Towards strengthening the coordination by clients in multidisciplinary projects with multiple contractors

A case study research into the front-end contractual instruments of a client and managerial measures during the execution of a project

Written by
Josje Gerlag

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Graduation thesis

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Preface

With delight, I present my Master's Thesis research as the final milestone of my Master Construction Management & Engineering at the Technical University of Delft. From March 2023 until now, I did research at the Engineering firm of the municipality of Rotterdam about the coordination process of public clients within multidisciplinary projects with co-contractors, with this report as the final result.

My interest in the human contribution to the construction sector and construction projects grew throughout my studies. Choosing the track Projects & People reinforced this. Technology, construction, and the legal system have a certain level of predictability. Humans, on the other hand, have less obvious traits and are somewhat less predictable. This human behavior and human interaction within the construction industry might have been the subjects that triggered me the most during my studies. I intend to incorporate this subject into my future career.

I would like to thank all the members of my graduation committee for sharing their knowledge and their support during this period. First my 1st supervisor, ir. Magchiel van Os, thank you for your enthusiasm and for sharing your fair share of experiences about coordination and interface problems within the field of civil engineering during our sparring session. Next to this, thank you for giving me the room to share my experiences and to vent. Also, thank you to my 2nd supervisor, Dr. ir. Erik-Jan Houwing, for sharing your knowledge and experience within the scientific field. This helped me with creating methodologically sound research especially. Next to this, I want to thank my chair, Prof. mr. dr. Evelien Bruggeman, for sharing her knowledge within the legal field of the construction world and giving me practical tools to build on during the meetings. Last, a special thank you to my company supervisor, ir. Ard den Outer, for providing me with the components within the municipality of Rotterdam I needed to build my research on. Next to this, I want to thank you for your guidance and help to improve myself, on both a professional and personal level.

Finally, I want to thank the people close to me. Thank you for your unlimited support, positivity, and advice throughout this thesis adventure and my whole study period.

Enjoy,
Josje Gerlag

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Abstract

The current market forces of infrastructural projects in the Dutch construction sector necessitate public clients to divide a large-scale multidisciplinary project into multiple contracts. This causes diverse contractors to have to work simultaneously. Interfaces arise between the contracts, which require a deeper collaboration to align all activities. Coordination becomes a very important factor in such projects. Current attempts to create better coordination focus mainly on clients' contractual and organizational measures. This research aims to map the importance of the human aspect within coordination and help a client organize itself to create a better coordination process. This is done by looking at the contractual and organizational instruments that stimulate coordination. Hereby, the organizational measures are divided into relational, personal, and governance aspects.

Through a literature review, the steering mechanisms for good coordination within the contractual, relational, personal, and governance contexts were established. A case study provided the issues of coordination in practice and laid down the basis of possible instruments to help a public client with the coordination process. The main takeaways were the misinterpretation and misalignment of the specifications of agreements, choosing the wrong coordinator, the lack of attention to relations, and the unclear governance from the client's side. After this, a preliminary framework of the coordination process was reviewed through expert sessions. Together, this created the basis for the final framework of this thesis.

The key findings of this research were the need to facilitate coordination and collaboration during the pre-execution through requirements in the contracts and a start-up period with the involved clients and the co-contractors. During the execution phase key findings were the need to facilitate coordination and collaboration by the attention to the human aspect and its process, besides aiming for the best project result. This research contributed to the current literature by showing how the current coordination processes of a public client within the Dutch construction sector lack attention to the human side during projects.

Executive Summary

Up until now, the parameters for construction projects have focused on time, quality, and costs. However, a shift towards focusing on the process instead of the results is observed within the construction world, especially in multidisciplinary projects with numerous parties involved, making the process more complex. The way collaboration between those parties is arranged has a significant influence on the project result. It requires good coordination during the execution. Coordination is seen as the management of interdependencies between activities, actors, and environment to reach a certain goal.

Public clients appear to face difficulty in finding the right setup to work with multiple parties within multidisciplinary infrastructure projects in the Dutch construction sector (Gemeente Rotterdam, 2018; Commissie Veerman, 2009). This difficulty arises from the misalignment of both contractual and managerial contexts during execution. The contractual context is organized during the pre-execution phase, while the managerial context pertains to how a project manager performs during execution and coordinates all contractors involved.

Current research has identified the bottlenecks of coordination with multiple contractors within the contractual and organizational spheres of a project. However, whether and how the softer side and soft skills of a person influence the coordination process have not yet been researched from a client's perspective. A combination of different instruments within the contractual and organizational context, including the soft skills of a manager, has yet to be found. This thesis aims to address this gap. The main research question is:

How should the coordination of a multidisciplinary project with co-contractors be organized through front-end contractual arrangements and the managerial context during execution, by a public client?

To answer the main research question, sub-research questions were set up:
SQ1: How is 'good coordination' established? What are the current barriers?
SQ2: What are the theoretical steering mechanisms of coordination with co-contractors?
SQ3: Where do problems occur, hampering the effect on coordination, and what are the origins of these problems?
SQ4: What are the instruments of a public client to tackle coordination problems, within a client's boundaries?

This thesis consists of four phases: a literature study, a case study, expert sessions, and the creation of the final framework, as shown in Figure 1.

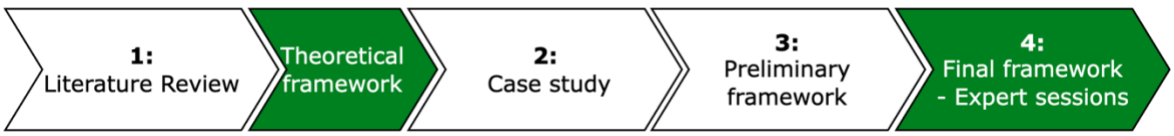

Figure 1. The phases of the thesis

The goal of the literature review was to create a theoretical framework about approaching good coordination, based on the current scientific literature. The case study aimed to identify where coordination problems occur in practice and to understand their origins and effects. Four different

cases within the municipality of Rotterdam were selected: Hoekse lijn Phase 1, Metro aan Zee, Maastunnel renovation, and Rotterdam Centraal Station reconstruction. Interviews and document studies were conducted for each case. After the case study, a preliminary framework was established, incorporating the results of the case study and transforming them into practical measures to address coordination within complex multidisciplinary infrastructure projects. Subsequently, four individual expert sessions were conducted to validate the outcomes of the case study and assess the feasibility of certain measures within the current methods of the Municipality of Rotterdam. With input from the previous phases, the final framework was developed.

The literature study addresses SQ1 and SQ2. Good coordination is established by having accountability, predictability, and common understanding. Accountability is reached by having a suitable coordinator with a mandate, project managers with the right skills, and arrangements on liabilities and duty to warn. Predictability is reached by agreements on planning and technique. Having common understanding is reached through not hindering each other, consultation and communication structures, and expressing information needs of all parties, including feedback. The literature review also provided the steering mechanisms for coordination, as shown in Table 1, within the contractual, relational, personal, and governance contexts.

Table 1. Steering mechanisms for coordination

Contractual	Relational	Personal	Governance
a. The scope of the coordination assignment and the associated powers and tools	f. Early formation of integrative work practices	j. Experience	n. Clear responsibilities
b. The way decisions are made about coordination	g. The development of a common philosophy	k. Competent on a technical level (hard skills)	o. Proactive attitude within organization
c. The distribution of risks associated with coordination	h. Open communication	l. Competent on a social level (soft skills)	p. Preparation time
d. The way in which the parties deal with conflicts	i. Early and clear role expectations	m. People-oriented characteristics	
e. The way in which the parties settle disputes			

Through interviews and document analysis in the case study, four phenomena were identified as the main causes of a sub-optimal coordination process:

1. Misinterpretation and misalignment issues of the agreement specifications

   When a client procures a project, specifications are stipulated based on the client's wishes. However, contractors may interpret these specifications differently. Next to this, it became clear

that different contracts of the co-contractors lead to misalignment of the specifications, related to consultation, communication, planning, etc. These factors impact the level of collaboration and the complexity of coordination.

2. The wrong choice of coordinator

Optimal coordination depends on choosing the wrong coordinator (client vs. contractor). The factors that need to be considered are: the environment of the project, the mandate of the coordinator, and the interests of the coordinator in the overall project.

3. Lack of attention to relations

When a project is divided into multiple contracts, numerous parties have to collaborate on the interfaces between these contracts. This necessitates increased attention to the human aspects of those collaborations. The findings indicate a lack of attention to relations with other parties. The predominant focus is on the technical content of a project.

4. Insufficient governance

Many coordination problems arise due to inadequate alignment of the governance, particularly in projects involving multiple clients. The dispersed division of responsibilities among clients creates an unclear and non-cohesive atmosphere during project execution. Additionally, intra-organizational governance is perceived as bureaucratic and underperforming. Within the organization, a lot of different interests and opinions contribute to an incoherent client.

The final framework outlines how to address potential coordination issues in multidisciplinary projects with co-contractors. It shows which aspects of the different contexts have to be considered and highlights the instruments available to a public client. The four arrows at the top of Figure 2 display the actions a client has to take to organize a better coordination process.

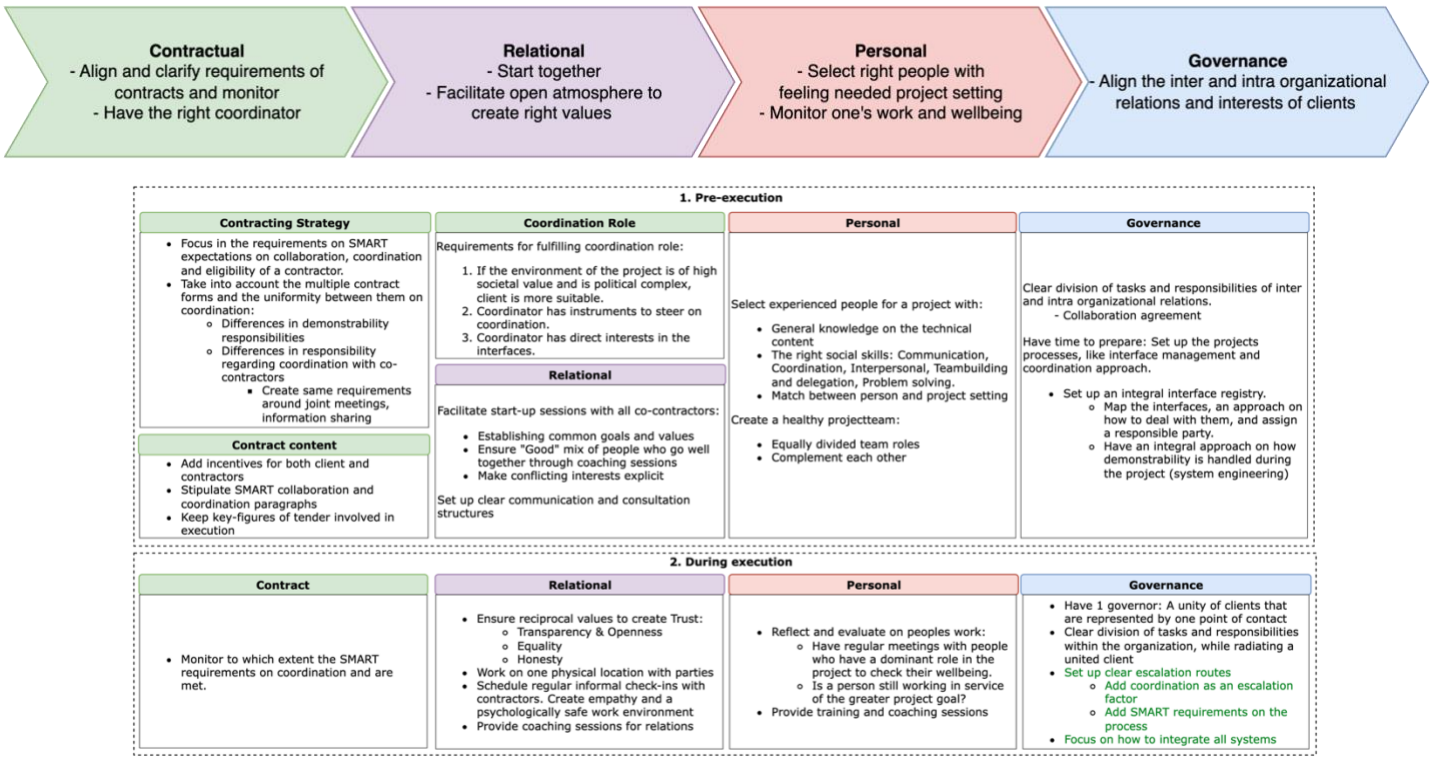

Figure 2. Framework of the research (Enlarged version can be found in CH 11)

Content

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List of abbreviations

PM	Project manager
PDM	Project Delivery Model
DBB	Design-Bid-Build
DB	Design-Build
UAV-1989	Uniforme Administratieve Voorwaarden 1989
UAV-2012	Uniforme Administratieve Voorwaarden 2012
UAV-GC	Uniforme Administratieve Voorwaarden voor Geïntegreerde Contracten
IM	Interface Management
CS	Centraal Station
MaZ	Metro aan Zee
PbHL	Projectbureau Hoekse Lijn
CAM	Combinatie aanpak Maastunnel
HREC	Human Resource Ethics Checklist
DMP	Data Management Plan
SQ	Sub-question
RQ	Research-question
OBRgw	Ontwikkelingsbedrijf Rotterdam Gemeente Werken

CONTEXT of the research

1. Introduction

This first Chapter provides the context of this thesis in paragraph 1.1. Some background information is given here on the topic of this thesis. After this, the reading guide is presented in paragraph 1.2.

1.1 Context

In the last decades, construction projects have grown rapidly in both size and complexity (Luo, He, Jaselskis & Xie, 2017). Bigger projects usually have a lower performance outcome, like schedule delays and cost overruns. This is due to the increasing complexity of the projects and not understanding that complexity (Williams, 1999). Baccarini (1996) explained project complexity as 'consisting of many varied interrelated parts, which can be characterized in terms of differentiation and interdependency.' Differentiation implies the number of different components in a project like tasks, specialists, subsystems, and parts. Interdependency is the level of interlinkages between these components. A complex construction project has a lot of different components and requires a lot of different tasks and specialists to be completed. All these components complement each other and make the total construction work. To ensure this complementation, aligning all facets of a project is needed.

The traditional assessment of whether a project is a success depends on the time in which it is delivered, the budget compared to the final costs, and whether the project meets the client's expectations (Baker, Murphy & Fisher 1983; Turner, 1993). In the current construction world, the alignment and collaboration of stakeholders become a bigger part of the project performance and significantly affect time, cost, and quality (Atkinson, Waterhouse & Wells, 1997; Larsson & Lasson, 2020). This is necessary to deal with the growing complexity of projects today.

The more complex and sizable projects require a different project approach. More specialists are needed for more complex and diverse activities. Something a client might not have in-house. In the last decades, the variety of ways of procuring expanded within the Netherlands and the rest of Europe. Next to the traditional contracts, more integrated contracts arose. With the traditional way of procuring, the design and construction phases are separate. After the design is made, a project is procured to one main contractor who is responsible for the construction. With integrated contracts, a contractor is already involved in an earlier project phase and has more responsibilities.

After a client decides which project approach is best suitable for a certain project, he publishes the assignment for a project, traditional or integrated. Contractors can then place a bid on it. A client chooses the best suitable bid according to certain award criteria. This could be the lowest bid or the best value for money. A client also checks whether the potential contractors are eligible. This is to see if the contractor is skilled enough to complete the project.

Currently, the larger multidisciplinary projects are divided into smaller 'sub-projects' and contracted separately. With sub-projects, multiple smaller contracts are drawn up for the different parts of the project and multiple contractors work separately on their part. The choice of dividing a project into different sub-projects or contracting it as a whole has different considerations. According to Couwenberg (2011), dividing a project into multiple sub-projects happens most when:

- A project has a long lead time and parts of the project are put into use intermediately.
- A project has specific components, which need a specific kind of contractor.

- A project is too big to procure to one contractor.
- The requirements of some parts of the project are not available yet.

The increasing complexity of projects is also noticed within the infrastructure sector in the Netherlands (Arts, 2007). Therefore, most large-scale infrastructure projects are divided into sub-projects. It is also related to the supply side of the construction market, the contractors. Whether contractors bid on projects, depends on the market forces (scarcity of contractors), the scope of the project, and the risks a contractor could carry in relation to the potential of a profit (Kim & Reinschmidt, 2011). The current status of the Dutch construction market is a bit uncertain, due to different external factors, like the energy prices, the hassle with permits, and the construction limitations due to the nitrogen policy set by the Dutch government (TwynstraGudde, 2022). Together, this makes contractors less interested in bidding on a large tender.

Another reason projects are divided into different parts is because of a publication by the European Commission. The European Commission explained that EU members should use co-contractors and sub-projects more often to give more possibilities to middle and small enterprises within tenders (Directive COM, 2011) (PIANOo, 2012).

Procuring a project through multiple contracts has pros and cons of a client. Gulijk & Muller (2011) described the most important ones. They are shown in Table 2.

Table 2. Pros and cons of procuring in one and multiple contracts (Couwenberg, 2011; Gulijk & Muller, 2011)

Procuring in one contract	
Pros	Cons
- Interfaces are covered in one contract. - Fewer risks connected to aligning contractors. - The client requires fewer employees to coordinate project.	- Less influence from the client. - Specialized activities require subcontractors. - Overall costs are higher.
Procuring in multiple contracts	
Pros	Cons
- The expertise of each contractor can be utilized fully. - The client has short connections with all contractors which leads to a better overview of the progress. - The client has a bigger influence on the work. - If executed correctly, the costs of the overall project are lower.	- The possible high failure costs. - The uncertainty surrounding the interfaces.

Interfaces refer to the boundaries of the different sub-projects that are intertwined or have some overlap. The uncertainty around this could also be compared to how Baccarini (1996) explained complexity with interrelated parts and interdependency. Contractors of different contracts depend on each other on those interfaces and will have to cooperate.

According to Couwenberg (2011), the interfaces are also one of the main project risks when choosing subprojects. The responsibilities need to be very clear and coordination is necessary to have good alignment of the different interfaces. When a project is divided into sub-projects, the number and types of interfaces increase (Chen, Reichard & Beliveau, 2006). This leads to the growing importance of interface management.

Primarily, the client decides how he procures a project. If he divides a project into sub-projects, he needs to think about the risks. As shown before, interfaces are one of the main barriers when dividing a project. To take this barrier away, coordination between the interfaces and interface management has to be set up.

Interface management is very important with projects that are divided. Managing the interfaces that occur requires a good management skillset (Chen, Reichard & Beliveau, 2007). To manage the interfaces of sub-projects and the interactions between the involved contractors, good coordination is needed. Coordination is often described as the management of interdependencies between activities or organizations to reach a certain goal (Okhuysen & Bechky, 2009). To achieve the project goals while working with multiple contractors, good coordination is a necessary condition. If coordination fails and contractors do not know in which sequence activities have to be carried out and which contractors are involved in the activities, interface problems will become an issue. That is why the facilitating aspect of clients is important in coordination (Strang, 2018). Strang (2018) showed that this facilitating aspect can be provided in two ways, through pre-arranged agreements and the management during execution.

By principle, the client is responsible for the coordination of the activities of all the individual contractors during execution (Van den Berg, 2013). However, the coordinator role could also be assigned to a contractor or a third party like a consultant (Gulijk & Muller, 2011). The decision on who coordinates can be stipulated in the contracts. To make sure every client and contractor knows what their role is within the total project, and to be as transparent and cooperative as possible, an arrangement could be set up between all parties. A so-called Coordination agreement. The idea behind this agreement is that all parties contribute to the improvement of the coordination process and agree to collaborate where necessary. Such an agreement specifies who is responsible for what, what the liabilities are, and which parties should be approached and when. Also, the parties agree to attend coordination meetings and cooperate with the activities that flow from them. This shows the facilitative role of bringing the parties together and aligning their activities on interfaces through agreements.

However, this does not mean all risks of dividing a project into sub-projects will be prevented. During execution, unexpected issues could arise. The party who is responsible for the coordination has to coordinate the issues that arise during the execution phase, in a perfect project world. This party has to act in favor of the total project outcome and has to meet the contractual obligations that were set up with all parties at the start. If the coordinating party is a contractor or third party they might get an extra fee as compensation for the coordination task, since this brings extra risks in terms of the responsibility for overall project failure and extra workload (Gulijk & Muller, 2011). When the scope of a sub-project changes, a contractor needs to change his approach, which could lead to more costs and in the end a claim towards the client or coordination party for not meeting the agreements stated in the contract. So, the one responsible for coordination plays an important part in keeping all parties content and facilitating them in being able to do their work. The coordinator needs to have a certain number of skills due to their central role in collaboration and being the connector between all sub-projects and contractors. This requires a facilitative management role during execution. Also, the coordinator has to act on uncertainties and improvise on the spot. This all together shows how coordination is a key factor in multidisciplinary projects that are divided, which is why this is the topic of this thesis.

1.2 Reading guide

The content of this thesis revolves around the coordination of multidisciplinary projects that are divided and how this is facilitated through the prearranged agreements and management during execution. Figure 3 shows the outline of this thesis. It gives an overview of all the takeaways for each chapter. This first Chapter (1) gave an introduction to the research subject. Chapter 2 elaborates on the problem and shows this thesis's research problem and research questions. To research the problem further, Chapter 3 presents the chosen methodology to gather, analyze, and use data to answer the research questions. In Chapter 4, a literature review is presented. This is the basis for the theoretical framework of this thesis. Chapter 5 shows the case study setup, including the selection criteria for the project and a description of each selected case. In Chapter 6 the analysis and results of each case are presented. After this, the cross-case analysis is presented in Chapter 7. Chapter 8 compares the outcomes of the results with the theoretical framework set up in Chapter 4. It also describes the way the preliminary framework is built up and presents the content of the framework. By synthesizing all chapters, Chapter 9 presents the validation of the preliminary framework through the expert sessions and the final framework of this thesis, which is the final product. In Chapter 10, the outcomes of this research will be evaluated and discussed critically. The limitations of the research will also be presented. Chapter 11 elaborates on the conclusions of this thesis and provides recommendations for further research.

