depth. Broadening its application to other contexts would increase the generalisability of the framework and provide opportunities to validate the causality between the individual abilities and innovation success. Currently, the qualitative causal relations given in the results provide an explanation about the role of each ability, but no concrete impact on success could be determined. A more qualitative study focussing on the importance of the presence of the individual abilities could expand the suggested framework and fill the weight factor proposed in Appendix B. This study has shown that the *adaptive* abilities are not easily attained in a project team setting, however they might still play a role in the success of innovation implementation. It could therefore be explored further. The *adaptive* abilities could act as a predictor variable

that is unlikely to be changed by a project team, but is to be worked around.

Moreover, future studies could explore the difficulty in attaining the different abilities needed for a capability, once they have determined that a project team is lacking abilities. The framework is setup to be able to indicate multiple paths to attain the abilities. However, the transition of a project team missing abilities to one with has yet to be explored. Therefore, this study calls for in-depth research to test the initial presence of innovation abilities in project teams and implement measures to increase the innovation capability during the design process. The indicators are currently taken from literature, which could be expanded upon further. The indicators are currently broadly stated, but they can be redefined for more specific contexts to increase the frameworks usability.

Finally, the results of this study are constrained to abilities needed to attain the implementation of the innovation in the design of a project. The practical application of these innovations in the construction phase will require other abilities to manage and could supplement the findings and framework created in this research.

AKKNOWLEDGEMENTS

First, I would like to express my deepest appreciation to my supervisors for the continuous support that they have given me in conducting this research. I would like to thank Robin de Graaf and Tom Coenen, for without their advice and listening ears, this research would not be here. I would furthermore like to thank Ingrid Bolier. Through numerous meetings, cups of coffee and enthusiastic proposals, she has advised and supported both me and the goal of this research. Her close involvement motivated me to commit fully to the research project and help Witteveen+Bos prepare for the challenges of future projects. All of them have not only supported me through expertise, knowledge and feedback, but actively promoted my growth as a researcher and professional in the construction industry.

Second, I would like to express my gratitude to my parents for their unwavering support and faith in me, which persisted not only during my thesis but also throughout my entire undergraduate and graduate studies. If I were to list every single occasion when my mother expressed her pride in me or my father provided me with guidance and assistance, this document would considerably exceed its current length. Therefore, I will keep it brief and simply say thank you.

Finally, I would like to thank my girlfriend, who would always be ready to support me and keep me level-headed during difficult or stressful periods. She has helped me more times than she can imagine, for which I'm forever grateful.

APPENDICES

List of appendices:

A. Innovation capability framework for public project design teams
B. A possible framework for future studies

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Appendix A Indicators of innovation abilities in project teams of public projects