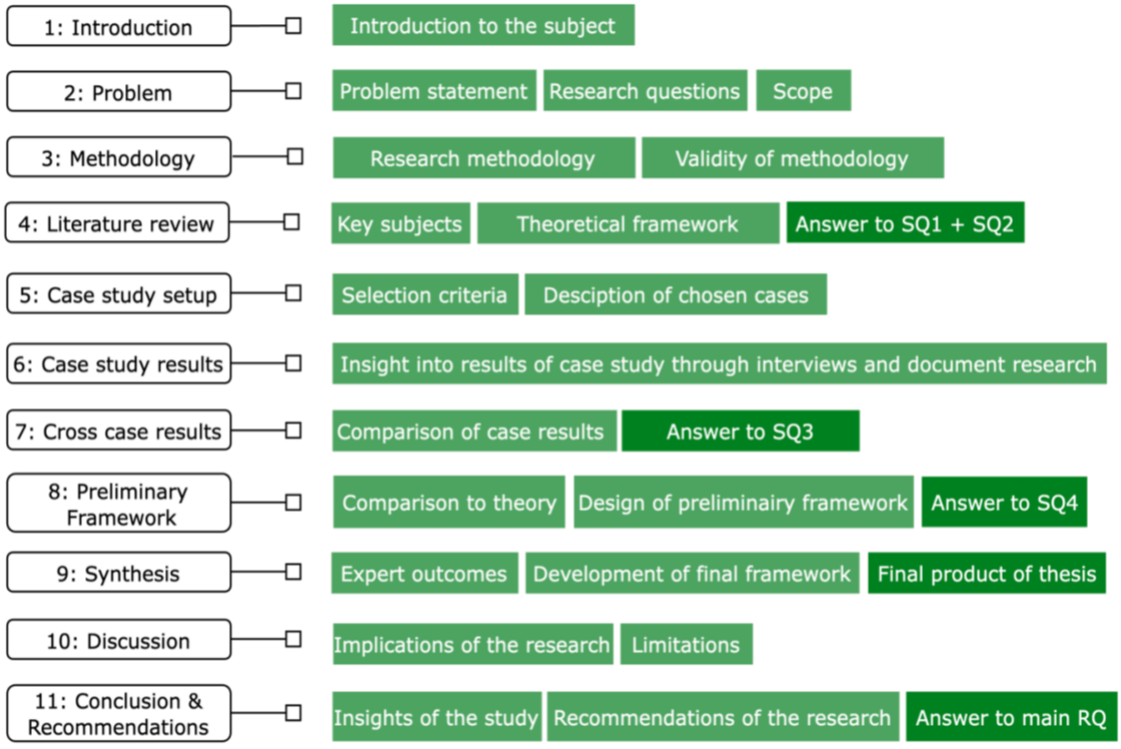

Figure 3. Thesis outline

2. Problem

This Chapter revolves around the main problem of this research. First, an insight is given into the cause in paragraph 2.1. After this, the problem statement of this thesis is formulated in paragraph 2.2 and the research gaps are identified in paragraph 2.3. With this, the research question of this thesis is set up in paragraph 2.4, including the sub-questions. In paragraph 2.5 the scope of this research is presented. Lastly, the conceptual model of this thesis is presented in paragraph 2.6.

2.1 The cause

Although coordination is very important in multidisciplinary projects that are divided into multiple contracts, reality shows that coordination with multiple contractors is not always organized properly. A lot of multidisciplinary projects in the construction sector that are divided into subprojects do not have the proper coordination. The Dutch news channel NOS Nieuws (2018) presented how the conversion of the subway of the Hoekse Lijn was a failure. Different contracts were set out because of the specialistic disciplines that were needed. These different contracts needed to be coordinated and aligned. In the end, the project budget was exceeded by 90 million euros. The municipality of Rotterdam had to make up for 30 million euros. An investigation followed by the municipality of Rotterdam. They concluded that insufficient coordination between all contractors, and the lack of organization on the client's side were the main reasons why the project had delays and exceeded the budget. The coordination role was appointed to a contractor. During execution, it became clear that he did not have the right instruments on a legal basis, nor the intrinsic motivation, to coordinate sufficiently. This highlighted the need for improvements in the setup and execution of coordination in the current projects managed by public clients (Gemeente Rotterdam, 2018).

With the Noord-Zuidlijn project, the construction of a subway between the North and the South of Amsterdam, the coordination of the interfaces appeared to be a big contribution to the delays also (Commissie Veerman, 2009; Enquete Commissie Noord-zuidlijn, 2009). The project involved multiple contracts, partly due to the specialized activities it required. The report on the project of Commissie Veerman (2009) showed that coordination and interface management were the main bottlenecks during execution. Responsibilities on the client's side connected to interface management and an overall planning appeared to be missing at the start of the execution phase.

The coordination of complex multidisciplinary projects with multiple contractors appears to be suboptimal at the moment, lacking sufficient facilitation and the right coordinator or organizational setup. Both the Hoekse lijn and the Noord-Zuidlijn show this. Yet, not dividing projects into sub-projects is not feasible in the Dutch infrastructure sector. Winters (2014) demonstrated that the capacity of a construction project and external knowledge and experience are key considerations of dividing a project. Next to this, the procurement phase is relatively short. This does not provide the needed time to build a proper relationship between contractors to get the needed quality of coordination. The current construction market is not equipped to procure a big multidisciplinary project integrally, without the rise of too many risks. If prevention is not feasible, the focus shifts to minimization. But how is a client able to facilitate coordination on a project in such a way that the project's success is not in danger?

2.2 Problem statement

Facilitating good coordination and controlling the interfaces within a project with multiple contracts requires a good setup of multiple aspects within the project cycle. This is especially important in multidisciplinary projects with multiple contractors, which require more coordination due to a higher ratio of relationships and interfaces compared to smaller projects or those with a single contractor. This is why this thesis focuses on multidisciplinary projects with multiple contractors.

Different schools of thought on tackling interfaces appear within the scientific field. Each one targets a different phase within the project:

- Tackling the problems within the way the project is divided (Pavitt & Gibb, 2003; Shokri et al. 2012): This direction focuses on the way a project is divided into multiple sub-projects. By finding the right approach to knowing where to divide and to accommodate which part of the project in which contract, they advocate that problems about coordination on interfaces can be minimized.
- The alignment of control measures (Nooteboom, 2004; Fellows & Liu, 2012): This direction focuses on aligning the controlling measures within the contractual spheres and organizational spheres.
- A combination of both (Chen, Reichard & Beliveau, 2008; Huang et al., 2008): This direction focuses on the combination of making the right division, and having the right controlling measures.

Winters (2014) combined the multiple directions into his Master's Thesis in an attempt to find the origin of the cause of the interface problems. He found that one of the main causes of interface problems is the lack of clarity about coordination and the associated responsibilities.

Nooteboom (2004) stressed the importance of coordination on the interfaces and explained how the impact of managing the occurring interfaces is underestimated in the construction sector. The management of interdependent parts of the sub-projects gets too little attention and lacks tuning during the execution phase. Time delays, higher costs, and/or a downgrade in the quality of the overall project are the possible consequences of this (Chen et al., 2007). For clients, this might result in an unsuccessful project in the end or going over budget and time, as happened with the Hoekse Lijn and the Noord-Zuidlijn.

An interesting observation regarding the coordination and interface problems described above is the absence of an interactional/relational context. Contractual and organizational controlling measures are discussed, but the managerial aspects are not taken into account. Managing ways and establishing the right collaboration and coordination setup for a project become more and more important as a critical element of project success (Forbes & Ahmed, 2010; Moradi & Kähkönen, 2022).

Huang et al. (2008) researched interface problems within the construction sector. They concluded that most interface problems are due to know-how factors, besides the already known contractual factors. The know-how factors refer to the managerial part of interfaces, like the way of managing, the experience of a project manager, and how coordination is set up. This way of managing can be seen as the softer side of managing in personal and relational spheres. The softer side is about how the project manager communicates, collaborates, leads, and solves problems effectively. The project's relational setting becomes of interest. The explicit boundaries of a project like the planning, the contracts, and the requirements on technical content are already widely known control measures,

the softer measures on collaboration are less known. However, the right combination of hard and soft skills in managing a complex project is crucial for project success (Azim et al., 2010).

The necessity of both hard and soft skills as part of a project manager's competencies has come to light (Huang et al., 2008; Kirsch, 2000). The needed skills of a project manager have evolved from only hard skills like time management, budgeting, and risk management to the softer side of management, which includes leadership, communication, conflict resolution, and building trust. Figure 4 below outlines the research area of this thesis in green.

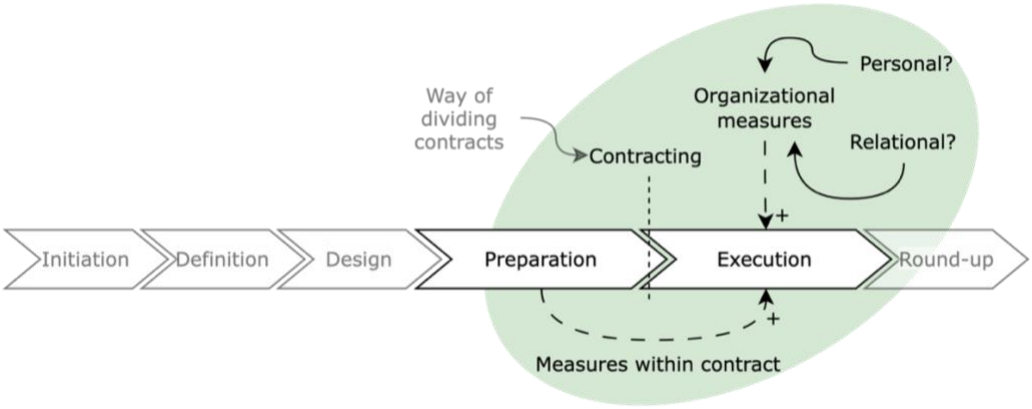

Figure 4. Scope: Different control measures

Next to the needed soft skills to smoothen the coordination process with multiple contractors, contracts often set the boundaries of what is possible within a project. Some requirements of coordination within a project are already put into contracts. The responsibilities and liabilities are somewhat described and most projects have General Terms & Conditions in which an overview of the legal requirements is given. This part shows the rigid boundaries in which coordination can be defined.

Depending on the way the contracts are used, they can either provide a certain rigidity or not. A contract according to the letter of the law means that a contract is followed literally. A contract in the spirit of law is more about the meaning behind it and has looser boundaries. Within projects, choosing according to the spirit or letter of law defines how the collaboration is set up and how parties deal with conflicts. In an open relationship based on trust, the spirit of law is used. In a strict and closed relation, the letter of law is more the standard. How the client and contractors interact and their intentions often define to which extent the contracts are used as a guideline or to the letter. Beuve, Moszoro & Saussier (2017) discussed the rigidity of public contracts. Once a contract is drawn up, ad hoc changes are hard. Amendments could be made, but a more dynamic way of complying with the projects' contractual requirements is hard. This ensures that, especially with public contracts, contracts shape the amount of allowed flexibility within a project. The set of requirements addressed in contracts defines a 'hard boundary' of the project and the coordination process within this.

Clients often initiate a project and have the power to shape it by choosing a certain procurement strategy (Eriksson et al., 2019). Choosing the right project scope and contractual setup during procurement is a key element in how the coordination process will evolve during execution. Choosing to divide the project into sub-projects, extra coordination is necessary to make all the sub-projects connect well and to avoid uncertainty for all parties involved. Also, arranging coordination and its process through contracts takes some of that uncertainty away. As shown above, the relational and managerial aspects of coordinating and controlling interfaces, and the way this is established within contracts, have not been sufficiently addressed. The right mix of contractual agreements and

management during execution to strengthen the coordination of interfaces has not yet been established for the client. Specifically in the case where a project is divided into sub-projects and multiple contractors have to collaborate to make the overall project successful. This requires extra coordination. Problems occur when the set-up of the coordination and the interfaces is unclear, and misaligned. The organization of coordination that is resistant to the uncertain project spheres and their interfaces has yet to be found. This leads to the following problem statement:

Inadequate coordination during the execution phase of multidisciplinary construction projects with co-contractors is perceived to cause uncertain and unaligned interfaces, resulting in high project failure costs. The right mix of front-end contractual arrangements and managerial instruments during execution to affect the relational context as control measures for coordinating interfaces has yet to be found.

2.3 The research gap

Interfaces themselves and coordinating them are subjects of a lot of studies. Also, how coordination is generally incorporated into contractual arrangements can be found in studies. The focus, however, has always been on the contractual and organizational control measures when executing a project with multiple contractors. The relational context has been left out here. With many contractors involved during execution, a lot of extra relations arise and extra cooperation and collaboration are needed. This supports the focus shifting more toward the relational setting.

How a public client is able to coordinate a project during execution through both the softer managerial measures and stricter legal measures, and which instruments they have in order to do this, is yet to be found. This shows the research gap. For public clients, the more practical application of both legal and managerial aspects of coordination is unclear. The possible instruments a client has to facilitate this, have to be uncovered.

The theoretical contribution of this research is the focus on the relational setting and the client's perspective and contribution to this subject. What is the effect of the relational spheres on coordination and collaboration with multiple contractors? What are the client's instruments in coordinating a project with multiple contractors? How can they influence the harder legal context and the softer relational/managerial context? The term 'harder measures' refers to the front-end contractual arrangements, while 'softer measures' relate to the managerial interactions during the execution of a project. The research takes into account both the managerial theories and the legal theories on coordination, takes into account the relational context, and compares these theories with practice. The effect of mediation of a person on the coordination process will be elaborated on. This has not yet been done for a public client and their coordination processes.

The practical contribution of this research is a framework that synthesizes both theoretical considerations and the outcomes of the case study and expert sessions. This helps the municipality of Rotterdam in arranging their coordination process within projects with multiple contractors. Highlighting discrepancies in current projects will provide the municipality of Rotterdam with valuable information on areas for improvement. The contractual and relational measures the municipality could take for their current discrepancies will give practical instruments for future projects. Not just a general improvement list will be provided, but the application part is valuable here.

2.4 The research questions

With the problem statement explained above, the main research question of this thesis is formed:

How should the coordination of a multidisciplinary project with co-contractors be organized through the front-end contractual arrangements and the managerial context during execution, by a public client?

To answer the main research question, four sub-questions are set up. These questions all cover a part of the research. The first SQ is about the concept of good coordination. What is good coordination and what are the current barriers that affect coordination? It is also interesting to see what the relation is between 'good coordination' and interface management.

SQ1: How is 'good coordination' established? What are the current barriers?

The second question is about the steering mechanisms of coordination. What are the theoretical drivers for coordination in the contractual, relational, personal, and governance contexts? With this sub-question, a theoretical framework can be set up about a theoretically sound coordination approach. This framework will be used to compare the theory with practice.

SQ2: What are the theoretical steering mechanisms of coordination with co-contractors?

The third SQ intends to show what the discrepancies are in practice. By looking at the physical approach of projects within the municipality of Rotterdam, the core of the coordination problems within projects should be uncovered. When this is known, one knows what to look out for in future projects and what the pitfalls are. Measures to minimize and avoid this in future projects can only be developed when the origins of the problems are known.

SQ3: Where do problems occur, hampering the effect on coordination, and what are the origins of these problems?

The last SQ is about how a client is able to affect the coordination process. The practical measures should become clear. Certain rules and protocols bind a client, so these measures should fit within these bounds. By looking at what could be improved in the coordination and what the bounds are of a client, a solution space could be tuned for the client. The applicable tools will come to light and will be mapped for the municipality of Rotterdam.

SQ4: What are the instruments of a public client to tackle coordination problems, within a client's boundaries?

2.5 Scope of the research

The scope of this research explains what the boundaries are of this research. It shows what has been taken into account, and what has been left out. Table 3 presents this.

Table 3. Scope of the research

In scope	Reason
Measures to minimize the negative effects of the division into sub-projects	This thesis focuses on the measures that can be taken by a public client, in order to minimize the possible negative effects of dividing a project into sub-projects. This thesis does NOT look at the right ways and strategies of the decisions of dividing a project.
Public client	Public clients are the instructors of most of the bigger projects.
Traditional and D&C contracts	The municipality of Rotterdam uses traditional (UAV) and D&C (UAV-GC) contracts for most of its bigger projects.
The Dutch rules & regulations	Because the project of the case study was executed within the Netherlands and the public client is based in the Netherlands, the Dutch rules & regulations are used.
Relation between Client-Contractor	The relationship between the client and multiple contractors is influenced by the instruments of the client. They have a direct contractual relationship with each other. The interactions between client and contractors are the center of this thesis
Complex multidisciplinary infrastructure projects	Complex multidisciplinary projects are divided into sub-projects and multiple projects most of the time. Also, a lot of parties are involved with this, in comparison to smaller projects. With more parties, a more complex relational context emerges and coordination becomes even more important. Next to this, the infrastructure sector has become increasingly complex and is mostly in the hands of public clients.
Effects within the execution phase	All the measures should have their effects within the execution phase.
Inter-project interfaces	Inter-project interfaces are the interfaces that occur within a project. Extra-project interfaces are interfaces connected to the external environment of the project.

2.6 Conceptual model

This paragraph presents the conceptual model for this thesis in Figure 5. The conceptual model shows the relation of both the contractual and organizational measures to the coordination. If the legal, personal, relational, and governance contexts are set up well and aligned, the overall coordination becomes better. This results in a better overall project result. What needs to be taken into account here is that this model is set up for a multidisciplinary project that is executed with multiple co-contractors. The interfaces between the different contracts of the co-contractors are indicated with the double-sided arrow between the contractors.

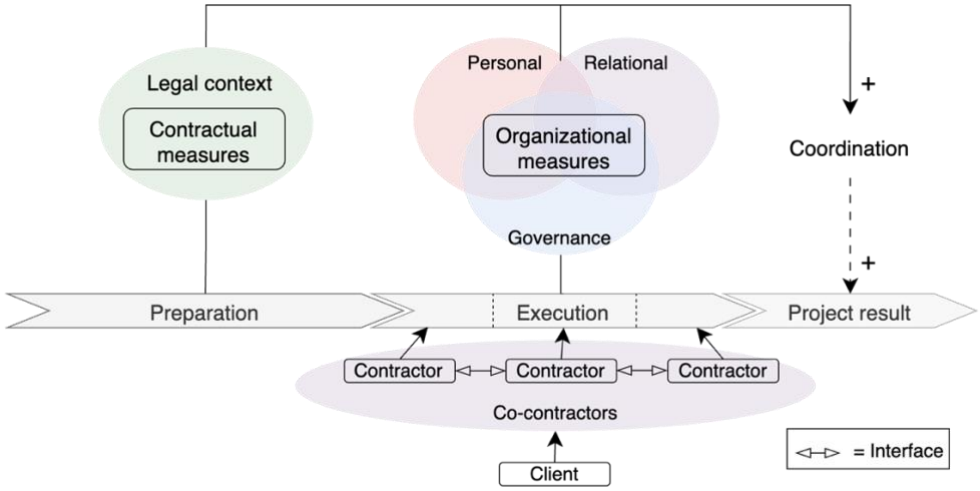

Figure 5. Conceptual model

3. Methodology

This Chapter explains the methods used for this study. The study is divided into four phases. Every phase has a different method to gather and analyze data. Each phase is elaborated on in a different paragraph. The four phases are:

1. Literature review
2. Case study
3. Preliminary framework
4. Final Framework

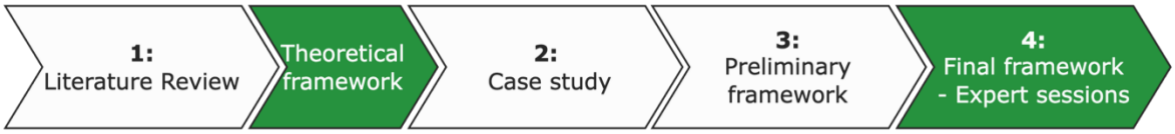

Figure 6. Phases of thesis

3.1 Literature review

The literature review provides a foundation for the different concepts used, and the following phases of the thesis. With the literature review, existing knowledge is compared and synthesized, in order to create a theoretical framework and obtain knowledge (Carnwell & Daly, 2001; Snyder, 2019). The concepts are explained, relevant theories and models are discussed and connected, and their suitability for this thesis is explored. Using existing knowledge is seen as a critical building block for research (Snyder, 2019).

There are different typologies to review the existing literature. For this study, the main goal of the literature review is to summarize the prior knowledge of the concepts and to check their applicability to this research. The type of theoretical review that fits this is the more traditional 'narrative review' (Paré, Trudel, Jaana & Kitsiou, 2015). A pitfall of the narrative review is the possible subjectivity, due to the review process being mostly not explained or laid down (Green, Johnson & Adams, 2006). To avoid this, the review process is explained in Appendix A, which shows a scheme of the scientific literature review process.

The literature review results in a theoretical framework. This framework provides a scientific view of how coordination should be established and how the contractual, relational, personal, and governance contexts influence this.

3.1.1 Data gathering of the literature review

The type of data for this phase consists mainly of scientific literature. The scientific literature is gathered through the platforms 'Google Scholar', and 'Scopus'. The articles on these platforms are mostly included in peer-reviewed journals. With peer-reviewed articles, an evaluation is done by experts and a control on quality is established (Rowland, 2002). This gives an article extra scientific value. The problem statement and the conceptual model of Chapter 2 are the basis for the topics that were researched in the literature review. With these topics, multiple aspects of the research are highlighted.

The main topics to be researched were:

- Co-contractors
- Coordination
- Project Delivery Methods
- Interface management
- Soft skills
- Contractual context

As can be seen in Appendix A, almost no literature is about co-contractors in the Scopus database. This is why the choice is made to research this concept with Google Scholar. Also, the contractual context around coordination, apart from the Project Delivery Methods, is hard to find within Scopus. This is researched with Google Scholar as well. For the contractual context, extra literature is used that is advised by Prof. Bruggeman, the Chair of this thesis.

For the literature review itself, the literature found in the databases is used, but also the citations and sources within the literature. This is done to get a broader understanding of the different concepts and terms used.

Grey literature is also assessed in the literature review. Grey literature gives a more overall insight into the topics, especially into the more practical side. Grey literature consists of documents and websites from organizations, like national and local governments, parties within the construction sector, and institutions. This type of data is not peer-reviewed but is considered as formally truthful.

Grey literature is gathered through the internet, which is openly accessible to everyone. Some of the grey data is gathered through the database of the Municipality of Rotterdam. This data is not openly accessible and is gathered with a certain level of discretion. The gathering process of the grey literature is shown in Figure 7.

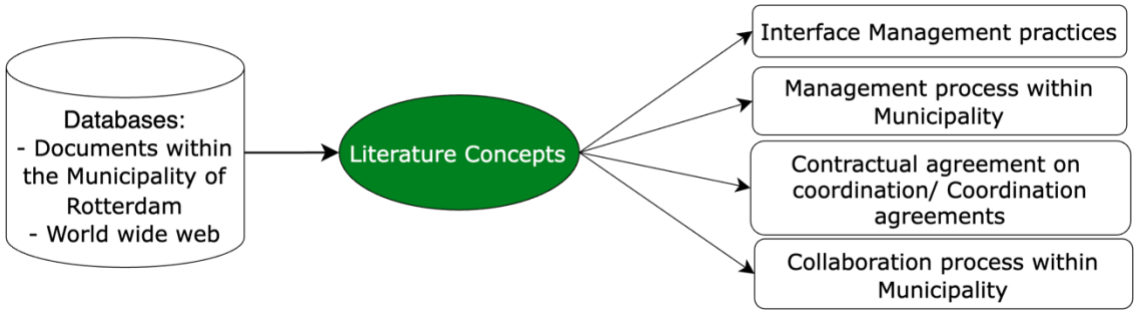

Figure 7. Gathering process of grey literature

3.1.2 Data analysis of the literature review

After the data is gathered for the literature review, it is analyzed. This is done by reading the materials on different topics and organizing them on the contents of them. Having an overview of the content creates the possibility to connect the articles and synthesize them into the final literature review. The steps to analyze scientific and grey literature are as follows:

- Read the abstract to determine the relevance to the thesis
- Read in-debt to get a deeper understanding of the concepts

- Connect the materials to the known literature on the concepts
- Create a theoretical framework for the thesis

Appendix A shows a deeper insight into how the scientific literature is analyzed.

3.1.3 Validity of literature review

The validity of the literature study is increased by using peer-reviewed literature primarily. By laying down the reviewing process of both scientific and grey literature, the validity of the narrative reviewing process is strengthened (Green, Johnson & Adams, 2006). This gives the possibility to replicate the search process and methods used to find and analyze the literature.

3.2 Case study

The second phase of this research includes the case study. The goal of the case study is to give a deeper insight into the coordination process of multidisciplinary construction projects, identify the key issues of current coordination, and show what the effects of both contractual and managerial instruments were on the coordination process. The case study consists of interviews and document research on the selected projects.

Multiple case studies are used to understand augur similarities of the coordination process through multiple projects (Yin, 2003). This way, the value of the results can be clarified. Chapter 5 shows the selection process for the cases included in the case study. By interviewing professionals who were involved in the projects, the practice of the coordination process is reviewed. The interviews are done with professionals working or were previously working for the municipality of Rotterdam. The document research should reveal the current project procedures and experiences on the topic coordination within the projects at the municipality of Rotterdam. The projects' contract documents and the execution phase documents are reviewed. This gives an insight into how coordination is written down in current contractual arrangements and what is documented about the coordination process during the execution of a project.

3.2.1 Data gathering of case study

The data for this phase is obtained through interviews and document research on the chosen cases.

Interviews

Interviews with professionals involved in a multidisciplinary project within the construction sector provide a practical application of the study. By interviewing the people involved in the different projects, a representation of reality is created. The interviews are semi-structured. This guides more toward the desired outcomes of the interviews but still leaves room for interpretation and additional information about the topics. Semi-structured interviews are a qualitative approach to gathering data (Ahlin, 2019).

With a semi-structured interview, a basic question dialogue is set up with open questions. Open questions can be seen as questions that are not only answered by yes or no. They stimulate broader explanations. Open questions give the interviewee the possibility to explain their point of view and their interpretation of certain topics. The interview questions are based on the outcomes of the literature review. The interview approach is shown in Figure 8. After the interviews have taken place, they are

transcribed. The transcribed interviews are the starting point for analyzing the interviews. The interview strategy can be found in Appendix E.

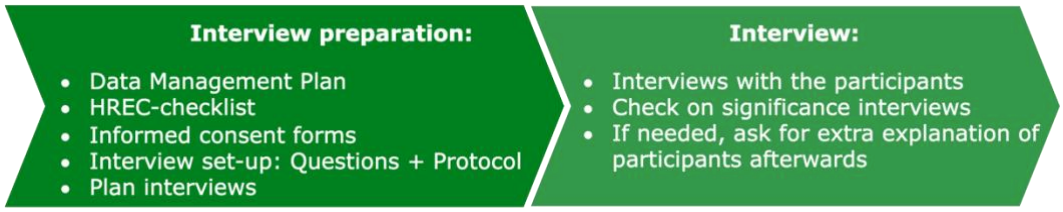

Figure 8. Interview Approach

The topics of the interview are:

- Experience and selection of the project manager
- Experience in coordination and collaboration of the project
- Management of interfaces
- Skills of project manager and managerial application within the project
- Contractual conditions and its pros and cons

The participants of the interviews were involved in the projects chosen for the case study. The participants should be:

- Either be Involved in the managerial activities during the project or have a deeper understanding of the legal context around projects
- Know about the project's interfaces and the managerial activities around this
- Have at least 10 years of experience in project management

Due to confidentiality, the names of the participants are left out. Since the specific role of a participant within a project can also reveal the person, this is left out too. The participants' overall roles were: project manager, contract manager, interface manager, or legal advisor on big projects. Chapter 6 provides an overview of the participant IDs.

Document research

The document research focuses on the documents created and used in the coordination of the cases. The documents are retrieved through the project database of the municipality of Rotterdam. Access to these documents is granted by the municipality of Rotterdam. The documents are not publicly accessible. This is to make sure no sensitive information is disclosed. Also, the participants of the interviews are asked about the documents on coordination of the interfaces within the projects, since the database itself does not contain all internal project documents. Figure 9 shows the document research approach within the project database of the municipality of Rotterdam.

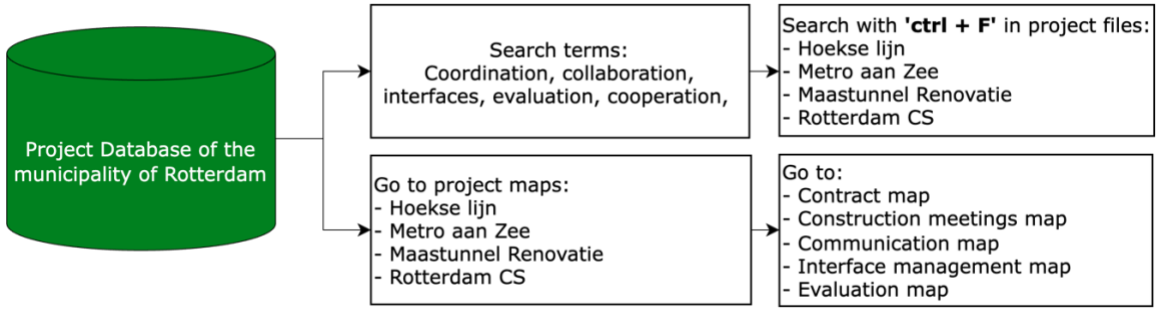

Figure 9. Search approach in Project database of the municipality of Rotterdam

To make sure the data of interviews and the document research are dealt with correctly, a Data Management Plan (DMP) is set up. This shows how the data is stored and used to keep the data safe and preserve the privacy of the interviewees and the municipality of Rotterdam. Next to the DPM, a Human Recourse Ethics Checklist (HREC) has been set up. The HREC is a document that shows how the researcher intends to handle Personal Identifiable Information and deal with the risks that might come with this. The DMP is checked by a data steward of the faculty of Civil Engineering and Geosciences. Both the DMP and the HREC are approved by the 1st supervisor of this thesis, ir. Van Os. The DMP and HREC can be obtained on request.

3.2.2 Data analysis of case study

The data analysis of the case study is split into the interview part and the document research part.

Interviews

The transcribed interviews are the foundation for analyzing the collected interview data. Braun & Clarke (2006) use 6 steps to analyze qualitative data, like interviews. This research uses the steps they describe as a guideline for analyzing the interview data, see Table 4.

Table 4. Steps of thematic analysis by Braun & Clarke (2006) and practical application

Phase	Description of the process	Application to this thesis
1. Familiarizing yourself with your data	Transcribing data (if necessary), reading and rereading the data, and noting down initial ideas.	Transcribe interviews, send transcript to participants + get agreement on transcript, write down first insights.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.	2.1: Generating initial codes: Transfer transcripts to ATLAS.ti, inductive 1st round coding. 2.2: Generating initial codes: Deductive 2nd round coding by clustering codes into code groups.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.	Cluster code groups into Themes, check themes and connection to literature review.
4. Reviewing themes	Checking the themes' work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.	Create table with 1st and 2nd codes and their groups, classify all codes to overarching themes coding scheme.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme.	Relational context, personal context, contractual context, and organizational support.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, the final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.	Final results, thesis report.

The transcribed interviews are coded, using ATLAS.ti 23. ALTAS.ti is a software used to analyze qualitative data. While coding the interviews, certain segments of texts get a label. This label could be a short sentence or word that summarizes the concept of the text segment. With coding, the amount of data is reduced into more accessible and usable codes. These codes will result in certain themes that help answer the research questions (Byrne, 2022). Coding knows three different approaches:

- Inductive coding: Coding by new codes based on the content of the data.
- Deductive coding: Coding by using existing theories as a basis.
- A combination of inductive and deductive coding: Coding starts freely by coding based on the content. After this, the codes are clustered into themes that are related to the existing theories.

This research uses a combination of both inductive and deductive coding. With a mixed approach, the researcher is able to uncover unexpected outcomes within the data, without losing the structure that is set by the literature review.

Document research

Upon gathering the documents, a careful reading is conducted, and those documents that are relevant to the research are selected. The selected documents containing interesting data for this research are labeled within the server of the municipality of Rotterdam, or are saved on the researchers personal cloud storage. This makes it easier to retrieve them if necessary.

The interviews, together with the document research will provide all information on a case. The processes for coordinating the interfaces for every case will be laid down. After this, all cases are compared. This shows whether the cases have similarities or differences in their processes. If any concepts/themes occur in every case, it can be concluded this is an overall phenomenon.

3.2.3 Validity of Case Study

With the case study being a qualitative research method, validity is perceived as relatively low in comparison to quantitative research. To increase the validity of this study, several actions are taken. Firstly, using a multiple case study, the outcomes are stronger and more reliable and will create a more convincing result compared to a single case study (Baxter & Jack, 2008). So, four cases are used in this research. Next to this, two types of data are used for the case study. Doing both Interviews and document research, the validity of the case study becomes higher (Yin, 1998).

One single case consists of multiple participants for the interviews. Multiple perceptions on the same case are collected with this. The constructional validity is higher by using multiple perceptions and comparing them (Quintão, Andrade, & Almeida, 2020). Quintão et al. (2020) also explained that external validity depends on the chosen cases and the interview protocol. With this, a chapter is dedicated to the case study setup, Chapter 5. The specifications for the case study setup are stated and honored. The case requirements are stated and elaborated upon.

Also, an interview protocol is set up to increase the external validity. The interview strategy, together with the protocol, is shown in Appendix E. An effort has been made to do all the interviews under the same circumstances. The same interview set-up, the same location, the same questions, and the same attitude from the interviewer's side. The internal validity depends on whether the outcomes of the interviews are grounds for plausible causal arguments that follow. Easier said, do the results of the case study represent the truth for the overall population? The interview questions are chosen

carefully so that the influence of other factors and subjectivity is minimized. To keep the interviews objective, semi-structured interviews are chosen. The primary questions are asked to all participants, under the same circumstances. This also increases the validity of the study.

After the interviews are transcribed, they are sent back to the interviewees to be verified and to limit wrongful interpretations. This strengthens the reliability of the transcribed interviews. When coding starts, the data is already checked once.

3.3 Preliminary framework

The preliminary framework includes the literature review combined with the theoretical framework, and the case study results to develop the framework on how good coordination is established on a multidisciplinary project with co-contractors. This phase compares the theoretical framework to the case-related outcomes on the steering mechanisms for the contractual, relational, personal, and governance contexts. With the found discrepancies, measures could be set up to reach a better coordination process. The preliminary framework establishes the foundation for the final framework, serving as the basis for its content.

3.4 Final framework

The fourth phase synthesizes all previous phases into one framework. The practical instruments to create a better coordination process are combined. In this phase, a framework is developed that includes the outcomes of the case study, with the adjustments retrieved through the expert sessions. The earlier preliminary model is iterated to a final one. This last phase is the practical application of this research.

With expert sessions, a part of the data for phase 4 is acquired. The goal of the expert sessions is to validate the outcomes of the case study and to see what the improvement steps of the client could be within the boundaries of their profession. Also, the experts take a critical look at the preliminary framework. To continue, measures are created to prevent or minimize the issues and improve the coordination of multidisciplinary projects. The experts have an opinion on what possible solutions are within the boundaries of the research. This is taken into account when developing the final framework.

3.4.1 Data gathering of the expert sessions

The type of data gathered here, are the recommendations given by the experts. The gathering process happens by organizing a 1 on 1 discussion session between the researcher and the expert. The main goal of this is to validate the case study results, to reflect on the preliminary framework, and to give an insight into what possibilities are for the final framework. Experts on the topics of this research will be asked to join the session. The expert session strategy is shown in Appendix H. The experts who participated and their participant IDs are shown in Chapter 9. The selection criteria of the experts are:

- A minimum of 10 years of experience within the construction sector
- Not involved in the case study to maintain objectivity
- Experience in either the preparation or execution of multidisciplinary projects of the municipality of Rotterdam

The chosen mix of experts has to be able to:

1. See if the instruments fit within the organizational structure of the municipality of Rotterdam.
2. See if the measures focusing on the contractual arrangements are feasible.
3. Assess to which extent the instruments are applicable in practice.
4. Show both the Client and Contractor perspectives.
5. Determine if the instruments will incentivize both the project managers and the contractors working during the execution.

The discussions with the experts are done in individual sessions because the main goal is validating the results of the case study and discussing the preliminary framework. Due to other factors, like getting all experts in one location at the same time and the summer break being in the same period as the expert sessions, an individual session is a better fit for this thesis and the limited timeframe.

A downside of individual sessions could be a lack of incentive to challenge each other's thoughts and opinions by other experts. This could give a deeper insight into the overall research. However, since the goal of the session is to mainly validate the results and framework, the by-catch of such a discussion is dropped.

3.4.2 Data analysis of expert session

With a discussion set-up and not an interview set-up, the experts can talk about certain topics of the research freely. These topics mainly involve the outcomes of the case study, focusing on the coordination problems and the instruments to improve this. What the experts say about the instruments determines to which extent the case study outcomes are also an input for the final framework. Analyzing the insights provided by experts regarding the preliminary framework allows for adjustments and refinements based on their input. This functions as the input for developing the final framework.

Next to this, the experts have a deep understanding of what instruments the municipality of Rotterdam has in terms of both rules and regulations and the way projects are managed. This provides the experts with the possibility to say what measures might help the municipality and to what extent the measures might have an effect on the current situation. What is said about the measures and their effects, is noted and analyzed. After this, an analysis is done on how these measures might fit into the current process and how this is best to be installed. This is the start of phase 4. Figure 10 shows the data process of the expert session.

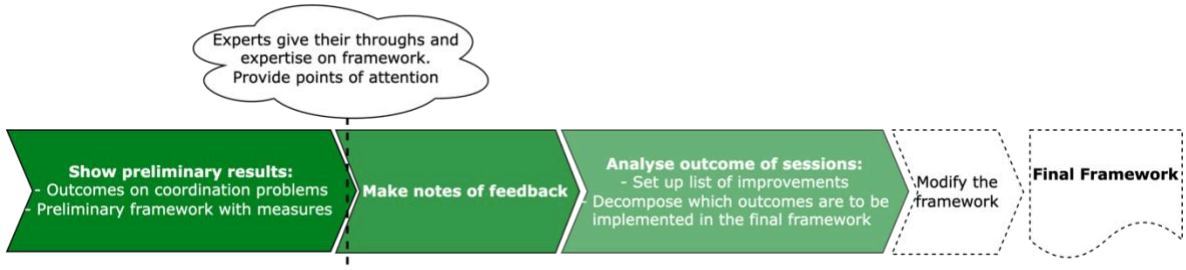

Figure 10. Process of Expert sessions

3.4.3 Validity of Expert Session

The main goal of the expert sessions is to validate the case study outcomes. However, how can the validity of the expert sessions themselves be ensured? To increase the validity of the expert sessions,

all sessions follow the same protocol. Appendix H shows the expert session strategy. This appendix dives deeper into the expert session setup and the structure of the sessions. It strived to execute all expert sessions in the same way. Also, due to choosing multiple experts with diverse specialisms, the constructional validity is increased.

3.4.4 Development of final framework

The earlier literature study, case study, preliminary framework, and expert sessions are the input for the framework. The final step of this thesis combines all data, to develop the final framework. The coordination problems and their origins are found, the possible instruments of the municipality of Rotterdam are clear, and the improvement measures are combined into a practical framework. This phase synthesizes the earlier phases. The final framework can be seen as the product of this thesis.

3.5 Research design

The research design of this research is shown in Figure 11. All the phases of the research are shown, together with the outputs of every phase and the (sub-)research question they intend to answer.

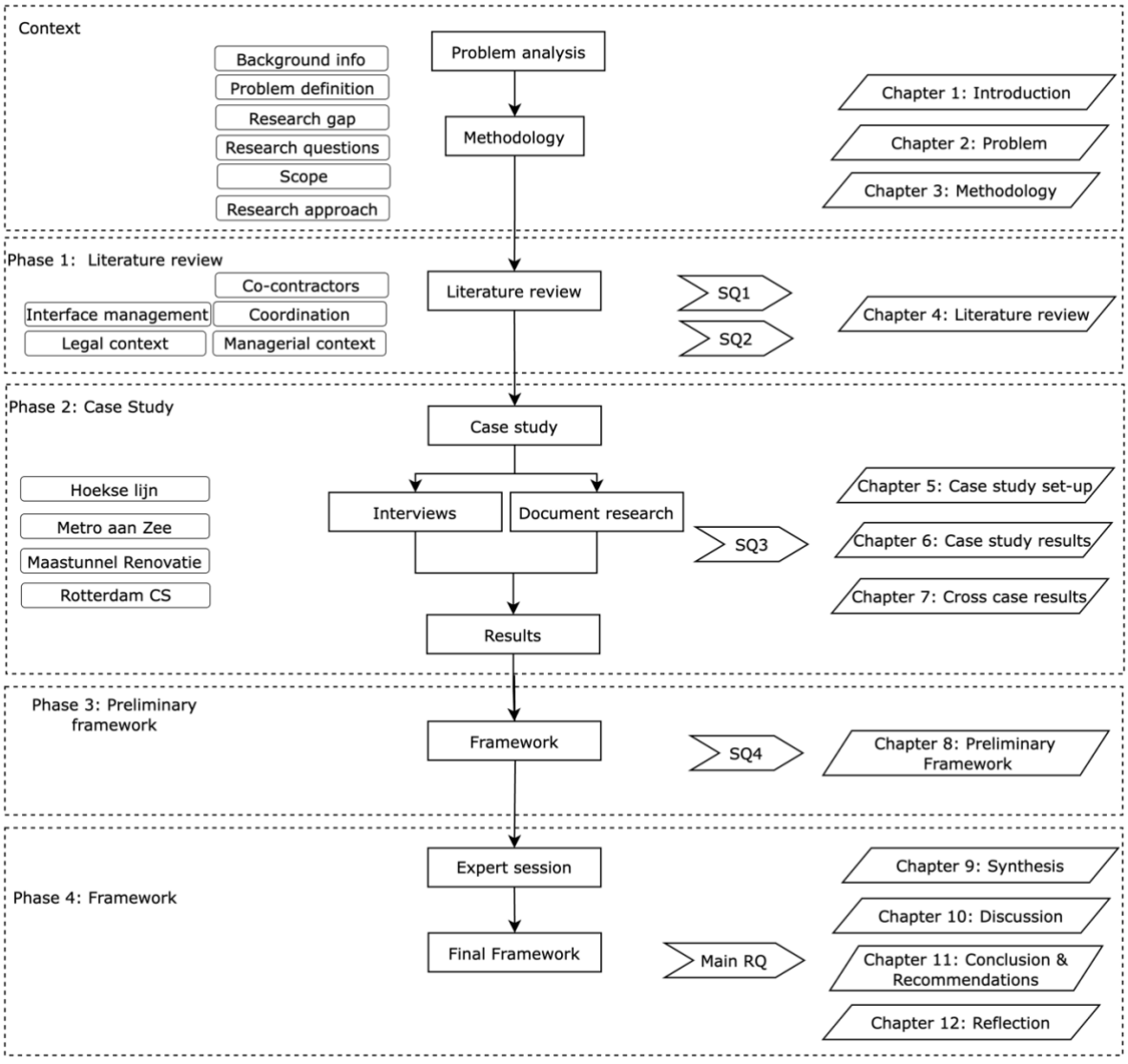

Figure 11. Research design

PHASE 1: Literature review

4. Literature review

This Chapter provides the literature review. The literature review elaborates on multiple concepts that are of value to this research. It shows what the scientific papers explained about the topics in the past and how this is connected to coordination. Every concept is explained upon in a separate paragraph. The topics are:

- Co-contractors and its connection to project delivery methods: Defining what co-contractors are and how co-contractor relations work in combination with Project Delivery Method creates clarity on what is meant in this thesis and how the relations operate in theory.
- Interface management: Interfaces occur the in overlap between contracts of multiple contractors. How management of these interfaces work is set out widely in theory, but has multiple definitions and approaches.
- Coordination: By creating a clear image on what coordination in in this research, ang wat good coordination implies, a better
- Managerial concepts: Concepts that affect the relational, personal, and governance contexts are set out, in connection to support better coordination.
- Legal concepts: The legal environment sketches the harder boundaries of a project and how management and coordination ate set up. Different contract forms result in different responsibilities and liabilities around coordination.

The literature review aims to answer *SQ1: How is 'good coordination' established? What are the current barriers?* The concluding paragraph presents the theoretical framework of this thesis. This framework shows a theoretical view of which aspects are important in the coordination of multidisciplinary projects with multiple contractors, and aims to answer *SQ2: What are the theoretical steering mechanisms of coordination with co-contractors?*

4.1 Co-contractors

This paragraph explains the meaning of co-contractors in relation to this research. The entities of choosing co-contractors when executing a project are also explained. Lastly, this paragraph shows how working with co-contractors relates to the Project Delivery Method (PDM) of a project and how the responsibilities and liabilities are spread out.

4.1.1 Co-contractors vs. co-contracting

Different terms on co-contractors and co-contracting are found in the existing literature. These should not be mixed up. The Directorate for Legal and Administrative Information of France describes co-contracting as: *'Several economic operators who choose to respond to a public contract in a group to pool their professional, technical and financial resources.'* (Department for Public Procurement France, 2020). Cole, Rayner & Bates (1997) and Gomes-Casseres (1996) describe it as the effective alignment of management systems, operational processes, and information systems, to achieve harmonization in procurement strategy such that the boundaries between different firms at various stages of the supply chain become blurred without reaching the point of actual merger. Co-contracting is really about an intensive collaboration from the start of a project. This term is used more in other sectors, like the economic sector, as compared to the construction sector.

A co-contractor, on the other hand, is described as a third party who is assigned a separate part of a service or work from the main contractor and only has a contractual relationship and liability towards the client principally (Law Insider, n.d.; Department for Public Procurement, 2020). This research will use the term 'co-contractor' and leave out the term 'co-contracting' to avoid misunderstandings.

Co-contractor: *'A third party who is assigned a separate part of a service or work from the main contractor. Principally, the party only has a contractual relationship and liabilities towards the client.'*

4.1.2 Co-contractor entities

As explained in the introduction, executing a project with multiple contractors who have different contracts - co-contractors - has multiple advantages and disadvantages. The project's characteristics have to be clear to decide on dividing a project into sub-projects. According to Couwenberg (2011), dividing a project into multiple subprojects happens most when:

- A project has a long lead time and parts of the project are put into use intermediately.
- A project has specific components, which need a specific kind of contractor.
- A project is too big to procure to one contractor.
- The requirements of some parts of the project are not available yet.

Winters (2014) continued on this subject by researching the division motivations of a client. He identified both stimulating and obstructive reasons to work with co-contractors. Appendix B shows an adapted table of the stimulating and obstructive reasons of Winters (2014). He added the increase in architectural value, procurement laws, increased quality, capacity expansion, alignment with the environment, and the construction culture as stimulating aspects to choose for co-contractors.

With the larger complex multidisciplinary infrastructure projects within the Netherlands nowadays, the best option is working with co-contractors in general (Arts, 2007). Especially when taking into account the status of the current construction market and its supply possibilities from contractors.