	Innovation Abilities	Indicators	Sources confirming and expanding on the ability and its indicators
Absorptive	**A1.1** Ability to mobilize and/or coordinate actors in other (parts of the) organization(s)	**a.** Important actors outside the core team to get them involved/engaged in the innovation are determined.	(Leijten, 2017; Nambisan & Sawhney, 2011; van Oorschot et al., 2020)
		b. Someone good at convincing others for the use of an innovation, with a network of key actors is determined.	(Cohen & Levinthal, 1990; Mulgan & Albury, 2003) (Leijten, 2017; van Oorschot et al., 2020)
	A1.2 Ability to integrate implicit and explicit knowledge and other competencies	**a.** Actors are brought in that unlock new knowledge for the team and the team recognizes that using new knowledge is a process.	(Weissenberger-Eibl & Hampel, 2021)
		b. The value of new knowledge and competencies is recognised, through trust in the teacher-firm. (Prior relevant knowledge is needed)	(Lane et al., 2006), (Weissenberger-Eibl & Hampel, 2021)
		c. Knowledge is made context-specific and applicable (through a presentation, a route of the innovation implementation, a simulation, etc.).	(Weissenberger-Eibl & Hampel, 2021)
	A1.3 Ability to emphasize small successes to reach a consensus	**a.** Positive progression in the innovation journey is shown.	(Termeer & Metze, 2019)
		b. Interim targets are set.	(Termeer & Metze, 2019)
		c. Team members' innovative activities are acknowledging/encouraged .	(Termeer & Metze, 2019)
		d. The positive (potential/realized) impact of technical innovation is identified on social aspects (of stakeholders).	(Termeer & Metze, 2019)
	A1.4 Ability to start the dialogue on the concrete realization of ambitions	**a.** Making ambitions/goals concrete (measurable/SMART).	(Cohen & Levinthal, 1990; Nonaka & Toyama, 2005, Lenderink et al., 2020, Tryggestad et al., 2010)
		b. An individual is made responsible for realising ambitions/goals.	(Nam & Tatum, 2010; Simons & Nijhof, 2020; Zeinstra, 2017)
		c. Steps/resources needed to achieve ambitions/goals are identified (including budget).	(Cohen & Levinthal, 1990; Tryggestad et al., 2010)
	A1.5 Ability to frame innovation in a social, administrative, and individual context	**a.** The use of the innovation is framed to be a necessity with the (to be convinced) 'audience'. These can include but are not limited to project directors, municipal boards, other departments, future contractors, etc.	(Lane et al., 2006; Lichtenthaler & Lichtenthaler, 2009; Nonaka & Toyama, 2005)
		b. Examples of a previous successful application is given.	(Lichtenthaler & Lichtenthaler, 2009)
		c. Project-specific adjustments to the innovation are proposed.	(Lane et al., 2006; Lichtenthaler & Lichtenthaler, 2009; Nonaka & Toyama, 2005)
Adoptive	**A2.1** Ability to provide insight into and/or verify the effects and properties (value) of innovation in a specific pilot	**a.** A pilot has been done; Actors from that pilot are involved in the project team to use the lessons learned. They share their learned lessons.	(Arora et al., 2014) (Mulgan & Albury, 2003; van den Bosch & Rotmans, 2008)
		b. The expectation (of the innovation) is made clear through individuals with previous experience. Their insight is "trusted" by the team.	(Arora et al., 2014), (Brem & Viardot, 2015)
	A2.2 Ability to provide insight into and/or verify the effects and properties (value) of innovation in multiple (geographical) contexts	**a.** A list of clear benefits of implementing the innovation is made.	(Ozorhon et al., 2016)
		b. The difference in value between a reference design and the design including the innovation is elaborated on through social, ecological, and economic aspects.	(Chavan, 2013), (Jay & Bowen, 2015)
		c. (Sustainability) Functions of innovation have been given value in design.	(Lin et al., 2016; van Oorschot et al., 2020)(Jay & Bowen, 2015)
	A2.3 Ability to test manageability of (sometimes clashing) forces: scope, functional performance (quality), costs, and time	**a.** Having a high executive capacity at the project team; there is little waiting for permission (from (senior) management).	(Leijten, 2017; van Oorschot et al., 2020)
		b. Clear progress (reports) (costs + risks, solutions) is prepared for decisive actors to review. The individual responsible for reaching the innovative goals (see A1.4b) can best carry out this progress submission.	(Leijten, 2017)
	A2.4 Ability to keep an overview of developments, predict the consequences of decisions and adjust in case of unforeseen circumstances	**a.** The implementation process is divided into small steps.	(Bolier et al., 2023; Mulgan & Albury, 2003; Termeer & Metze, 2019)
		b. The team has permission (from (higher) management) to change steps.	
		c. A premeditated adjustment direction is determined (through risk analysis).	
	A2.5 Ability to create/use support and momentum in the ecosystem	**a.** A public announcement has been made in the media.	(Slaughter, 2000)
		b. Key actors are involved in the (small) successes.	(Termeer & Metze, 2019)
		c. The team has influence in the network where setbacks may arise, and is willing to use their network to gain support.	(Kazanjian et al., 2000; Leijten, 2017; Nauwelaers & Wintjes, 2008; Ozorhon & Oral, 2017)
	A2.6 Ability to implement diverse innovations and learn from the common mistakes	**a.** A 'public entrepreneur' is present; Someone willing to take a risk, think outside the box, and take responsibility for possible failures.	(Gullmark, 2021; Nam & Tatum, 1997; Van Oorschot et al., 2020)
		b. Meetings are held with different disciplines within the public organisation, on the innovation application in their context.	(Gullmark, 2021; Nam & Tatum, 2010)
		c. The organisation has a lack of micro-management and an allowed-to-fail attitude toward the project team.	(Gullmark, 2021)
	A2.7 Ability to implement an iterative learning cycle at the single innovation level	**a.** A design loop is present, in which certain ideas could be adjusted after evaluation.	(Bolier et al., 2023; Leijten, 2017),
		b. Potential stakeholders who may pose a barrier are engaged during the cycle and their concerns are considered before the final cycle.	(Aagaard, 2012; Brem & Viardot, 2015; Slaughter, 2000)
Adaptive	**A3.1** Ability to coordinate the start of the adaptation phase with the readiness of the organisation	**a.** Multiple resources are provided to support the project team (Staff, in-house knowledge, required software, etc., extra budget).	(Aagaard, 2012; Brem & Viardot, 2015; Slaughter, 2000)
			(Biedenbach & Müller, 2012; Chakravarthy, 1982; Robertson et al., 2012)
	A3.2 Ability to adjust organizational routines, culture and/or structures with small concrete steps	**a.** A coalition of employees is created willing to take the next step for implementation (including influential employees at the client organisation).	(Aagaard, 2012)
		b. An impeding practice/legislation is questioned and discussed to be changed or ignored. This vision is pushed by the design team throughout the public organisation.	(Aagaard, 2012; Biesbroek et al., 2014; Robertson et al., 2012)
	A3.3 Ability to create a policy to prevent any unwanted effects	**a.** Negative aspects of the innovation, or unintended consequences from its use, have been addressed by adapting traditional practices.	(Biesbroek et al., 2014; van de Ven, 1999), (Weissenberger-Eibl & Hampel, 2021)
	A3.4 Ability to secure a level playing field in the market	**a.** Personnel (of the client organisation) "feels" that applying innovation is mandatory, or is made to do so.	(Simons & Nijhof, 2020)
		b. The design team is consistently grading/testing for (sustainability) innovation. Designs without innovation are rejected/fined.	(Simons & Nijhof, 2020)
	A3.5 Ability to attribute value at a strategic level in the long run	**a.** The client organisation's long-term vision is considered during the design phase, and long-term benefits are identified.	(Lin et al., 2016; van den Bosch & Rotmans, 2008; van Oorschot et al., 2020)
	A3.6 Ability to challenge the market	**a.** Relevant knowledge concerning the innovation is present in the team through a representative on the client side.	(Nam & Tatum, 2010)
		b. Innovation is discussed as the new standard in the client organisation (through efforts of the project team).	(Edler et al., 2015; Lenderink et al., 2020ll)

Appendix B A possible framework for future studies