If the choice is made to divide a project, a client has to think about the possible risks. Gulijk & Muller (2011) described the possible high failure costs and the interfaces that arise as the most important risks. When procuring a project to one contractor, interfaces are minimized. This is one of the main reasons why scientific papers might advise against working with co-contractors. Other factors are of influence when making this decision. What does a client need to take into account when procuring a project with co-contractors? (Winters, 2014; Gulijk & Muller, 2011)

- Managing the interfaces that arise
- The increase of managerial complexity: the need for monitoring and coordination
- The knowledge that stays with the contractor, no knowledge expansion in-house
- With less integral contracts, the incentive to innovate stays low

4.1.3 Relation to other project delivery methods

Co-contractors are an option in multiple project delivery methods (PDM) within the construction sector. Both traditional collaboration and more integrated collaboration methods can be combined with co-

contractors. Even with Integrated Project Delivery like alliances, co-contractors are possible. In practice with public clients, this option occurs less often.

Within the different PDMs, interfaces occur and co-contractors are involved. This research revolves around the coordination problems that occur between co-contractors and the client. This is also the scope within defining the PDMs. The PDM of a project defines the overall responsibilities and relationships of each party involved in a project (Chen, Liu, Li & Lin, 2011). To understand what these responsibilities are, the two most common PDMs used with public procuring in the Dutch construction sector by the municipality of Rotterdam are explained:

- Traditional: Design-Bid-Build (DBB)
- Design-Build (DB)

Also, the coordination responsibilities are explained for each PDM. To keep the focus on the scope of this research, only the client-contractor and client-co-contractors' relations of the PDMs are looked at. The designer and the sub-contractors relations have been left out.

Traditional: Design-Bid-Build

The traditional PDM is Design-Bid-Build (DBB). This PDM has been dominant up until the end of the previous century. A client contracts a designer (architect) for the design and a contractor for the execution separately (Ahmed & El-Sayegh, 2020). A sequential project delivery is set up. The designer has no contractual relation with the contractor. All information flows through the client. A description of what has to be built is laid down in the specifications in detail. The UAV is used for the general terms & conditions in traditional contracts. Almost no design freedom is given to the contractor. The client monitors both the designer and contractor during the phases to ensure compliance with the contractual requirements of the work (Mahdi & Alreshaid, 2005).

The coordination responsibility in traditional contracts is primarily part of the client's job between the different contractual relations he has. When this PDM is chosen, the client is responsible for delivering the right design to the contractor with all the needed information. The client also coordinates the activities of the contractor with the activities of any co-contractor who has a separate contractual relationship with the client. Since contracts with a DBB PDM have a strict separation of responsibilities, coordination within such a contract is less necessary (Azhar, Kang & Ahmad, 2014). However, this does not take away the fact that coordination is needed if multiple contracts with different PDMs have to be aligned on interfaces. The contractor could hire subcontractors and is responsible for their work, which also means that the contractor coordinates them. This is not part of the client's activities or responsibilities.

The client is primarily responsible for coordination between the contractor and co-contractors who do not have a contractual relationship with each other (Van den Berg, 2013). This is also laid down in the general terms and conditions within construction contracts, which is elaborated on in paragraph 4.5. If not stated otherwise in the contracts, the client coordinates between the contractor and other co-contractors. The co-contractors do, however, have an obligation to do due diligence when their work interferes (Van den Berg, 2013). This means that the co-contractors have to be aware of each other's work and interests and take this into account. Figure 12 shows a traditional DBB and its relation to co-contractors. The different colors represent different contracts.

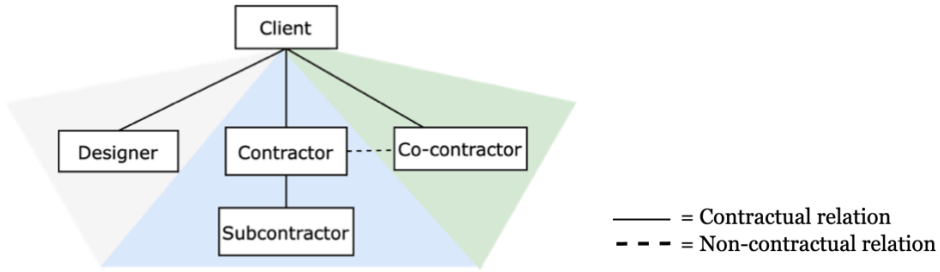

Figure 12. Design-Bid-Build

Design-Build

With The Design-Build (DB) PDM, both the design and the execution are executed by the same party within one contractual arrangement. The client sets out one contract covering the architectural, engineering, construction, and (sub)contracts involved in the design and building phases (Noorzai, 2020). This PDM shifts a part of the client's responsibilities and liabilities to the contracting party. The party who is in charge of the design and construction generally takes over the coordinating and monitoring responsibilities throughout the project's phases. The UAV-GC is used for the general terms & conditions for integrated contracts like DB. Clients have less control and input in the final design. The client drafts certain design requirements and criteria, but how these are filled in is up to the contractor (Fong, Avetisyan & Cui, 2014).

DB fits in projects that require more coordination, due to the more complex projects that emerge with more specific demands and works (Azhar, Kang & Ahmad, 2014). Since the design and construction are phases that are executed within one project team and are laid down in one contract, coordination of the client is less necessary here. These two phases are more synergized since the same team is responsible for both. Especially with more complex and multidisciplinary projects that require a more difficult design with multiple facets, this is a pro. The contractor knows better what the key parts are of the design and where the possible bottlenecks occur.

When having a co-contactor next to the DB PDM, it is primarily the client's job to coordinate this. Figure 13 shows the relations with a Design-Build contract. The biggest difference with Figure 12 is the design also being in the hands of the contractor. But since the client is less involved in the DB, certain interfaces that might occur between the different contractual arrangements are less clear to the client, since he does not know all the details of the design. This might need more involvement from the main contractor, who knows better what is going on in the project. This makes the main contractor a better suitor for the coordination task, in theory. The contractor might get a certain compensation for this since it involves more work to coordinate co-contractors.

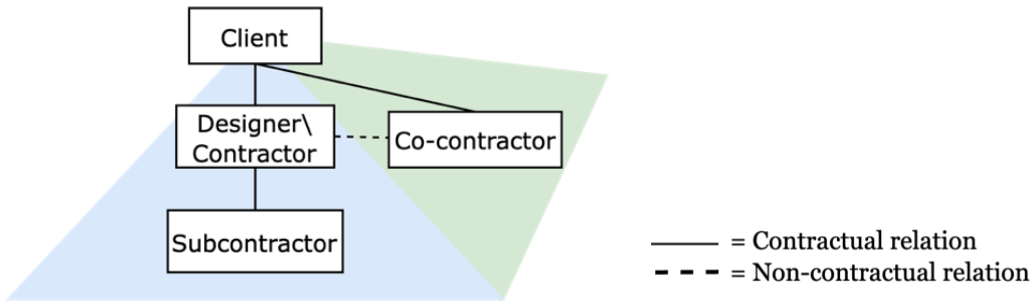

Figure 13. Design-Build

Suitability of DPMs with complex multidisciplinary projects

As said before, multidisciplinary projects require specialized and various disciplinal activities. A client could contract this through a DBB and make different specialized contractors responsible for different parts of the project. A client could also contract it with a DB. The main contractor uses his knowledge during both the design and execution phases. However, a project does not have to be procured in one DB. Multiple parts of the project can be procured in multiple DB contracts, or DBBs and DBs next to each other. This would still require coordination.

No matter the choice, as long as the project is set out into multiple contracts, coordination on the interfaces between those contracts is needed. Fong, Avetisyan & Cui (2014) have an interesting thought that counteracts the belief of choosing a particular PDM for the project's entities which establishes more project success than other PDMs. They believe that the Process, People, and System are the three dimensions that help achieve project success. Figure 14 shows the combination of Process, People, and System.

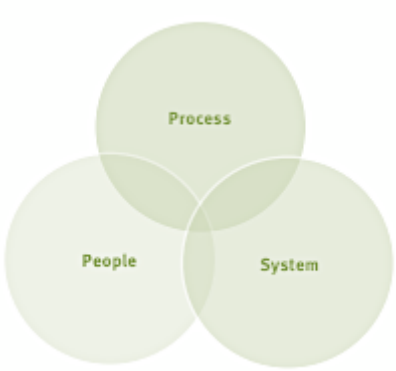

Figure 14. Process, People & System (Fong et al., 2014)

The process is about how the project is managed with which resources. The roles and responsibilities have to be clear. Within Process, a core component is coordination. Coordination makes sure that a project is delivered.

People show the 'human factor' within a project. The stakeholders of a project are key. People form, interact, and develop relationships in projects. Within the people part, implementation is key. Implementation means the human implementation of a project; A project is not happening without people. And these people need to be satisfied with the project.

System is revolved around the external forces of a project. Societal, Economic, and Regulatory forces affect how the project is expected to 'look' and abide by. Within the system, alignment is needed. Alignment is about the project complying with the needs and expectations of the external environment. Next to this, the project has to align with certain conditions the external environment has set, like ethical, political, and regulatory factors.

This has a great connection to the subject of this research. No matter which PDM is chosen, project success depends on how you fill in the process, deal with people, and how you place the project within its environment. With co-contractors, the roles and responsibilities need to be clear and coordination has to be set up right, the parties need to have good collaborate and interact in a good way, and the project has to be aligned with its external environment. This last part is also interesting when looking at the sub-projects. Sub-projects need to be aligned with the needs and expectations of the overall project, to function well.

Conclusion of PDMs

What stands out for the different PDMs and their characteristics is the relationship between the coordination responsibility of the client and the scope and complexity of the project. Bigger and more complex projects require more coordination between the different facets of the project (Azhar, Kang & Ahmad, 2014). In general, the client is responsible for the coordination of (sub)projects where co-

contractors are involved (Van den Berg, 2013), but with the more integrated PDMs this is harder. The client is less involved in the execution and has less influence on the project's progress. This is up to the contractor when having more integrated contracts. The client has to involve the contractor in the coordination of (sub)projects with co-contractors, to manage the occurring interfaces and make the overall project a success since the contractor has more knowledge of what is going on in detail.

As Fong et al. (2014) explained, the PDM of a project is not a crucial factor in a project's success. It is about how the project is managed, the relations and interactions of the involved parties, and how the external environment influences the project. This is why the thesis focuses more on how these aspects are set up, rather than the chosen PDM.

4.2 Interface Management

Interface management revolves around managing the interfaces within a project. This paragraph dives into what interfaces are, what interface management is, and what the different categories of interface management are. Also, the interface problems known in the scientific literature are laid down.

4.2.1 Interfaces

Definitions

The interfaces that occur with projects involving co-contractors have to be managed. Interfaces themselves have a range of terminologies. Since this research focuses on multidisciplinary projects in the construction industry, the interfaces that are looked into are the project interfaces. The counterpart of this is a product interface, which focuses on the production of products and services (Archibald, 2003).

One of the first definitions of interfaces within the construction sector was given by Wren (1967), which is: *'The common boundary between independent but interacting systems, organizations, project phases, and construction components.'* Stuckenbruck (1988) explained interfaces as: *'Interfaces arise from the division of work into parts executed by different people or organizations.'* Healy (1997, p.268) describes project interfaces as: *'A boundary where an interdependency exists across that boundary and where responsibility for the interdependency changes across that boundary.'*

The different explanations all refer to interfaces as a sort of division or boundary of work or system, but where both sides are interdependent and interact with each other to get the right execution of the work. In this study, it is important to understand this. Multiple contractors carry out their work but have to collaborate on the parts of their work that overlap, in order to get a good project result.

Interface levels

Interfaces could have different levels in a project environment. A division between the internal and external interfaces is made for projects (Stretton, 2016; Chen et al., 2007). Internal interfaces are present within the project itself and in one contract or scope. External interfaces refer to interfaces of a project with external entities and between multiple contracts and scopes. Looking at this, a sub-project with its contract could be seen as the internal boundary and the overall project with multiple sub-projects and contracts interfere with each other as external interfaces. When having a project with

co-contractors, it is interesting how these levels of interfaces can go both ways as the overall project can also be seen as the total project's internal spheres.

Nooteboom (2004) explained that the execution of a project will be more effective when the external interfaces of the multiple sub-projects get allocated to the client. For the client the overall project can be seen as the internal sphere, he has the power to influence it.

Collins, Durham, Fayek & Zeid (2010) describe three levels for interfaces: inter-project interfaces, intra-project interfaces, and extra-project interfaces shown in Figure 15.

- Inter-project interfaces refer to the interfaces between parties who are directly involved in the project planning and execution.
- Intra-project interfaces are the interfaces within the organization of the independent parties itself, involved in the project.
- Extra-project interfaces refer to the interfaces between the project parties and parties who are not directly involved in the project.

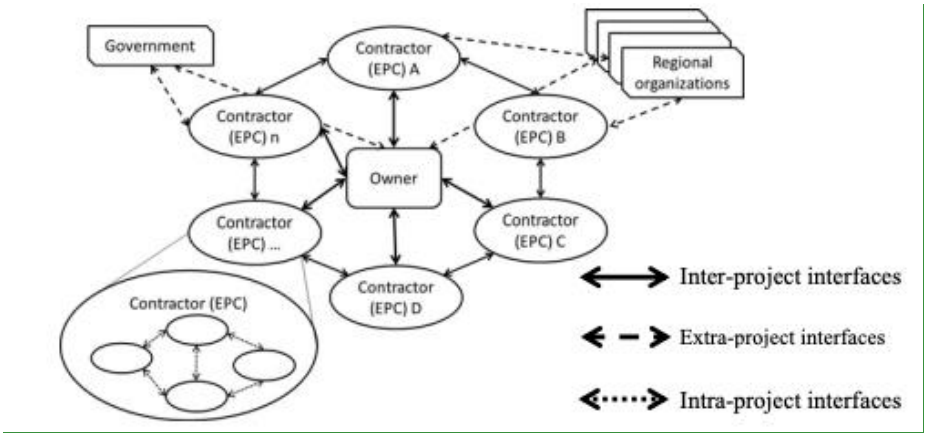

Figure 15. Levels of project interfaces (Collins et al., 2010)

The scope of this research is inter-project interfaces: The interfaces between the client and the co-contractors involved.

Interface categories

Project interfaces have known multiple categorizations throughout time. Stuckenbruck (1988) describes personal, organizational, and system interfaces within project interfaces. Personal interfaces mean the 'people' involvement in a project. This is the relational sphere within a project team. When people are involved, conflicts can occur and need to be managed. The project manager could have a mediator role in this and has the task of resolving potential conflict and personal problems. Organizational interfaces refer to the organizational differences, next to the personal differences. Organizations have different goals, processes, and management styles, which leads to different cultures and intercourses. This could lead to conflicts and misunderstandings on the interfaces of projects. The system interfaces refer to the 'non-people' interfaces like the hardware, facility, and product.

Wren (1967) & Healy (1997) identified the time, geographic, technical, and social interfaces as part of project interfaces. Time interfaces occur when a certain activity flows into another activity that sequentially follows up on each other. Geographical interfaces are location-bound and involve activities

that might be carried out at the same place. The technical interfaces refer to the technologies that are used. Social interfaces are 'people-affected' and refer to the different parties having to collaborate.

A newer categorization is made by Chen et al. (2006) through physical, functional, contractual, organizational, and resource interfaces. Chen et al. (2006) focus more on the interaction of the different categories. Physical interfaces are the real-life interactions between physical elements of a project, for example, elements of a building. Functional interfaces arise when functions of a system are divided into sub-functions that are necessary for the functioning of the main system. Contractual interfaces refer to the overlap among multiple contracts with the executive contractor, subcontractors, and suppliers connected to their responsibilities and agreements. Organizational interfaces focus on the interactions between the different parties involved. Resource interfaces are about the needed materials, manpower, information, and space and their interactions with each other and the coordination of this.

Over the last decades, a lot of different terms on interfaces and their categorizations have arisen. This is partly due to the increasing insights in the project world, and interface management in particular. This research focuses on the categories of contractual interfaces and organizational interfaces, but also the personal category of Stuckenbruck (1988) is taken into account within the organizational context. With this scope, the research does not look at physical divisions within a project, but more at how the contractual and organizational/social parts are arranged to avoid or minimize interface risks.

4.2.2 Interface Management

Definitions

Interface management (IM) is about managing the interfaces that are present in a project. Multiple definitions are known about IM. Nooteboom (2004) described it as: *"The management of common boundaries between people, systems, equipment, or concepts"*

Shokri et al. (2012) explained it as*: 'The process of managing communications, responsibilities and coordination of project parties, phases, or physical entities which are interdependent.'*

Within the field of construction and civil engineering, the next definitions are used often. The research team of The Construction Industry Institute (CII) defined it as: *'management of communications, relationships, and deliverables among two or more interface stakeholders'* (CII, 2014).

Chen et al. (2008) described it through Wideman as: *'The management of communication, coordination, and responsibility across a common boundary between two organizations, phases, or physical entities which are interdependent'.*

Despite the differences in the definitions of IM, the main idea stays the same. The management of projects/entities that are interdependent and require management across the common boundaries of their works. For this research, in particular, communication, coordination, and responsibility are interesting. This is taken into account for the definition of this research.

This research describes interface management as: *'The management of communication, coordination, and responsibility across a common boundary between multiple project parties, which are interdependent'*

Importance of interface management

A critical part of project success is interface management (Stuckenbruck, 1988; Pavitt & Gibb, 2003; Nooteboom, 2004). If the project interfaces are not managed correctly and actively, projects are bound to get problems in the long term. To reach project goals in terms of costs, time, and quality, interface management is required (Shokri et al., 2012). With the right interface management, stakeholder alignment is improved, communication and coordination are enhanced, and potential conflicts and transaction costs are reduced (Nooteboom, 2004).

Interface management is widely seen as an information and relational processing activity, in which the softer side of project management is crucial (Chen et al., 2008; Shen et al., 2017). The softer side of project management is related to creating trust, openness, and communication. This softer side is getting more attention and is getting recognized as a critical factor in project success (Awan, Ahmed & Zulqarnain, 2015). How interface management is organized is important to the way the different project participants interact and deal with the interfaces and their incidentals.

Problems with interface management

Interface problems are an important factor in possible project failures. This is why it is good to know where these problems arise and what their origin is. Recent studies have shown that a lot of these interface problems are due to the incorrect way of mapping and managing them. Chen et al. (2007) explained that poor interface management performance and mismatches of interfaces are causes of delays and extensive rework on projects. So, the interfaces should be managed properly.

Crowley & Karim (1995) stated quite early on that tightly organized interfaces with closed external boundaries (the project's external environment) limit project participants from interacting openly and exchanging information accurately and timely, which results in projects not running smoothly. This shows the importance of the 'social' part of the parties involved. The way participants interact with each other has a big influence on how interfaces are handled, and thereby the project's success. Newer research focuses more on the social aspects of project and interface management. Awakul & Ogunlana (2002) and Yeganeh, Azizi & Falsafi (2019) showed that different cooperative attitudes of parties within a project are one of the main causes of interface conflicts. The influence of a good social environment within a project is a key driver for success.

Huang et al. (2008) researched the interface problems and their origins. They found that the main interface problems are related to know-how factors and environmental factors of a project and its participants. Figure 16 shows the interface problem factors.

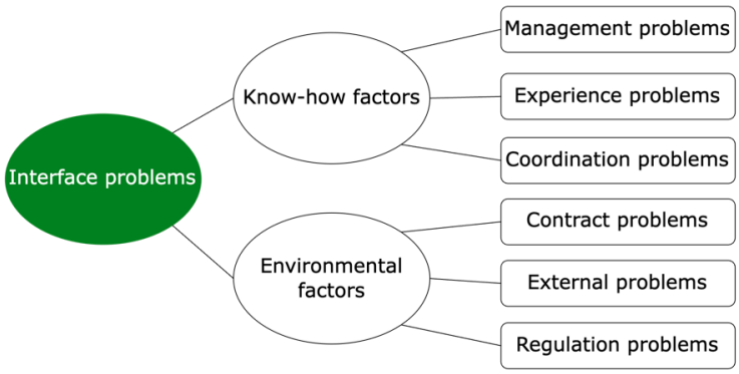

Figure 16. Interface problems factors (Adapted from Huang et al., 2008)

Know-how factors

Huang et al. (2008) stated that know-how factors are connected to the people's side of interface problems. Management, experience, and coordination problems all refer to how people deal with a project's interfaces. Management problems are problems that occur due to the 'lack of management' by the manager of a project. Poor communication and coordination, postponing and bad-timing of decision-making, delay in payments, insufficient compatibility of detail design, and contradictions in the project plan are scaled under this. Experience problems refer to the level of experience of all the project participants and the lack of learning from faults made in the past. Lessons learned are critical to improving project performance, but this is still lacking. Also, certain parties are not experienced enough to deal with the interface problems that occur within projects, which leads to them not being flexible and able to adapt to new environments and techniques. Coordination problems are issues that result in the inefficiency of the project. Scheduling and planning problems and the lack of communication and openness through for example management systems that should provide new information about projects.

Environmental factors

Environmental factors refer to interface problems that are less easily influenced by people within a project and are more external (Huang et al., 2008). Contract problems are caused by the contract that is set up between the different parties involved in a project. An unclear or incomplete contract can lead to interface problems. Also, a deviation from the design or a contract's requirements leads to interface problems. These problems arise when a contract does not fit the project's requirements or when the project scope changes during execution. External problems cannot be influenced at all by the project parties. Things like the weather, the geographical entities, and market-related influences like the material prices have to be dealt with as they are at that time. Regulation problems refer to the laws and regulations that apply to a project and its environment. Laws and regulations differ for countries, provinces, and municipalities within for example the Netherlands. A project has to comply with this.

Influence areas for this research

Although it is very useful to know the factors that have a big influence on the interfaces, the division used by Huang et al. (2008) for the environmental factors is not followed in this research. Huang et al. describe the environmental factors as less easily influenced by the people within a project. The contractual arrangements are, however, influenced by the parties who are involved in the execution of a project. The parties agree on the contents of the contracts, before execution. If a contractor does not agree with the content of a draft contract, he can negotiate this with the other involved party. So, he can influence the content. If he does not agree with it, he is not obligated to sign the contract. Next to this, during execution contract amendments are still possible to a certain extent.

This research takes into account the interface problems explained by Huang et al. (2008) but sees the contractual setting as a direct influence on the parties involved. Especially because the measures used to tackle interface problems can be installed in an earlier stage of the project, it is important to see this as a direct influence.

Next to the contractual context, the relational context is taken into account. As explained by Huang et al. (2008) and Yeganeh et al. (2019), the relational context is a big influence on the interfaces and coordination of them. This is why this is also a main influence area in this thesis. How the relational

context is, depends on the cooperative attitudes of parties, this is a direct influence on how coordination is established and how it deals with the interfaces.

As explained by Stuckenbruck (1988) and Huang et al. (2008), the management ways of a project manager influence how the interfaces are handled. This thesis defines this as the personal context, the effect of the personal entities of a project manager on the know-how factors. The experience, soft & hard skills, and personal traits of a project manager influence the way the interfaces are managed.

The last influence area that is taken into account is the governance context. The governance context is about the organization of parties involved in a project, especially on the client's side. The way an organization is set up, how governance is established, and how this is radiated to the project spheres influences the interfaces and coordination. Figure 17 shows the influence spheres of the project parties in the colored areas. They influence the contract content and the know-how factors as described above.

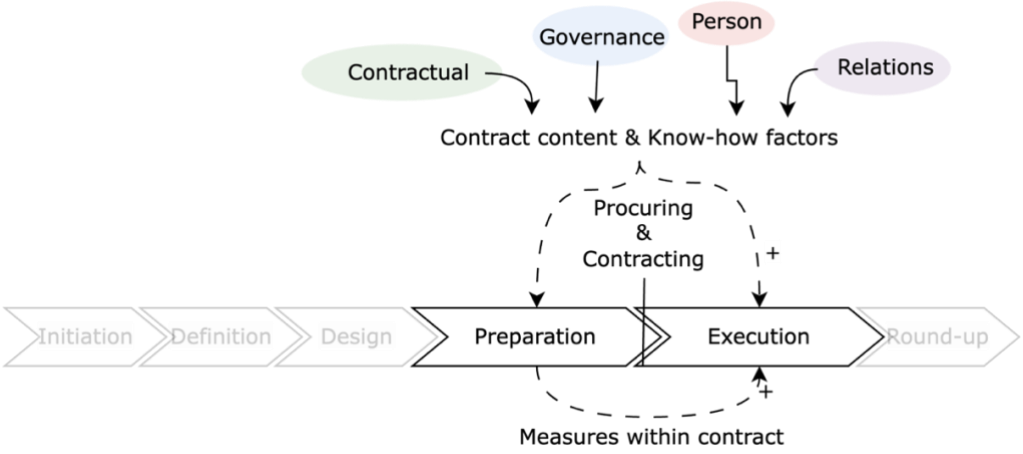

Figure 17. Influence spheres of project parties

4.3 Importance of coordination

If multiple parties are involved in a project, coordination is of great importance. With more parties, coordination becomes even more important. The way a project is coordinated has a large influence on project performance. Coordination is mostly described as the management of interdependencies between activities to reach a certain goal (Okhuysen & Bechky, 2009). This paragraph explains what 'good coordination' is through multiple theoretic views. Also, an elaboration is given on which factors influence coordination. From this, steering mechanisms are defined for every influence area, contractual, relational, personal, and governance.

This research describes coordination as: *'The management of interdependencies between activities, actors, and environment to reach a certain goal'*. This research its predominant focus is the coordination actions and processes of a client to steer co-contractors and their interfaces.

4.3.1 Good coordination

To have good coordination, Okhuysen & Bechky (2009) explained that the project organization has to comply with three conditions: Accountability, Predictability, and Common understanding. Accountability refers to the clarity of who is responsible for which part of the process. Predictability is about knowing which activities have to be done before another one starts and how the activities are

connected. Common understanding shows the importance of a common view on the whole process, including the responsibilities and activities.

With accountability being important, a coordinating party should be appointed during project execution. Mostly this is either the client or the main contractor. The role should be fulfilled by the party who has the competencies to fulfill the coordinating role (both hard and soft skills), who has a good information position within the project, and who has knowledge about the project-specific coordinating problems and risks (Zheng, Wen & Qiang, 2020).

Using accountability, predictability, and common understanding, Strang (2018) set up a list of requirements for good coordination. Good coordination requires a coordinator to be authorized to instruct other parties, the coordinator being the most suitable party, agreements on both the planning and technique to have multilateral alignment, parties joining a consultation structure, parties expressing their information needs, a duty to warn for circumstances that jeopardize the alignment of work, no unnecessary hindrance of activities, and a liability arrangement to incentivize parties to abide by their obligations.

This can be translated into 8 barriers that stand in the way of good coordination. These are: a coordinator having no mandate, having the wrong coordinator, having no agreements concerning the alignment of planning and technique, no consultation structure, parties having no room to express their information needs, no duty to warn, unnecessary hindrance of activities, and having no liability arrangement between parties.

Strang (2018) transformed the coordination requirements into five activities to create good coordination: Leading, Facilitating, Communicating, Control, and Recording. The main activities for good coordination are: identifying strategic activities and potential delays, ensuring timelines of all work carried out, maintaining records of all information about the project: drawings, directives, verbal instructions, and received documents, maintaining proper relationships with the parties involved, manage the quality of all work carried out, and connection with clients, consultants, and contractor.

To create awareness and comply with the requirements of good coordination, a practical application is necessary. Shen & Chang (2011) elaborated on eight different tools to facilitate coordination in projects:

- Meetings: discuss coordination, and ideas and settle conflicts
- Informal discussions: Informal talks between parties
- Site visits: To gather, share, and confirm the information and to do inspections
- Written correspondence: Explanation of subjects, sending reports
- Plans: Describing plans and procedures of the project and coordination
- Schedules: Time schedules to inform about time-related activities
- Reports: Reports about the course of activities
- Contract documents: Laying down the rights and obligations of parties

4.3.2 Factors influencing coordination

How coordination can be influenced within projects, depends on multiple factors. These factors are mostly related to the managerial context, legal context, or the characteristics of a project (Strang, 2018). How management is arranged and how the contracts are arranged have the biggest effect on coordination. Looking at what affects management, 3 categories arise: the relational, personal, and

organizational context (Huang et al., 2008). The relational context is about how the multiple parties interact, the personal sphere is about the project manager of a project and their management ways, and the organizational sphere is about the organizational setup of the individual parties.

The legal, relational, personal, and governance sides within a project all contribute to coordination and how interfaces are managed as shown in the previous paragraph and Chapter 2. To find the optimal way for this, the steering mechanisms for each one are laid down. This gives the thesis the handles to develop a framework, which includes the theoretical view on 'good coordination'.

Kamminga (2008) described the success and failure factors influencing coordination. These factors are explained in Table 5 below.

Table 5. Success and failure factors influencing coordination (Kamminga, 2008)

Sucess factors	Failure factors
Strong commitment to project goals. Stimulated by team-building activities and reward system incorporated within the contracts.	Conflicts. Tackled by experienced persons who can see upcoming conflicts in an earlier stadium and to enlarge knowledge about controlling conflicts through training.
Being competent on both a technical and social level. Stimulated by training of people and selecting the right parties by looking at their technical knowledge and communicative skills.	Insufficient investment in project management. Tackled by training and experienced people.
Clear interaction and communication between parties. Stimulated by regular meetings under professional supervision, organize social events to enlarge mutual trust, and create special groups to deal with subjects like conflicts.	Bureaucracy. Could lead to impersonal relations, shredded responsibilities, and slow decision-making. Tackle this by decision-making techniques and train and select people on this.
Effective control and feedback. Stimulates the information supply of upcoming activities within a project. Is influenced by regular evaluations of the process through clear goals and good communication.	Distrust in the procurement and execution phases. Tackled by stimulating an open and active attitude. A client should act trustworthy and predictable.
	Short preparation time before enrollment of contractors. This results in sloppiness, which creates tension. Giving more preparation time should avoid this.

Strang (2018) made these factors of Kamminga more practical by looking at what steering mechanisms lie within the legal context. He looked at what has to be taken into account when contracts are set up and procured. These mechanisms have the biggest influence on how coordination evolves within the construction process. Strang translated the factors to: The scope of the coordination assignment and the associated powers and tools, the way decisions are made about coordination, the distribution of risks associated with coordination, the way in which the parties deal with conflicts, and the way in which the parties settle disputes.

To make this more practical, Strang attached a list on how to incorporate those steering mechanisms into the legal context of a project.

- The coordinator is authorized to instruct parties involved in the construction process and to supervise compliance with his instructions at various levels.
- The most suitable party fulfills the role of coordinator.
- Consultation takes place in a multilateral context that results in concrete mutual agreements about coordination.
- Parties participate in the construction process in a consultation structure.
- Parties communicate their information needs to each other.
- Duty to warn about circumstances, including (potential) conflicts, that could jeopardize the successful coordination of activities.
- Work agreements are made about (digital) information exchange.
- Parties do not unnecessarily hinder each other in carrying out work.
- A multi-stage form of dispute resolution.
- It is not based on mere best efforts or obligations on the part of the coordinator.
- A liability regulation that does not exclude the mutual liability of contractors for non-compliance with the multilateral agreement.
- Arrangements for exiting and joining the multilateral agreement.

How this is done with the softer relational, personal, and organizational steering mechanisms is not set out in a clear way within the literature. Kamminga (2008) talks about having common goals through team-building activities, having competent people with communicative skills, social events to enlarge mutual trust, training and experience, and effective control and feedback, but a practical approach like Strang presented is not set out. This is why the success and failure factors of Kamminga on coordination are used as a guide to create the other steering mechanisms, in combination with other literature. The steering mechanisms for the relational, personal, and governance parts are laid down in paragraph 4.4.

The steering mechanisms in the contractual context are:

a. The scope of the coordination assignment and the associated powers and tools
b. The way decisions are made about coordination
c. The distribution of risks associated with coordination
d. The way in which the parties deal with conflicts
e. The way in which the parties settle disputes

4.4 Managerial context

This paragraph explains the managerial context of a project. This managerial context focuses on social aspects like how good collaboration is reached and what the importance is of the 'human aspect' within a project, and with managing interfaces in particular. This paragraph also dives into the personal traits of a project manager and the soft skills that are big pros of project management.

4.4.1 Importance of the human factor

What becomes clear from earlier research is the importance of the soft side of managing interfaces and managing complex projects overall (Huang et al., 2008; Luo et al., 2017). Shen et al. (2021) added to this by highlighting the significance of stakeholders within the field of interface management. The governance and social norms appeared to have a positive influence on individual behaviors and

attitudes of parties. Shen et al. also mentioned that promoting trust, communication, and cooperation among the project parties enhances the interface management performance. The alignment between all stakeholders and cooperatives within a project is of great importance within interface management. With multidisciplinary projects where a lot of co-contractors are involved, collaboration is of even bigger importance. You want to create a collaborative culture where all parties are willing to work together towards a common goal.

What makes it hard within the construction sector, is the temporary and unique characteristic of projects. The networks in a project are temporary, which causes them to be less cohesive and unstable (Kadefors, 2004). So how do you create a collaborative culture?

Shen et al. (2017) showed how important trust is within multidisciplinary construction projects nowadays and how this is reached through inter-organizational openness and communication. Creating a collaborative culture first requires trust between parties, as trust between parties is seen as the cornerstone for interface management. Buvik & Rolfsen (2015) explained that trust within a project and cross-project-teams is created by:

- Early formation of integrative work practices
- The development of a common philosophy
- Open communication
- Early and clear role expectations

With trust and mutual commitment, the involved parties are more likely to share their valued resources and have more open and flexible organizational boundaries. Taking into account that trust is the basis for a collaborative culture and interface management, the factors of Buvik & Rolfsen are used as the steering mechanisms within the relational context of this thesis, in combination with the success and failure factors of Kamminga (2008) stated in paragraph 4.3.2. The steering mechanisms are: early formation of integrative work practices, the development of a common philosophy, open communication, and early and clear role expectations.

The above-stated steering mechanisms within the relational context do not have a practical application. Kamminga (2008) formulated activities on how the mechanisms can be incorporated into a project and its relational context. To create a common philosophy, team-building activities are stimulating. Also, to bind parties to a certain philosophy, a reward system could be incorporated within the contracts. For clear and open communication regular meetings are needed under professional supervision. Also, social events, coaching sessions, and clear consultation and communication structures are stimulating. An important note is that the client has an exemplary function. The client has to be trustworthy and predictable; this also stimulates open communication.

With a multidisciplinary project with co-contractors, more relations occur between all parties. This is why coordination and collaboration between all parties are even more important, in comparison to a project with only one contractor. A collaborative culture should be established by promoting trust. The steering mechanisms in the relational context are:

f. Early formation of integrative work practices
g. The development of a common philosophy
h. Open communication
i. Early and clear role expectations

4.4.2 Soft Skills

To reach the best project outcome and manage interfaces that might occur, the soft skills of a project manager (PM) appear to be crucial. As mentioned before, the soft skills of a PM are just as important as the hard skills in managing a project. Since the beginning of this century, researchers have advocated and shown the increasing importance of the soft skills of a PM (Kirsch, 2000; Shi & Chen, 2006; Awan et al., 2015).

Hard skills can be measured by for example the level of technical knowledge a PM has. Soft skills are harder to measure and seem more intangible. A common saying within the project world is 'soft skills are not measured but felt'. It is harder to study them through certain parameters, make them objective, and quantify them.

Different sorts of projects need different sorts of PMs. A very traditional project setup with little communication and collaboration between parties requires fewer soft skills from a PM. When a project is very complex and involves a lot of parties, a project manager needs more soft skills to coordinate all the parties. Since soft skills are more about the personal entities of a PM and their characteristics, it is harder to learn through books. A part is learned by experience and training, but a part is due to one's personality (Gulati, 2021). That is why it is even more important to find the right PM for the right project with both a good set of hard and soft skills. Laker & Powell (2011) refer to hard skills as technical skills, like planning. They refer to soft skills as intrapersonal and interpersonal skills, which focus on personal behaviors, like communication. Soft skills show how we interact with each other and can be seen as the catalyst for project success (Gulati, 2021).

Shi & Chen (2006) showed 5 sets of soft skills that they seem as required to be successful: communication skills, coordination skills, interpersonal skills, teambuilding and delegation skills, and problem-finding, analyzing, and solving skills.

Awan et al. (2015) continued on the research of Shi & Chen by showing that the 5 sets of soft skills of a PM are indeed contributors to project success and showing it through a more quantifiable study. El-sawalhi & Lafy (2021) researched which soft skills are the most important for a project manager for their relationship with others. Communication, team management, problem-solving, decision-making, empathy, sociability, and leadership appeared to have the most impact on others. Gulati (2021) did a literature study on soft skills and found active listening, communication, negotiation, conflict management, political and cultural awareness, and leadership skills to be the most important ones.

All the soft skills together contribute to a better project outcome. When looking for a project manager, it is important to take all the above-named soft skills into consideration and see what fits into the picture of the overall project and project parties. The most important personal traits of a project manager related to good coordination and interface management are a combination of the above-named soft skills, and the earlier-named factors influencing coordination. The steering mechanisms within the personal context are:

- Experienced
- Competent on a technical level (hard skills)
- Competent on a social level (soft skills)
- People-oriented characteristics

The above-stated steering mechanisms within the personal context do have a limited practical application. Kamminga (2008) formulated activities on how the mechanisms can be incorporated into a project and its personal context. Experience is gained by a lot of practice. Also, training is an important aspect that has to be used throughout the whole project cycle and a project manager's career. Training has to be done on both technical and social level. The selection of the right people is needed to provide the right project setting.

The personal context of a project manager has a big influence on how a project is managed and how coordination is done. The steering mechanisms in the personal context are:

j. Experience
k. Competent on a technical level (hard skills)
l. Competent on a social level (soft skills)
m. People-oriented characteristics

4.4.3 Influence of the client's organization

As stated earlier, within the organizational context, the way a client operates, how the client's organization structure is set up, how governance is established, and how this is radiated to the project spheres has an influence on the coordination of a multidisciplinary project with multiple co-contractors.

Kamminga (2008) explained that bureaucracy and a short preparation time are failure factors that influence coordination. Due to formal relations, shredded responsibilities, and a passive attitude, important decisions might not be made, or are not handled with the needed level of interest.

A short time to prepare leads to issues during execution. If coordination and interface management are not pre-thought of, a lot of tension arises during execution. There is little time for well-considered decisions and people might get irritated with each other. Taking this into account, the most important steering mechanisms within the governance context affecting coordination are:

- Clear responsibilities
- Proactive attitude within organization
- Preparation time

The above-stated steering mechanisms within the governance context do have a limited practical application. Kamminga (2008) formulated activities on how the mechanisms can be incorporated into a project and its governance context. Set up clear responsibilities and role divisions within the organization. Next to this, it is important to create short lines of communication. Keep a proactive attitude by setting priorities, having a clear decision-making process, and being transparent and directive. Strive for adhocracy. People within the organization can be trained to support this. It is also to create more time before the execution phase starts or make a buffer during execution to minimize tension due to limited time.

The steering mechanisms in the governance context are:

n. Clear responsibilities
o. Proactive attitude within organization
p. Preparation time

4.5 Legal context

When a project is divided into multiple sub-projects, different bilateral contracts with several contractors are the result. The different contractors and contracts have to be coordinated to get aligned and deal with the interfaces between the different contracts and the (components of the) works allocated to these contractors. Next to the know-how problems, Huang et al. (2008) identified contractual problems as one of the main contributors to interface problems.

Contracts describe agreements and the responsibilities and tasks for the parties involved flowing from the contract. Also, contracts can be a backbone during conflicts. In theory, every step of a project's execution can be stipulated in a contract. However, big complex projects often develop through time. Not every part of a project is clear from the start. Projects are unique and differ in location, scope, and content. Also, the market (contractors and suppliers) is dynamic. This together could lead to different contract forms being suitable for different types of projects given certain external factors.

As shown before, different project delivery methods contain different responsibilities and liabilities for the parties involved. The traditional model (DBB) separates the design and construction phases and uses separate contracts with different partners. With the Design & Build model (DB or D&C) the design and construction phase are handed out to the same party.

With the DBB model, mostly the UAV-2012 is used for the general terms & conditions. When using a DB model, the UAV-GC 2005 is used. The UAV-2012 and the UAV-GC 2005 are elaborated upon in the next paragraphs. Although different project delivery methods exist, all big projects with interfaces need coordination. This paragraph dives deeper into contractual agreements and their responsibility, coordination within the UAV, coordination within the UAV-GC, and the coordination agreement to show how the legal context around coordination is set up. The Dutch translation of the used sections of the UAV and UAV-GC is laid down in Appendix C.

4.5.1 Coordination within contracts

The way coordination with the contractors is stipulated in contracts has a big influence on how coordination will evolve during the execution phase of a project. A contract divides the responsibilities, can create incentives for the parties involved, and is an instrument to fall back on during conflicts. It is important to formalize agreements on these matters. By formalizing this, all parties know what they are up to, the risk of different perceptions on the stipulations is minimized, and it becomes easier for parties to address each other on compliance with the agreements (Kamminga, Simons & Goris, 2009).

Kamminga & Dohmen (2014) described multiple aspects of coordination that are important to include in contracts, which are also the steering mechanisms of the contractual context for this thesis:

- The scope of coordination assignment and the associated authorities: What has to be coordinated by whom, and what are the measures and mandates this coordinator has?
- The way in which decisions are made about coordination: Who is the one making the decisions? What are de decision-structures?
- The division of risks that coheres with coordination: Who is the responsible party when coordination fails?
- The way in which parties deal with conflicts: What are the rules and regulations on conflicts?

- The way in which parties settle disputes: Are there damages to recover? What are the damages? Who is liable for what?

All these questions need to be answered within the contracts. If one of these questions stays unanswered, the risk of a lower project success arises. The general terms and conditions already answer some of these questions, depending on the contract type. The next section gives a deeper insight into this.

4.5.2 Coordination in UAV

When using a traditional construction contract (DBB), the general terms and conditions are mainly covered by the Uniforme Administratieve Voorwaarden (UAV). The UAV describes the standard arrangements between the client and contractor on a work.. The responsibilities and liabilities in certain situations for the parties are laid down in the UAV. The responsibilities also stipulate how coordination is set up between the parties.

Until the last decade, the UAV-1989 was used. Now the UAV-2012 is used. The biggest difference is the incorporation of the technical installation works within the UAV-2012, next to the general works. Also, some outdated sections were renewed, clarified, or removed. The differences do not have a direct effect on the subjects of this research, resulting in an elaboration on the UAV-2012 only. Below, the sections within the UAV-2012 that are connected to the responsibilities of coordination are discussed.

Coordination responsibility

Within the UAV 2012, the 'client's agent' is principally the managing party, so the client or an employer's agent. However, the UAV does leave a certain room for flexibility by stating that this could be different if it is stipulated otherwise in the specifications. This means that another party than the client can be appointed as coordinator. The paragraph that is of importance is par. 31. This paragraph states what is stipulated about the 'relation to other works'.

Chapter 9, par. 31 states:

1. *If different works interfere with each other, this is to be stated in the specifications.*
2. *If not otherwise stated in the specifications, the coordination of the interfering works is done by the employer's agent.*
3. *The contractor tolerates – without entitlement to other compensation that is meant by the next section – that third parties, to whom the employer's agent allows, that work is carried out simultaneously and in the same place.*
4. *He tolerates thereby that works and auxiliary works are used that are already made. For this usage, the contractor is able to claim additional payment, if more of him is desired than can be reasonably demanded.*

The specifications stipulate the general description of a construction project and the corresponding activities. By providing an extended explanation of the assignment, both the client and contractor know what has to be built, how, and when. Because of the specifications, a contractor knows what his responsibilities are and what is expected of him. Within the specifications, the responsibilities, authorities, and risks of the involved parties are intended to be demarcated fairly. The extent to which

the specifications are elaborated is based on the PDM. A traditional setup is explained more extended and with more detail, in comparison to a more integrated setup.

RAW specifications are used within the civil engineering sector like bridges and infrastructures. STABU specifications are used to describe the needed quality and technical stipulations on the materials used in utility constructions. The client stipulates the assignment, and the contractor builds it. Coordination can be organized within the specifications. Within the specifications, the coordination responsibility can be assigned to either the client or contractor with the needed powers. Also, an expectation on how the role has to be filled in can be stipulated. The specifications can be seen as the 'basis' and 'guideline' of the collaboration between the client and contractor.

Chapter 9, par. 31 shows that, if not stipulated otherwise, the coordination is done by the client or the client's agent. The client is ultimately responsible for coordinating the work between different contractors. Next to this, the contractor has to give a co-contractor access to his work and building site. Otherwise, the overall work might experience problems.

The section also states that contractors have to carry out their work in such a way that it does not give any unnecessary hindrance to third parties. These third parties could be seen as other contractors. It also explains that a contractor has to accept that other parties will work within the same place as them if it is allowed by the client. This is an important stipulation within the UAV when working with co-contractors. It shows that contractors have to accept each other within the project location and not hinder one another. If this does happen, claims can be made and damages could be paid.

To understand what is stipulated about the client and employer's agent, the next sections of the UAV-2012 are presented. In Chapter 2 'representation of parties' is discussed how both the client and contractor are represented. The client can appoint an 'employer's agent' who represents the client within the work.

Chapter 2, par. 3, section 4 states:
'As long as and as far as the client does not indicate otherwise in writing to the contractor, the employer's agent represents the client in all matters regarding the work. In the case where the client is named explicitly within the UAV, only the client is competent.'

Chapter 2, par. 3, section 6 states:
'An employer's agent exercises the supervision of the work and on the compliance of the agreement.'

These sections show that a client is able to appoint a person or persons, that acts in favor of the client. The client's agent represents the client in the day-to-day work within a project and the responsibilities that flow from this. The coordination responsibility as well, if not determined otherwise in the specifications. Also, the employer's agent supervises the work and whether the work is in compliance with the contract.

Support of coordination responsibility

Par. 31 of the UAV-2012 explains the general coordination responsibility. However, more explicit paragraphs and sections are included in the UAV-2012. These are elaborated on below.

Chapter 9, par. 26 explains that a planning is to be made by the contractor and needs approval of the client. Section 1 states:

'The contractor drafts an, adapted to the nature of the work, general time schedule as soon as possible. In this time schedule is clearly stated how, in which order, with which material and with what materials the contractors plans on executing the work and his parts, as well as the time he deems necessary for each part. It also states at what times and the sequence of the parts the contractor must have at his disposal for the purpose of the progress of the work, for which the client or the employer's agent must provide according to the agreement. The general time schedule must meet the requirements set out in the agreement with regard to the performance of the work, and will be provided with a proper explanation by the contractor.'

This specifies that a planning is to be made by the contractor and needs approval of the client or employer's agent. This planning consists of all the activities, the time needed for them, the materials and manpower needed. This planning has to abide by the specifications of the agreement between the parties. The client is thereby able to accept this planning or ask for changes if deemed necessary. If any changes are requested by the client after the planning is accepted that are beyond reasonably required, the contractor could claim additional payments. The planning serves as a guideline, but does not legally bind the contractor. The agreement specifications are to be abided by every party and are binding.

When working with co-contractors, the planning needs to be tuned to all activities of every contractor. This means that the coordinator has to take this into account when accepting the planning of all contractors, in the case of the UAV-2012 generally the client. Also, the planning is principally not binding (Chao-Duivis, 2013). This can cause problems when one of the co-contractors has delays, which makes it impossible for another co-contractor to carry out his work. In such cases it is useful to differ from the UAV and agree with the parties involved that the planning in fact is binding (Chao-Duivis, 2013).

Par. 26, section 7 states:

'Changes made by the employer's agent to the approved general time schedule or detailed work plan entitle the contractor to additional payment, if more is required than can reasonably be expected of him.'

If a change is made in the general time schedule by the client, a contractor might qualify for a claim. The client might have to compensate the contractor if the contractor suffers negative effects of the change. If one of the co-contractors causes a delay, the UAV-2012 states that the client is responsible towards other contractors with the use of a bilateral agreement. If this influences another contractor in a negative way, the client has to pay for this. The client, in his place, might be able to get a claim from the co-contractor who caused the delay or extra work. The UAV provides an indirect claim through the client, but a direct claim is not in place.

Next to the planning, other ways to create good coordination between parties are established within the UAV-2012. Chapter 9, Par. 27 explicates ways to communicate about the work. This can be done through reports, diaries, and meetings. Only the weekly report is obligatory through the UAV-2012. Diaries, meetings, and other reports are only deemed obligated if this is stated in the specifications of the agreement.

Chapter 9, Par. 27, section 1 states:
'The employer's agent prepares weekly reports. This includes notes regarding:

- *the progress and status of the work;*
- *the unworkable days and the granted postponement of delivery;*
- *the supply and removal and approval of building materials;*
- *the supply and removal of equipment and aids;*
- *changes to specifications, more and less work, processed quantities and provisional items;*
- *inspection, approval and delivery of the work;*
- *the provision of drawings;*
- *incidents concerning the safety and/or health of persons.'*

The employer's agent is responsible for drafting the report and providing this to the contractor. The contractor is able to make objections to the report or accept it. If the contractor has objections, he has to show the parts he objects to and the reasons why.

Chapter 9, Par. 27, section 9 states:
'If it has been agreed that meetings will be held during the execution of the work, the employer's agent will make reports of this. The reports will be presented to the contractor as soon as possible for agreement through a signature. If the contractor cannot agree with the contents of the report, a note will be added to the report stating which parts and for what reasons he objects. The report will be determined at the subsequent meeting.'

The UAV-2012 describes that meetings/consultations have to be held according to the specifications of the agreement. These meetings need to be reported and signed by the parties involved. If someone does not agree with the report, a note is made to the particular section. However, the UAV-2012 does not obligate the contractor to attend.

This still leaves a lot of room for interpretation on how coordination is done through the meetings. It is not obligated for all parties to be involved if it is not stated in the specifications, which could lead to information asymmetry and communicational problems. The UAV-2012 does not provide obligations about attending meetings. However, the UAV does stimulate the meetings and the information transparency connected to the meetings. If this is not stated in the specifications, the UAV does not obligate coordination and consultation in a physical setting but does support it through the weekly reports.

4.5.3 UAV-GC 2005

The Uniforme Administratieve Voorwaarden voor Geïntegreerde Contracten 2005 (UAV-GC 2005) applies to more integrated contractual arrangements. In principle, the UAV-GC does not lay down the responsibilities and obligations of the work with the client. With more integrated contracts, the client could be less involved in the design and execution of a project. This is why, in practice, the coordination responsibility is shifted to the main contractor, especially toward the subcontractors of the main contractor. When a project is divided into sub-projects, this responsibility changes. Coordination is necessary between the multiple contractors and interfaces that arise. A client might be the one who will coordinate this. It is important to clarify who is responsible for the coordination in this situation, the client or one of the contractors. With co-contractors, however, the main contractor does not have

any contractual relations towards a co-contractor, just like the UAV 2012. This makes it hard to include a co-contractor in the coordination process through legal obligations when another contractor is coordinating.

How the general responsibility of coordination is laid down in integrated contracts, is stated in Chapter 4, par. 8 'relation to other works'. This paragraph states:

1. *'If during the fulfillment of the agreement activities are executed by co-contractors, on behalf of the client, which may affect the work and/or the long-term maintenance, the client has to state to the nature of this work, the planned time on which they are performed, as well as the coordination thereof in an accompanying notice Request specification annexed.*
2. *When executing the work, the contractor takes into account the activities of secondary contractors referred to in section 1.*
3. *The contractor is obliged to allow co-contractors to perform the activities referred to in section 1 at the times referred to in that section. He is obliged to allow co-contractors to use the results of the work.*
   In his offer, the contractor is deemed to have taken into account the fact that the activities referred to in section 1 are carried out by co-contractors. However, he can also claim a right to reimbursement of costs and/or an extension of terms, with abidance of the provisions of paragraph 44 section 1 sub a.'

The UAV-GC does not show who is responsible for the coordination with co-contractors. This could be done by either the client, contractor, or a third party that is included in the coordination agreement. The primary responsibility is not laid down by the client. The UAV-GC does state that the client has to lay down the activities and time schedules of other contractors, as well as how this is to be coordinated. The responsibility of putting this into writing and giving notice to the contractor lies with the client. When working with co-contractors, the UAV-GC does not create any legal basis for co-contractors towards one another. The coordination agreement can create legal authority between co-contractors. When the coordination responsibility is laid down by the main contractor, the coordination agreement can give him a legal basis to coordinate with co-contractors. The coordination agreement is elaborated on in the next paragraph.

Like the UAV 2012, the UAV-GC 2005 states that a contractor has to take into account any co-contractors' works and does not cause hindrance. A contractor has to accept that a co-contractor might carry out activities in the same location and build on the work of the contractor.

To specify coordination, chapter 4, par. 7 states how the planning is to be used. Par. 7, section 1 states: *'With the execution of the agreement, the Contractor is obliged to take into account the schedule and the agreed milestone dates included in the Request specification annex.'*

Planning-wise, the UAV-GC uses milestones and dates to coordinate the planning of a project. This means that a contractor has to deliver certain parts within a certain amount of time, otherwise, measures will be taken against the contractor. This creates a binding planning for the contractors involved. Also, meeting the planning milestones can be incentivized by a reward system. So, a contractor gets a bonus for reaching a milestone within time. This has to be specified in the agreement.

The UAV-GC however, does not say anything about having weekly reports, meetings, or diaries about the progress of the work specifically. The UAV-GC refers to the request specification annex, which

is a specification with requirements on what is needed exactly. This could include specific requirements on the progress of the work, but also an explanation of the work itself. More practical instruments on how coordination is established between the parties are less extensive in the UAV-GC, in comparison to the UAV-2012.

The UAV-GC has a different approach to liabilities. The client is able to hold a contractor liable when one of the milestones is not reached within time through a certain fine. Also, if the work has any defects that could not have been detected during execution, the client can hold the contractor liable to an extended amount of 1,5 million euro or 10% of the price. This is, however, no incentive for the contractor to his responsibilities around coordination itself.

4.5.4 Coordination Agreement

The coordination agreement is an agreement that can be used when a project is carried out with co-contractors. Generally, a coordination agreement lays down what the responsibilities are concerning the coordination of the work between the parties involved. The client is mostly the main responsible one for the coordination of the work unless it is stated differently within the coordination agreement. It is possible to assign the coordination responsibility to the (main) contractor or a consultant.

Content of a coordination agreement

A general coordination agreement contains:

- Names of the client, consultant, and all the contractors who join the agreement
- The party who is assigned the coordination role
- Specifications of the job
- Content of the agreement
- Signatures of all parties

The part that differs most in practice is the content of the agreement itself. But some of the most used topics are stated below (Rijksvastgoedbedrijf, 2012; UMCG, 2013; Ministerie van Infrastructuur en milieu, 2016). Appendix J shows a model of a coordination agreement of the Rijksvastgoedbedrijf.

A time schedule or detailed work plan: Every party needs to sign the schedule or work plan. Next to this, it is often the case that something about full cooperation and collaboration is mentioned.
Tasks of the coordinator: The coordinator has to coordinate all parties, services, tasks, interfaces, and locations and integrate them. Next to this, he oversees the progress of the time schedule with the connected activities and the compliance of this.
Give notice when delays occur: Parties have to give notice to all parties when delays happen. Often, the coordinator has to schedule a meeting with all parties as a reaction to this. In this meeting measures to minimize the delay and overrun costs are discussed for the overall project. If this results in a change in the time schedule, the coordinator communicates this to the client.
Damages:

- Damages due to other parties: If a delay by a party results in damages to another party, the causing party has to compensate the other party for its damages. Additionally, parties renounce their entitlement to claim damages of the client on every legal basis, except for gross negligence of the client.

- Damages due to client: When delays in the time schedule occur due to the client, he has to compensate the affected parties. This mostly applies when a direct cause can be proven by evidence.
- Force majeure: In case of force majeure, no damages can be reimbursed.

Negligence: If one of the parties is negligent, the client has certain measures, laid down in the UAV. If the party is still in default, the client is able to force measures to make the neglecting party finish the work, or the remaining work is carried out by another party and the client terminates the agreement with the neglecting party.

Third parties: Third parties have to be named.

Settlement of disputes: Disputes are settled in accordance with the rules of the arbitration regulations of the 'Raad van Arbitrage voor de Bouw', translated 'the Council of Arbitration for the Construction Industry'.

Notes on the coordination agreement

The coordination agreements focus on the collaboration between co-contractors. It gives clarity on who is the coordinator, and what tools he has to coordinate. Because the coordination agreement forces contractors to work together, the 'softer spheres', like the communication and the collaboration culture within a project improves.

Bilateral vs. Multilateral

The client is able to decide whether bilateral or multilateral legally binding obligations follow from the coordination agreement. When choosing a bilateral form, the parties involved have a legally binding agreement with the client, but not with the co-contractors of the coordination agreement. With a multilateral agreement, the co-contractors are also legally bound by each other.

When damages have to be recovered, this is a big difference. With a bilateral agreement, the damages can only be recovered from enactment by the client, or the other party of the agreement. All parties of the coordination agreement only have a direct connection with the client. With the multilateral agreement, damages can be directly recovered from the one who caused it, within the coordination agreement. Strang (2018) described that this is one of the aspects that have to be laid down, in order to have a higher project success. However, the question is whether creating a legal link between co-contracts creates a better atmosphere in the relational context. This might lead to more mutual conflicts between co-contractors.

4.6 Conclusion of Literature Review

The literature review provides a basis to answer SQ1 and SQ2, which were:

SQ1: How is 'good coordination' established? What are the current barriers?

SQ2: What are the theoretical steering mechanisms of coordination with co-contractors?

Answering SQ1, accountability, predictability and common understanding are the leading factors to understand good coordination. It should be clear who is responsible for which part of the process and which activities have a sequential relation. Also, the parties involved should have a common view on the whole process. This last point shows the importance of alignment of the parties involved. To make this more practical, a list of requirements for good coordination is set up. Good coordination requires a coordinator to be authorized to instruct other parties, the coordinator being the most suitable party,

agreements on both the planning and technique to have multilateral alignment, parties joining a consultation structure, parties expressing their information needs, a duty to warn for circumstances that jeopardize the alignment of work, no unnecessary hindrance of activities, and a liability arrangement to incentivize parties to abide by their obligations (Strang, 2018). Also, Kamminga (2008) explained that strong commitment is needed, a project manager should be competent on a technical and social level, communication and interactions between parties should be clear, and there should be room for effective control and feedback to stimulate information supply amongst others.

Combining this, good coordination is established by having accountability through having one suitable coordinator with mandate, project managers with the right skills, and arrangements on liabilities and duty to warn, predictability through agreements on planning and technique, and having common understanding through not hindering each other, consultation and communication structures and expressing information needs of all parties, including feedback.

The second part of SQ1 is about the barriers of establishing good coordination. The found barriers when looking at the requirements of Strang (2018) are: the coordinator having no mandate, having the wrong coordinator, having no agreements concerning the alignment of planning and technique, no consultation structure, parties having no room to express their information needs, no duty to warn, unnecessary hindrance of activities, and having no liability arrangement between parties. Kamminga (2008) explained that the failure factors of coordination are conflicts, insufficient investment in project management, bureaucracy, distrust during procurement and execution, and insufficient preparation time. These are closely related to the barriers stated and need to be taken into account too.

To answer SQ2, Table 6 is set up. This provides all the steering mechanisms within the contractual, relational, personal, and governance contexts.

Table 6. Steering mechanisms for coordination

Contractual	Relational	Personal	Governance
a. The scope of the coordination assignment and the associated powers and tools	f. Early formation of integrative work practices	j. Experience	n. Clear responsibilities
b. The way decisions are made about coordination	g. The development of a common philosophy	k. Competent on a technical level (hard skills)	o. Proactive attitude within organization
c. The distribution of risks associated with coordination	h. Open communication	l. Competent on a social level (soft skills)	p. Preparation time
d. The way in which the parties deal with conflicts	i. Early and clear role expectations	m. People-oriented characteristics	
e. The way in which the parties settle disputes			

Using the steering mechanisms for each context named above, and the practical applications from the previous paragraphs, a theoretical framework is set up. This framework represents the theoretical view on coordination and how this could be strengthened within each context, see Figure 18. The green part represents the contractual context, the purple part the relational context, the red part the personal context, and the blue part the governance context.

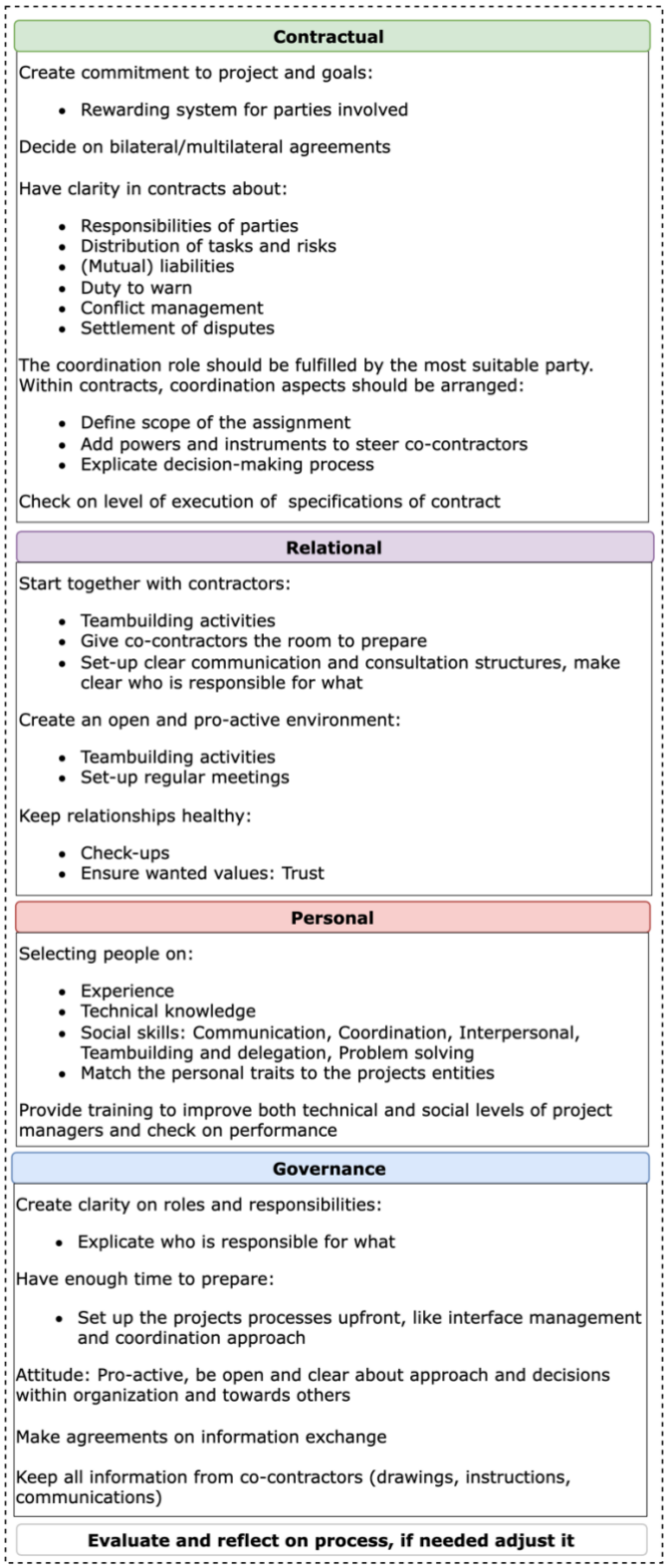

Figure 18. Theoretical framework

PHASE 2: Case study

5. Case study set up

This chapter explains which projects are part of the case study. First, the used selection criteria for the projects are presented in paragraph 5.1. After the selection criteria are explained, the selected projects are presented and elaborated on in paragraphs 5.2 and 5.3. The characteristics of each project are explained, like the location and type of project, involved parties, the contract entities, and the complexity of the projects.

5.1 Selection criteria for projects

As explained earlier, multidisciplinary projects with multiple contractors experience coordination issues. To look at this more extensively, some projects of the municipality of Rotterdam are used for the case study. The municipality of Rotterdam is one of the larger public clients in the Netherlands. The projects have to meet certain selection criteria to create representative cases. The selection criteria are summed up below:

1. Project entities: The project is a multidisciplinary infrastructure project. Multidisciplinary projects need more coordination compared to smaller projects. This results in the increasing importance of the relational aspects of collaboration (Arts, 2007; Azim et al., 2010).
2. Multiple contracts: The project is divided into multiple sub-projects and has multiple contracts and co-contractors. With this, interface management and aligning both the contracts and managerial options is a necessity (Huang et al., 2008).
3. Contractual content: Next to the contract itself, a coordination agreement or collaboration addendum is used during the execution phase of the project highlighting coordination.
4. Client involvement: The public client is involved during the execution of the project. With the client being involved, interactions between the client and co-contractors during execution can be mapped. This also reflects on how the contract is used during execution.
5. Complete and available data: The project is completed. This ensures a full picture of the project's progress. The data of the project needs to be available to view. The contracts, reports on meetings, interface documents, evaluations, etc. need to be accessible (Flyvbjerg, 2006).

5.2 Selected cases

Based on the selection criteria stated above, four projects are selected for the case study. An important note for selecting the cases is that information-oriented selection is used (Flyvbjerg, 2006). This implies that the selection is made on the expectation of the information content in each case. All projects are finished, are multidisciplinary, have multiple contracts with coordination agreements or collaboration agreements, have client involvement during the execution, and have available data. The chosen projects for this study are:

Case 1: Hoekse lijn Phase 1
Case 2: Hoekse lijn Phase 2: Metro aan Zee
Case 3: Renovation Maastunnel
Case 4: Rotterdam Centraal Station

The table below shows to which extent the projects met the selection criteria.

Table 7. Check on selection criteria cases

	Selection criterion				
Project	1	2	3	4	5
Hoekse Lijn	+	+	+	+	+
Metro aan Zee	+	+	+	+	+
Renovation Maastunnel	+	-/+	+	+	+
Rotterdam Centraal Station	+	+	+	+	-/+

NOTE: + indicates completely and -/+ partly. Renovation Maastunnel has -/+ on criterion 2 since the project is split up into multiple contracts, but a lot was put into one big contract. Rotterdam Centraal Station has a -/+ on criterion 5 because not all project documents could be retrieved and some important project managers on the project were not available for interviews.

5.3 Case description

This paragraph provides an overview of the four cases used in this research. Each case is elaborated upon. Table 8 below shows general information on the cases.

Table 8. Case overview

	Type of project	**Number of relevant contracts**	**Contract type**	**Number of clients**
1: Hoekse lijn phase 1	Conversion from train to subway tracks + subway stations	7	Traditional: RAW (UAV) & UAV-gc	3: Municipality of Rotterdam, ProRail & RET
2: Hoekse lijn phase 2: Metro aan Zee	Construction of subway + subway station	3	Traditional: RAW (UAV) and D&C	2: Municipality of Rotterdam & RET
3: Renovation Maastunnel	Tunnel renovation	3	Part traditional, part D&C with a tailor-made agreement	1: Municipality of Rotterdam
4: Rotterdam Centraal Station	Station renovation	7	Traditional: UAV & D&C	2: Municipality of Rotterdam & ProRail

5.3.1 Case 1: Hoekse Lijn Phase 1

The Hoekse lijn project is a conversion of a train track to a metro/subway track. The track runs from Schiedam, through Vlaardingen and Maassluis, to Hoek van Holland Haven, see image 1. This new subway connection enlarges the Rotterdam subway network. The new connection increases the overall passenger count, shortens the commute and travel time, and creates a direct connection to Hoek van Holland. The project was planned to be finished in 2017, with a duration of 5 months for the execution period. However, due to delays, the finish date became later. The complex part of the Hoekse lijn arose with the length of the conversion, over 20 kilometers, and the number of sub-projects that had to be integrated.

The municipality of Rotterdam was the client on this project, together with the RET and ProRail. The MRDH (Metropool Regio Rotterdam Den Haag), RET, and Municipality of Rotterdam were the responsible parties for the realization of a working transportation system. Next to this, ProRail was the administrator of the train tracks before the Hoekse lijn subway started running. ProRail helped with the preparations before execution. The local municipalities were responsible for their sub-projects within their municipality, like the station's surroundings.

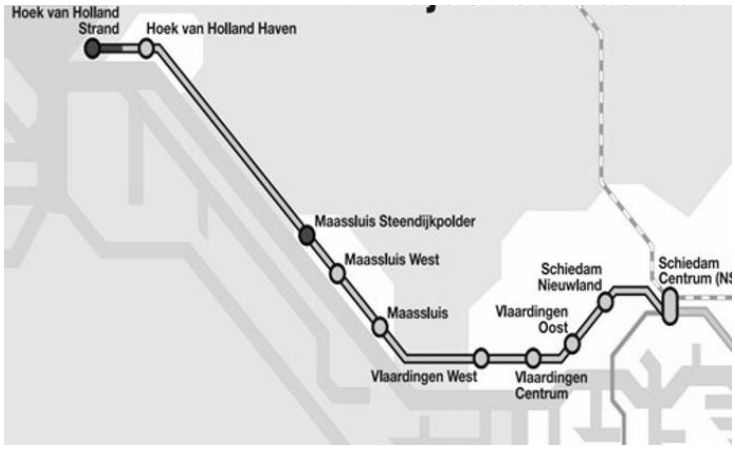

Image 1. Phase 1 Hoekse lijn (adapted from Rijnmond, 2017)

Contractual setup

The Hoekse Lijn project is divided into different work packages that are predominant in the different contracts that are set out. These work packages are contracted by the prime clients: RET, ProRail, and PbHL from the municipality (Projectbureau Hoekse Lijn). The clients put the different contracts of the combined work packages on the market.

The biggest contract was the conversion of the tracks and realizing the stations (Contract 5/6), contracted by PbHL. Other important contracts are the preload of Schiedam/Vlaardingen East and West, connecting the tracks to the existing track network at station Schiedam Centrum, lines and cables, track security, traction and energy, and supplies. Figure 19 shows relations between the clients and contractors in general.

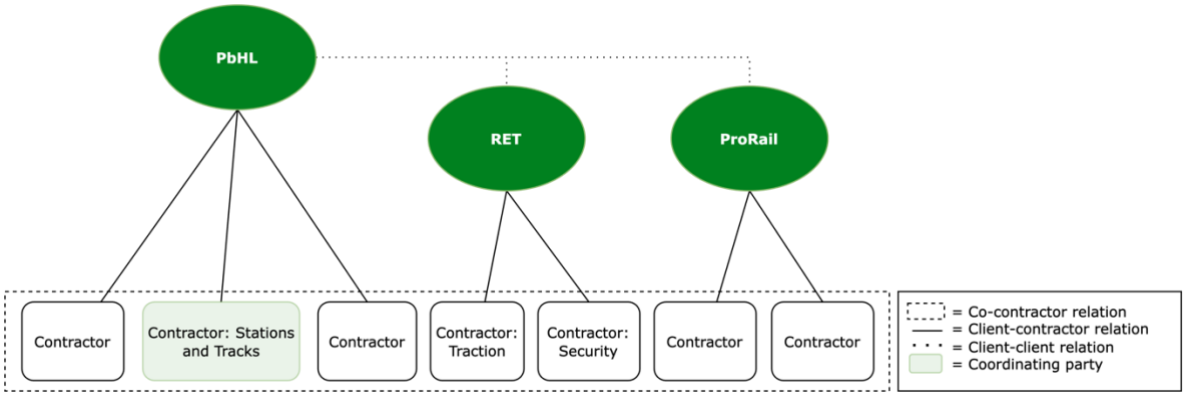

Figure 19. Relation of Client-Contractors of the Hoekse Lijn

Most of the contracts contracted by PbHL are traditional RAW specifications with a UAV-2012. With this, the client is responsible for the detailed design and the contractor constructs accordingly. The contractor of C5/6 was also responsible for the coordination between all the contractors, as stipulated in the specifications. A coordination agreement was signed. Next to the attached coordination agreement, there were no addendums to the contract about coordination, collaboration, or other concepts related to the managerial context during the start. The standard UAV conditions were applicable. The client has a lot of responsibility with the more traditional contract. He is responsible for the demonstrability of the construction and the paperwork that comes with it, amongst other things.

RET and ProRail, on the other hand, contracted mostly integrated contracts like D&B with a UAV-GC. This indicates that the contractor is involved in the design phase and gets more responsibilities, also on demonstrability.

5.3.2 Case 2: Hoekse Lijn Phase 2: Metro aan zee

The Hoekse Lijn phase 2 project is about the extension of the Hoekse lijn from Hoek van Holland Haven to Hoek van Holland Beach, see Image 2. The project is called 'Metro aan Zee', which means the subway next to the beach. The project also included a new subway station next to the beach. The project was finished at the beginning of this year (2023). The first subway with passengers went on March 31, 2023.

The complexity of the project increased due to the many contracts that needed to be integrated, the Natura-2000 area the tracks flow through, the unique conditions of the environment which required special designs, and the changing regulations about tracks.

Image 2. Metro aan Zee project (Source: Project plan MaZ)

Contractual setup

The project Metro aan Zee has two clients who have procured several contracts. The clients are the project team of the municipality of Rotterdam (MaZ) and the RET. The biggest contracts are C8, C14, and C15. C8 includes the construction of the stations and tracks between Hoek van Holland Haven and Hoek van Holland Beach. This contract is contracted to the combination Boskalis Swietelsky, by MaZ. C14 and C15 involve track security and the energy supply (traction) and are contracted by the RET. Figure 20 shows the contracts of Metro aan Zee. An important note, MaZ of the municipality was ultimately accountable for all contracts, politically and financially. Maz had to integrate all contracts and demonstrate the safety and functionality of the systems. However, the RET controlled the contracts they contracted themselves.

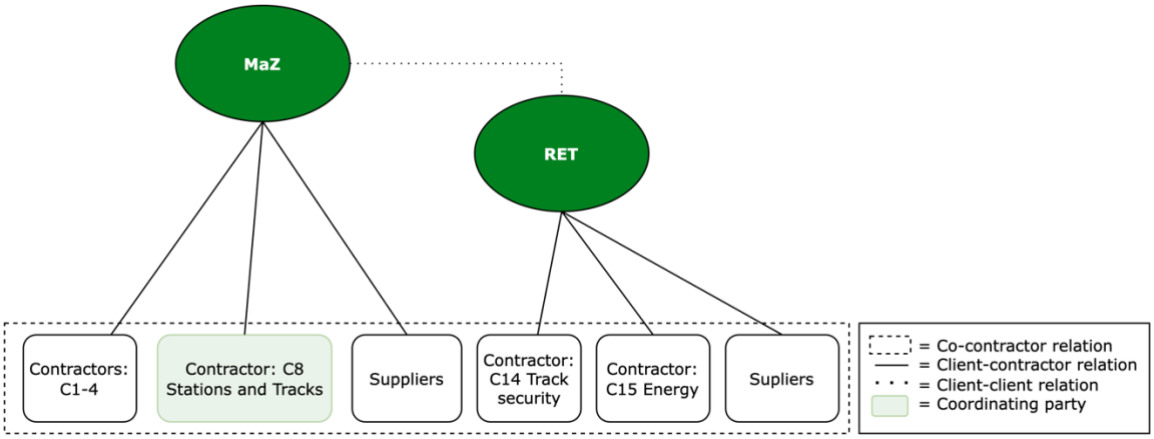

Figure 20. Contracts of MaZ

The contracts contracted by MaZ are mostly traditional RAW specifications with a UAV. The responsibility stayed with MaZ, both on the design responsibility and demonstrability of safety and functionality. However, for the C8 contract a 'plus' was added. A part of the project management in the area of system engineering became part of the contractor's job. The document management, verification of the system, and the testing and check on the C8 contract. This 'plus' within the contract was part of the specifications of the tender. Also, a coordination agreement was signed, which stated that the contractor of C8 was responsible for coordination of. The coordination role during the execution was part of the contractor's job. MaZ still had the task of integrating all systems and merging the demonstrability of the C8 part with all other parts.

The RET mainly contracted D&C contracts. The contractor was involved in the design stage and had more responsibility, also with demonstrating safety and functionality. A note on C14 and C15 contracts is that they originate from the Hoekse lijn project. These contracts were procured integrally for both Hoekse lijn and Metro aan Zee. So, the same contractors were involved in both projects.

5.3.3 Case 3: Renovation Maastunnel

The renovation of the maastunnel is a tunnel renovation project connecting the south of Rotterdam to the city center, see Image 3. The execution period was about two years, starting in July 2017 and ending in 2019. The municipality of Rotterdam was the client of this project. The concrete of the tunnel began to rot and the technical systems were outdated, so renovation was necessary. The main job was to repair the concrete and do maintenance on the technical installations of the tunnel. Also, the control center was renewed. Especially because of the new regulations concerning tunnel safety, updates on the technical systems were necessary.

The project was complex because of the tunnel being a 'rijksmonument' and the important role of the tunnel in the road network of Rotterdam, which made the societal pressure on the project high. This required little traffic nuisance and excellent coordination of all activities. During the renovation, one of the two tubes was open for traffic at all times.

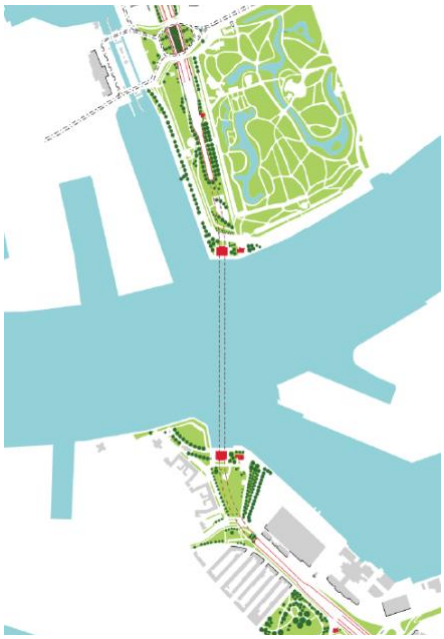

Image 3. Maastunnel renovation (Source: Project plan Maastunnel)

Contractual set up

The procurement of the Maastunnel renovation was focused on finding a construction partner, not just a contractor. The municipality wanted to realize the project together with the contractor. The candidates had to write a project approach in which the aspects of planning, quality, integrality, and collaboration were discussed. KIS was an important part of the tender, which stands for the direction on quality, integrality, and collaboration (sturen op kwaliteit, integraliteit en samenwerking) (COB, December 2016).

The main contract involved the restoration and renovation of the tunnel itself and had an integral character. The contractor boarded during the convergence phase and covered the execution phase, as well as a part of the conservation. The main contract was procured to CAM (Combinatie Aanpak Maastunnel, existing of the contractors Croonwolter&dros, Mobilis, and Nico de Bont), who had the best overall bid on the selection criteria. Next to this contract, another contract was set up for the traffic systems and suppliers, see Figure 21.

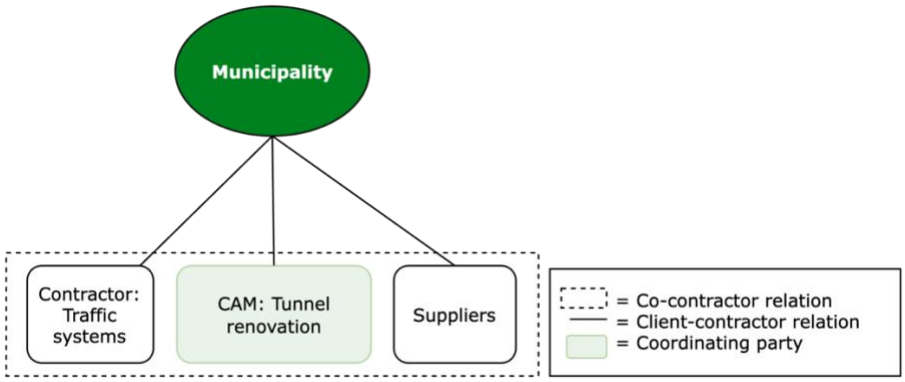

Figure 21. Contractual setup of the Maastunnel renovation

The agreement for the main contract did not have specifications with UAV or UAV-GC but came with a customized, tailor-made agreement. The agreement focused on collaboration and realizing the project together. The contract stated that the parties have to collaborate to realize the project (section 3.4 of the contract). In the contract, collaboration was defined as:

- How parties interact with each other in general,
- How parties hold consultations with each other,
- How parties exchange information,
- How parties warn each other of possible imperfections or inaccuracies.

Next to the way collaboration is established, the parties are provided a workplace where both the client and CAM work during the convergence and execution phase. Collaboration within the renovation of the maastunnel was seen as the total of collaboration maturity and empathy.

Another interesting part of the contract was the added incentives for both the client and the combination. Next to the known fines for contractors not meeting certain milestones, the client could also be fined for delivering certain aspects too late, if the delay could cause to a delay for the contractor. For example, the municipality itself also could be fined when delivery of the construction site was too late. €50.000, - had to be paid for every day of a too-late delivery. This was installed to show equality between the client and CAM. Also, positive incentives were installed for the contractor. CAM would be paid extra for early commissioning.

5.3.4 Case 4: Rotterdam Centraal Station

In 2004, the reconstruction of Rotterdam Centraal Station and the area around it started. The execution of the project took around 10 years in total, finishing in 2014. Due to the increase in running trains, increase in passenger flows, and the Randstadrail project, Centraal Station needed to be reconstructed. The goal of the project was to increase passenger capacity and to be future-proof. ProRail and the municipality of Rotterdam were the clients on this project.

The reconstruction took 10 years because, amongst other things, the station stayed open for its users. This made the project extra complex. The station is located in the middle of a metropolitan area. The project had to affect its surroundings and the passenger flows as little as possible. This led to a very intense design and planning phase. During the execution, the pressure was high. Next to the area being complex, the alignment of all sub-projects of Rotterdam Centraal and the projects around added to the complexity, see Image 4.

Image 4. Rotterdam CS reconstruction (Source: Project plan Rotterdam CS)

Contractual setup

Project Rotterdam Centraal Station (CS) has multiple sub-projects with different contracts with two different clients, OBRgw from the municipality of Rotterdam and ProRail. The biggest sub-projects with OBRgw being responsible are the OV Terminal (OVT) on the city side, the connection to Metrostation CS, the bike parking, the Weenatunnel construction, the Kruiskadeparking, and the outdoor space arrangement incl. cables and pipes. ProRail was the client on the OV terminal on the rail side of the station. This is shown in Figure 22.

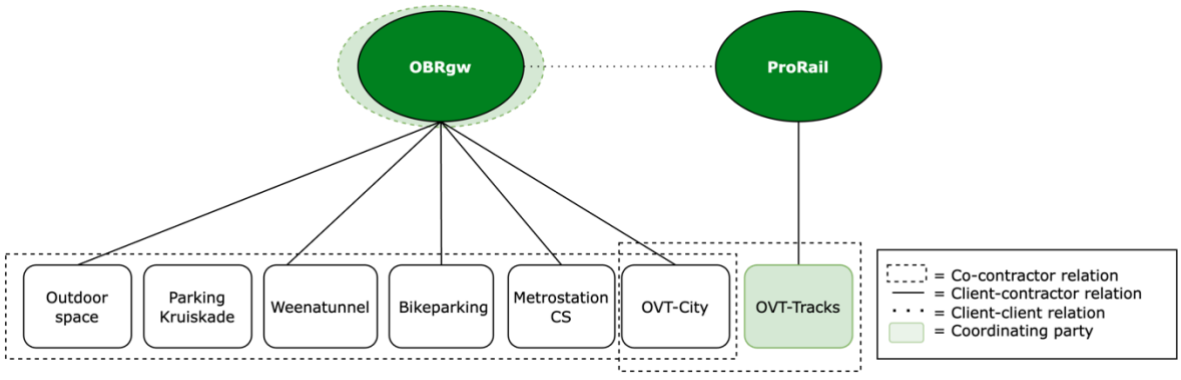

Figure 22. Sub-projects of CS with the responsible clients

OBRgw used a more traditional DBB project delivery method. RAW and STABU specifications were set up with UAV-1989 for these contracts. The OVT-city was procured to a Belgian contractor named Lemants. ProRail, on the other hand, used a D&C arrangement for their part on the OVT. This was procured to the combination BTRC (Bouwcombinatie TBI Rotterdam, Centraal). The boundary of the contracts on the OV terminal is shown with the red line in Figure 23. The upper part belonged to ProRail, and the lower part to OBRgw.

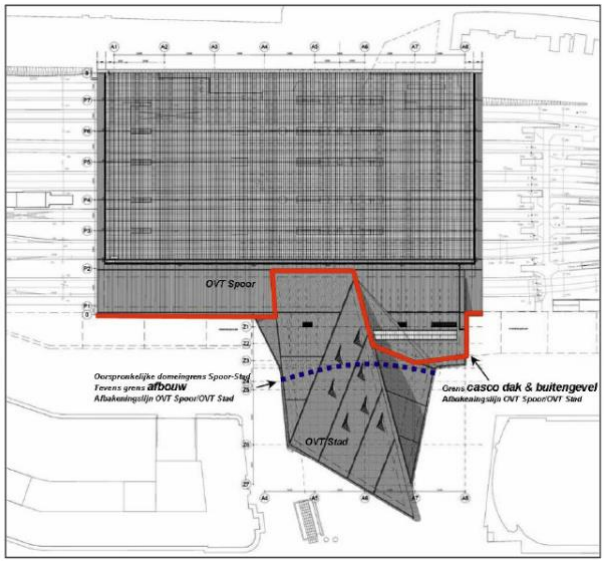

Figure 23. Contractual boundary of OVT (Source: Project plan RCS)

The contracts were of a traditional nature. No addendums were added to the contracts of OBRgw. One interesting thing was the little space. Not all contractors had their own building site or storage space. This required clear guidelines on allowances in each other's working space. The OBRgw was responsible for all their contracts and the coordination between them.

For the part of the OVT, a coordination agreement was set up between ProRail, OBRgw, and their contractors. With different contact forms and different contractors, coordination is needed. The coordination agreement supported this by having clear guidelines and rules.

6. Case study results

This chapter shows the case study results. Within this research the case study is used to get a deeper insight into the coordination process of multidisciplinary construction projects and to identify the key issues of current coordination. Also, the cases are used to see what the effects of both contractual and managerial instruments are on the coordination process. For each paragraph below, the case its coordination aspects are elaborated on, following the themes of the interview codings. First, the interview codings are described, which result in four themes. After this, the case results are shown.

6.1 Interviews codings

The interviews were coded with the analyzing approach explained in the methodology chapter, following the steps of Braun & Clarke (2006). The outcomes of the 1st coding round, the 2nd coding round, and the clustering of them into themes are shown in Table 9. The codes are clustered on similarity and regularity. With this, the links are analyzed and the overarching themes are created.

Table 9. Coding Scheme of interviews. NOTE: Appendix F shows how many interviews mention each code of the first cycle.

1st cycle coding	2nd cycle coding	Theme
being together - communication - flexibility - equality - common goals - openness - collaboration - trust	1: Values for cooperation	Relational context
agreements - measures - monitoring - consultation - planning - methods - directing	2: Cooperation support	
goals\ethos of parties - attitude - mindset - opportunistic behavior - underlying problems contractor - reputation - atmosphere	3: Behavior	
controlling parties - coordination/alignment of contractors - coordination assignment - suitability of coordinator - interfaces	4: Coordination approach	
honesty - understanding - long-term vision - humane	5: Emotional intelligence	Personal context
competences - fitness of parties - content-oriented - being skilled - level of fulfilling role - personality - selection procedure	6: Choice for people	
contractual arrangement contractor - coordination agreement - clarity and precision - humane representation - incentives - collaboration agreement - responsibilities of parties	7: Contract properties	Contractual/legal context
D&C - traditional agreement - two-phase agreement - UAV - UAV-gc	8: Contractual approach	
tendering - contractual strategies - unambiguousness - division in contracts	9: Procurement approach	
alignment of clients - organization	10: [project/client] organization	Organizational support (Governance)
evaluation - knowledge retention	11: Knowledge management	
working integrally - system integration - uniqueness of project	12: Multidisciplinary approach	
project preparation	13: Pre-execution stage	

The outcomes of the interviews show four main themes. These themes are:

1. Legal context: This theme focuses on how the procurement approach, contract procedures and their characteristics affect the coordination process.
2. Relational context: This theme describes how the relations are between the parties involved and its effect on the coordination process.
3. Personal context: This theme focuses on personal characteristics and how individual people are selected for projects.
4. Organizational support: This theme is about how an organization adds to project results and its coordination process and how the organizational arrangements influence this. Within the literature review, this is called governance.

Quotations for every case are used to show what is said about the themes by the interview participants. The participant IDs are used to show which participant said what. Since the interviews were done using the Dutch language, the quotes are translated into English in the report.

Table 10 shows the participant ID, and to which case they are linked. Some participants worked on multiple projects in the case study. However, due to traceability, these participants have been given a new participant ID for each case. In total, ten different professionals participated in the interviews. Some participants were interviewed for two cases.

Table 10. Participant overview with IDs

Participant number	Case	Participant ID
1	1: Hoekse lijn	PM1-A
2	1: Hoekse lijn	PM1-B
3	2: Metro aan Zee	PM2-A
4	2: Metro aan Zee	PM2-B
5	2: Metro aan Zee	PM2-C
6	2: Metro aan Zee	PM2-D
7	3: Renovation Maastunnel	PM3-A
8	3: Renovation Maastunnel	PM3-B
9	4: Centraal Station	PM4-A
10	4: Centraal Station	PM4-B
11	4: Centraal Station	PM4-C
12	General	JU-1

6.2 Results of Hoekse lijn

This paragraph shows the results of the Hoekse lijn case. The experienced coordination issues and the perceived experience around every theme (contractual, relational, personal, organizational) of the Hoekse lijn project are elaborated on using interviews and document research.

Legal context

The interviews show that interface management and coordination of the co-contractors was hard due to the unambiguousness of the specifications of different contracts used for the sub-projects. PM1-B explained that collaboration on the interfaces was hard due to parties not being obligated to come together on a regular basis.

"... what didn't go well at the Hoekse Lijn is that this was not clearly stated in all contracts due to the lack of unambiguousness."
~ PM1-B

The contracts show that the requirements on demonstrability, coordination with other parties, like the communication structure, consultation structure, and information sharing were not unambiguously stated. This resulted in no effective legal instruments for the client to bring the parties together.

Also, the differences in the PDMs of the contracts appeared to have given problems. The investigation of Gemeente Rotterdam on the Hoekse lijn (2018) stated that the interfaces were not managed well and parties did not coordinate on the interfaces in a proper way, due to the lack of alignment of the different contract forms. Parties did not consult with each other during the execution phase, which is especially necessary when the PDMs are different and follow different principles.

"In that sense, in retrospect, it is better to choose within the contracting strategy of doing everything within D&C," … "Or you simply make specifications like we have, but preferably all with the same contract form."
~ PM1-A

Next to the differences in the specifications of the contracts PM1-A, PM1-B, and PM1-C explained that the coordination role of the contractor, including interface management, as stated in the coordination agreement, has not been fulfilled up to standard. This is supported by a report document of the Steering Committee of the Hoekse lijn, 2017, and a progress report on the Hoekse lijn of March 17, 2017.

A lack of overall interest in the project is mentioned as one of the reasons why the contractor did not fulfill his coordinator role. This came forward in correspondence between the project manager of the Hoekse lijn and the alderman of mobility, sustainability, and culture on May 3, 2017. The contractor focused more on his own activities and contract, above others. The role of the coordinator conflicted with his own interest. PM1-A also stated this.

"…They do not feel integrally responsible." - About the contractor being the coordinator
~ PM1-A

Another reason as to why the contractor could not fulfill the coordination role, PM1-A and PM1-B stated the lack of mandate and instruments of the contractor on steering other parties. The coordinator did not have the right instruments to fulfill the coordinator role within the Hoekse lijn.

"...and then you put it into practice. Then you find out that the party that has the coordination role cannot actually fulfill it, because he does not have any mandate over the other contracts."
~ PM1-A

The results on the legal context of the Hoekse lijn show that due to not having unambiguously stated specifications within the contracts, not facilitating the alignment of co-contractors, and not choosing the right coordinator, a suboptimal coordination process is realized.

Relational context

The relational context of Hoekse lijn was perceived as non-collaborative and closed by PM1-A, PM1-B, and within the documentation of the project. One of the findings of an external report of AT Osborne on the feasibility of planning of the Hoekse lijn in September 2017 showed that the common thought on the project interest was lacking. Commitment of all parties is needed to complete the project in time. This, however, failed. An 'island culture' existed. Both leadership and the culture itself were not stimulating the 'best-for-project' mentality and were not propagated to the parties involved. As shown in the literature review, having common goals is one of the main contributors to better collaboration (Kamminga, 2008). The quote below of PM1-B supports this. PM1-A and PM1-B named working on one location with all contractors involved as a critical element that was missing in the Hoekse lijn.

> *"... at Hoekse Lijn there was actually little attention for mutual goals and collectiveness. You also noticed that in the working method, little attention was actually paid to the soft side. That has paid off in massive delays and poor working relationships…"*
> ~ PM1-B

PM1-A enlightened the little attention to the 'human side' within the project. It appeared that the way of collaborating, the values of collaboration, and how people want to work together were never explicated. Next to this, both PM1-A and PM1-B explained that people who pay attention to the softer 'human' side were missing, and the people who had to work together did not always seem to get along.

> *"We didn't have a mix of people who also paid attention to the relational atmosphere and the work ethic and how everyone was in the game."*
> ~ PM1-A

By switching people up and coaching sessions an attempt was made to make the relational spheres and collaboration better. This, however, did not work in the long term, according to PM1-A and PM1-C. They explained that everyone fell back into their own habits and the 'island culture' remained.

Next to the lack of mutual goals and the little attention to the human side, the mindset of the people involved was an issue. PM1-A, PM1-B, and PM1-C all made the connection between people's mindset and the attitudes of the PbHL and the RET, the clients on Hoekse lijn. PM1-A explained there was no cohesion between the clients on how to execute the project and who was responsible for what. Discords between the clients resulted in the co-contractors also being hesitant. The unclear guidance of both clients also contributed to the 'island culture', as shown in the report by AT Osborne (2017).

The results on the relational context of the Hoekse lijn show that a common goal between parties was missing. Due to the lack of cohesion an 'island culture' was created. The 'human side' got little attention. Attitudes were non-collaborative. Working on one location with all parties was seen as a critical missing element.

Personal context

All the interviewees explained they were selected because of their previous experiences and their network relations. They mentioned knowing what someone is worth as a pro. PM1-C called it 'Us knows us', which is the Dutch phrase "Ons kent ons". All interviewees explained that soft skills and the 'right

mix' of people were not really taken into account for the selection of project managers. The report on the Hoekse lijn by the Gemeente Rotterdam (2017) saw the project managers of Hoekse lijn as skilled and experienced enough to work on the project, so this did not seem to have a big influence on the coordination issues themselves.

The interviews showed the lack of connection between the mutual clients and the contractors. The people of the RET and PbHL did not seem to click. PM1-A explained that they were not able to set their personal feelings aside and move forward. This radiated towards the contractors and the overall project atmosphere. There was a need for unambiguous leadership, also stated in the progress reports of Hoekse lijn, 2017. But this did not come off the ground and the clients were not aligned, as mentioned in the interviews. PM1-B suggested that, in order to work together, a good collaboration of the people in higher places of the project is needed. Next to this, PM1-B explained that as a client, you have to be flexible and have to be able to think along with the contractors. Otherwise, it results in an even more rigid relationship.

As a client, it appeared to be important to have a deeper understanding of your contractors and their behaviors. When issues occur, you have to know what you are dealing with. This requires openness, transparency, and in the end trust. They were seen as very important for the relationship with the contractor, but also as a critical factor for project success by the interviewees. This goes both ways, from client to contractor and from contractor to client. Pursuing this within Hoekse lijn has, however, not been a priority according to the interviewees.

> *"It also requires a bit of transparency. How are things under the bonnet? The car has a nice shine and new paint, but if the underside rusts out, we have a bigger problem. So just tell me what's going on and we can deal with that. "*
>
> ~ PM1-A

The results on the personal context of the Hoekse lijn show that people were selected based on experience and their network relationships. PbHL and RET were not able to get over their mismatches of people and radiate unambiguous leadership from the client's side. Understanding each other and the values of openness, transparency, and trust appeared to be very important, but were not pursued enough within the Hoekse lijn.

Organizational context

During execution, issues arose due to the governance not being in place. Neither the RET nor the PbHL succeeded in creating a governance structure that fitted the Hoekse lijn, according to PM1-C. It was not clear who was in charge of what and who would take the lead during execution. The governance structure of the project was unclear, which led to unclear responsibilities, no communication on the interfaces, and little collaboration. Because of this, all contractors only focused on their activities, and the 'best-for-project' culture and coordination on the interfaces were never pursued, see the quote of PM1-A below. This was also shown in the progress reports of the Hoekse lijn and in the study of Gemeente Rotterdam (2017).

Especially since the RET and PbHL had different opinions because of their differences in goals and differences in work methods and culture, it was hard to find an unambiguous approach, according to PM1-A.

> *"... If you are going to do that conversion with two captains, it will not work. So, everyone kind of retreated to their own territory."*
> ~ PM1-A

> *"The difficult thing about the Hoekse lijn was that you had two cliental organizations and also contractors" … "There were a lot of opinions. The difficult thing was that it was unclear to everyone who was in charge."*
> ~ PM1-C

The project team on the client's side also had issues with the structure. The escalation lines were unclear, according to PM1-A and PM1-C. There were a lot of people involved on different levels of the municipality and there were a lot of groups to report to, like steering groups, directive groups, and organizational groups. Also, the progress reports on the Hoekse lijn of 2017 show that there were no clear organizational lines within the municipality, and the structure had changed a lot throughout the project. This resulted in indecisiveness because it was not clear who had the mandate to make certain decisions. Audits, notes, and mail traffic about the Hoekse lijn showed the unclarity through multiple questions; Who do I have to report to? What are the escalation routes? Who is my point of contact for which issue? Who is responsible for this part? The escalation route was also mentioned as an issue within the interviews. PM1-A and JU-1 enlightened that coordination is no direct trigger for escalation; Only time, money, and quality were direct trigger. Next to this, if escalation took place, no real response was given within the municipality, or the response came too late, according to PM1-A.

A last point of attention within the organizational context is the preparation of a project. The interviews showed that the pre-execution phases need more attention, especially interface management. PM1-A said that it is important to start with a blank sheet and arrange a project-specific coordination and interface process since every project is unique. PM1-A and PM1-C enlightened that this went wrong at the Hoekse lijn. Too many interface management processes had to be arranged while the project was in the execution phase. This is one of the reasons, according to PM1-C, why interface management never really succeeded. The quote below shows PM1-C's expression on interface management.

> *"Everything at Hoekse lijn had to be organized while being on the moving train…"*
> ~ PM1-C

The results on the organizational context of the Hoekse lijn show that the clients differed in cultures, work methods, and goals, which resulted in no cohesive and clear management. Coordination was not a direct trigger for escalation and the escalation routes were unclear and not functioning well. Too little attention was given to the start-up of the project, especially on the aspects of interface management.

6.3 Results of Metro aan Zee

This paragraph shows the results of the Metro aan zee case. The experienced coordination and the perceived experience around every theme (contractual, relational, personal, organizational) of the MaZ project are elaborated on using interviews and document research.

Legal Context

A big issue within Metro aan Zee appeared to be the demonstrability of the safety and functionality of all parts of the project and integrate this. This came forward in reports on progress meetings from the MaZ between 2020-2021 and the interviews. PM2-C stated that due to the differences in who is responsible for the demonstrability, differences in PDMs, and the way contractors realize this within their contract bounds, it is hard to integrate all parts to a whole. The next quotes are about de issues with integrallity.

> *"Then there is always the question of how was that set out and how is that secured in the other contracts. If those two large contracts are D&C contracts, then it was requested differently."*
> ~ PM2-C

> *"So, it was a very complex situation in the relationship, the contracts, the noses were not directed the same way."*
> ~ PM2-A

Both PM2-C and PM2-A connected the issues to the contracting strategies used. They explained how demonstrability and its responsibilities, and how to integrate all parts into a whole, needs to be taken into account before the contracts are set out. This was not done sufficiently for MaZ.

The municipality had high expectations of the coordination of the contractor of C8, as explained by PM2-A and PM2-C. The EMVI-submission of the contractor was impressive and one of the main reasons why this contractor was granted the contract. During execution, it became clear that there was a difference in the expectations of MaZ. What they meant with the described the requirements and the way in which the contractor fulfilled his role deviated. As shown in various reports of construction meetings in 2020, the client explained their concern about the EMVI requirements not being fulfilled. However, this did not result in better coordination. The next quotes are about this issue.

> *"You have discussions about how it is written in a contract, and not focusing on coordination itself. You write something down in the contract and you mean something by that, how is that interpreted and taken over?"*
> ~PM2-C

> *"From day 1, it did not come off the ground. They did not do what we asked and that consumed a lot of energy."*
> ~PM2-D

The interviews and reports of the construction meetings of 2020 suggest that there was a misinterpretation on how MaZ expected the coordination role to be fulfilled, and how it was fulfilled in reality by the contractor. MaZ dealt with this by taking on a facilitative role in coordinating the different

parties. The discussion with the coordinating contractor started about the misinterpretations of the requirements in the contract. This led to the contractor being monitored. However, the participants of the interview explained that was hard to take legal measures against the contractor because of the default due to the difficulty of proving the contractor did not fulfill his role. The contract did not explicate this.
PM2-A and PM2-C both mentioned a switch in personnel of the contractor as a contributor to the issues of not complying with the EMVI-plan. They stated that the foreman of the contractor, who was leading during the tender phase, left, which resulted in a different dynamic and different fulfillment of the roles and responsibilities of the contractor.

The results within the legal context of MaZ show that coordination problems occur due to the misalignment of contracts regarding demonstrability and functionality, and misinterpretations of the requirements on how to coordinate. The coordination did not come off the ground during execution due to, amongst others, changes in personnel on the contractor's side.

Relational context

Within the relational context, Metro aan Zee experienced multiple issues that affected the coordination process with co-contractors. The first thing that was mentioned as a burden on the relational context was the continuance of contracts, and with that people, from the Hoekse lijn, according to PM2-A, PM2-B, PM2-C, and PM2-D. The non-collaborative attitude and rigidity came partly from Hoekse lijn and the negative atmosphere became 'normal'. Collaboration was seen as a struggle, between the mutual clients and the clients and contractors. A progress report of April 2019 showed the need for extra attention to collaboration during the execution since parties still tried to focus on their own tasks and responsibilities and did not put effort into finding common grounds and goals to create a better environment.

Coaching sessions did not work. Advices, reports, and warnings seemed to be counterproductive, according to PM2-C. It resulted in an irritated sphere and distrust between parties. This is the cause for a lot of other issues, following an evaluation of management team MaZ on 30th May, 2023.

Another issue that influenced MaZ was the goals of the parties involved not being aligned. PM2-A described this as the most important factor in the relations. This already started at the client's side. The RET and MaZ did not have the same overall goal. Everyone acted in favor of their own goals, also the contractors, so the parties did not feel the necessity to come together.

"If you want to work together, then those goals, the highest level of abstraction, you must have in common. If that is not the case, you can organize all kinds of sessions and drinks, but then everyone will continue to set their own goals." … "That is perhaps the most important part where it went wrong, those goals."

~ PM2-A

PM2-C explained that, next to the rigid attitude of people and the misalignment of common goals, not being together physically had of big influence on the relations and collaboration. Covid-19 created restrictions on the construction site. Everything had to be done online and through MS Teams meetings.

This put even more pressure on the organization, and the coordination and collaboration, as explained in the progress reports on MaZ in 2020. The next quote is about being together.

> *"When working together, it is very important that you are together, physically, in the shack and on the construction site."*
> ~PM2-C

PM2-A explained that they tried to change the relations and the closed atmosphere between the municipality and the RET. The problems with the RET and their non-collaborative attitude were presented to the directives. The need to intervene was weighed against the interests of the RET and the municipality.

An important note of PM2-A and PM2-C is that the human aspect is important within relationships. When you can relate to someone on a personal level, your attitude becomes more open and you are willing to help a person. Showing empathy towards one another helps on a personal basis, but also on a professional basis when you have to help each other, according to PM2-A. When having a deeper understanding of what is going on with all parties involved, you are better able to act on it. Within MaZ this was tried by an app to track everyone's well-being. However, the overall relations between the parties were not influenced by this, according to construction meetings of Metro aan Zee in 2020-2021.

> *"It is useful if you can look into each other's worlds."*
> ~ PM2-C

Another factor that appeared to be an influence on the attitudes of parties was trust. With mutual trust, people tend to listen to each other better and feel like you will help them when needed. Being honest and open makes sure all issues come to light before those issues become bigger problems, according to PM2-B. A progress report on a construction meeting in July 2021 shows that the contractor had a bit of distrust towards the client. Due to not conforming with earlier made agreements and the disapproval of dossiers.

The results within the relational context of MaZ show that there was a negative, non-collaborative atmosphere, due to the continuance of contracts and people from Hoekse lijn, the lack of common goals, not working together on one location, the lack of willingness to change, and the lack of attention for the human aspects of relations.

Personal context

The selection of the people working on MaZ was mainly based on experience. Also, people were selected based on their network links, according to PM2-D. For MaZ, a part that appeared to need extra attention and made it extra complex as a project manager was the need for an integrally aligned system to deal with the requirements regarding a safe and functional subway track. This was expressed by all interviewees. Because of the different contract types, the responsibility of that demonstrability belonged to different parties. Parties might use different tools to show this demonstrability. Here the need for an integrality guarantor was raised. PM2-D explained that a system engineering kind of process was set up, in order to deal with all the requirements.

The attitude towards this system engineering process was mainly seen as tiring by the pragmatic people within the project, according to PM2-D. Some people did not seem to understand

the importance of the documentation that came with the demonstration and integrality of the overall systems. The overall atmosphere was also influenced by this. People felt like they were held back by the municipality at some times, because of this process, as shown in various progress reports on Metro aan Zee. PM2-C explained that it sometimes felt like a struggle. It is important to feel like you are working together on something, not against each other.

A note about an evaluation on the HH OPS team on April 14, 2022, showed that because of the high working pace and the pressure, job satisfaction went down, including the health of some of the team members of MaZ. One of the reasons for this was that the milestones of the project were not realistic anymore, but people were still pressured into reaching them, which is also shown in an evaluation of the management team on the 30th of May, 2023. People wanted to go for the 'quick fix' and micromanaging was part of the daily job. Tackling the underlying issue and fixing the deeper issue did not happen.

Another factor influencing job satisfaction was Covid-19. People were working at home, having no prospects. This resulted in coworkers being dissatisfied and falling into a bad mindset. A progress report of July 17th, 2020, explained that more and more people within the project teams struggled with the situation.

The number one thing that the interviewees found important for a project manager is knowing what you are doing and what you are talking about. This was stated by PM2-B, PM2-C, and PM2-D. You need to have a certain level of knowledge about the technical content of a project, and how to deal with the primal project management skills like analyzing the projects and its processes, and decision-making.

Secondly, understanding relations and how to communicate upwards and downwards and to reveal things to the right people at the right time was important. As a project manager, you have to create the right social setting in which people listen to each other and take each other seriously. PM2-B explained that this also contributes to mutual trust and a better collaborative environment.

The results within the personal context of MaZ show that the selection was based on experience, network relations, and the specific technical skills of people that were missing in the project team. High pressure was felt, due to the unrealistic planning, which resulted in lower job satisfaction and micromanaging. The most important trait of the project manager is to know the content, the second one is understanding the relational spheres and creating the right social setting.

Organizational context

In practice, some of the same problems of Hoekse lijn happened at MaZ within the organizational context. PM2-A explained that it was still not always clear who was responsible for what during the execution, between MaZ and the RET. Especially on certain critical milestones, such as the first test ride of the subway, it was not clear who would make that decision. PM2-D even stated that this was the most important issue of the project. PM2-D stated that a lot of people felt like they could say something about it, which eventually led to not having a decision at all.

As stated before, PM2-A explained that having no common goal between the RET and MaZ was also one of the main issues in the alignment within the cliental side. MaZ and the RET had different ways of operation, due to the differences in goals, but also different work cultures, different work ethics, and different people. PM2-B named this as a contributor to the problems within governance.

"...things went wrong mainly in the organization of the clients."
~ PM2-D

A problem within the municipality of Rotterdam itself is pigeonholing, according to PM2-D. The whole organization is divided into divisions. For most of the activities of the municipality, this works. However, with a multidisciplinary project integrality is needed. A lot of unknowns occur with a multidisciplinary project like Metro aan Zee, especially with the integration of all subsystems. PM2-D suggested that the municipality's current organization is not designed to deal with this.

The last issue the interviewees had within the organizational context was the lack of attention on the pre-execution phase, concerning the start-up with contractors and how the coordination process should be arranged. PM2-A focused on the collaboration with contractors on this topic. PM2-B focused on interface management and coordination on this topic. PM2-D focused on system engineering on this topic and said that you have to arrange your contracts and project organization in such a way, that in the end, you are able to deliver a functional safe system.

The results within the organizational context of MaZ show that a lot of issues arose due to the unalignment of the clients. Next to this, the municipality's organization is not designed to deal with a multidisciplinary project and integrate this. Due to a lack of attention on coordination, integration of system engineering, and start-ups with the co-contractors in the pre-execution phase, the client had to facilitate a lot during the execution phase.

6.4 Results of Maastunnel Renovation

This paragraph shows the results of the Maastunnel renovation case. The experienced coordination and the perceived experience around every theme (contractual, relational, personal, organizational) of the Maastunnel are elaborated on using interviews and document research.

Legal Context
The tailormade agreement for the Maastunnel renovation did focus on collaboration and working with each other, instead of next to each other. The contract stated guiding principles for collaboration. During the execution, this was experienced as pleasant and successful, as stated in multiple evaluation reports of 2019 on the Maastunnel renovation. PM3-A also emphasized this during the interview.

"For us, the Maastunnel was actually an expression of cooperation as a guiding principle."
~ PM3-A

However, the tailormade agreement appeared to have created a lot of extra effort for the market parties, as noted in the evaluation reports of 2019 on the Maastunnel renovation. This was due to the unfamiliarity with the contract. Lawyers of multiple parties had to study the contract in order to fully understand it, and translate this to the rest of the corporation. PM3-A explained that this is something to consider when using a deviation on the UAV or UAV-GC.

PM3-A and PM3-B explained that a certain level of equality between the client and contractor contributes to a better relationship. Within the Maastunnel renovation, this equality was strived for

through a legal instrument of adding incentives to both the client and contractor. The client could also be fined for delivering too late, just like the contractor.

The results within the legal context of the Maastunnel renovation show that focusing on collaboration within the contracts, making it explicit, and propagating this, results in a pleasant collaboration. By adding incentives for both client and contractor, this can be stimulated.

Relational context

The Maastunnel project had a convergence phase of one year, in which the client and contractors came together for the start-up of the project. PM3-B found this to be a crucial part of the relational context. PM3-B explained that people were able to get to know each other without the pressure of the execution. By taking the time for this, the chemistry between people is created. PM3-B emphasized the need for a good start-up together, in order to deal with set-backs later on. The quote below shows this. The relation with the contractors was seen as positive, 'an example of how a collaboration should be'.

PM3-B also emphasized the importance of uncovering the multiple objectives of contractors during a start-up. By acknowledging both the common goals, but also the conflicting goals, you know what you can expect of a contractor and what their intentions are. Through understanding how a contractor might act, PM3-B explained that the expectations will be more on the same line.

> *"By investing in the front, in starting together, you can deal more easily with those surprises without the project veering out of the way or crashing into the guardrail."*
> ~ PM3-B

Next to starting together, both PM3-A and PM3-B argued the importance of having one physical location to work from, for the client and co-contractors. They explained that this creates shorter communication lines with all parties involved, and creates space for the 'human-aspects'. The shorter communication lines resulted in issues being resolved more easily due to the direct communication, interfaces being managed more easily, and a more hands-on monitoring process. The human-aspect resulted in people understanding each other better, and creating empathy.

The evaluation reports on the Maastunnel renovation showed that by explicating what is expected of the collaboration, by naming collaboration pillars and a 'collaboration ladder' people knew what was needed to create a better collaboration. The reports show that people had higher job satisfaction because of this. PM3-A and PM3-B strengthen this by stipulating the importance of psychological safety and looking out for each other.

The results within the relational context of the Maastunnel renovation show that having a start-up with your contractors and establishing both mutual and conflicting goals, and getting to know each other on a personal level result in a better relationship during execution.

Personal context

The people on the Maastunnel were mainly selected based on their experiences and through their network connections.

Next to the relational context, there was also more attention to the softer side of people on a personal level. It was not only about the collaboration but also about the people themselves. Next to collaboration, personal well-being, and understanding were also aimed at. PM3-A explained that this

was a big pro of the Maastunnel renovation. The combination of knowing the content of the project, and having managerial skills, with the combination of humane aspects is seen as the future.

> *"Being a little more human, and not just an entity of the municipality of Rotterdam in the role of project manager, helps."*
> ~ PM3-A

An interesting aspect of this project is the personal coaching sessions. Project evaluations show that the focus was on an individual themselves and how they can grow and improve as an individual within the project and their relations, not just sessions about the overall relations.

A remark of PM3-A was that you need to find a balance to which extent you want the softer skills written down in contracts. PM2-A explains the usefulness of having collaboration and collaboration tools written down but enlightens the importance of putting them into practice. A project manager has to have the intrinsic motivation to act in accordance with the philosophy of the contract. PM3-B showed the same attitude towards this. PM3-B stated that the municipality should facilitate coordination, and not leave it to chance. However, take into account that it does not turn into an obligatory check-off list.

> *"Saying that you are going for the collaboration and then not doing it, is fatal for your credibility."*
> ~ PM3-A

The results within the personal context of the Maastunnel renovation show that the selection of people was based on their experience and network relations. There was more attention for people's psychological safety. To what extent the softer skills are written down in a contract or leaving it up to the project manager, should be balanced. Intrinsic motivation is needed with this.

Organizational context

The municipality had a clear organizational structure set up within the Maastunnel project itself. This helped with the clarity of the responsibilities on the client's side towards the involved contractors.

However, there were a lot of different interests within the municipal organization itself, according to PM3-A. The urgency of the Maastunnel renovation and it being a national monument caused more pressure from the municipality itself and the political field. A lot of people had different opinions, departments had different interests, which led to the municipality being less directive. PM3-A and PM3-B both named this as the biggest issue within the project. The client-contractor relation was aligned, but the client relations within the municipality were not.

> *"You see that the discussion is now shifting from how do you work together with contractors to how do you work together within the client's field. How can we better fulfill that commissioning role?"*
> *"Then that attention on coordination or control actually perhaps shifts to something that you look at within public commissioning itself. Inside the organization."*
> ~ PM3-A

The results within the organizational context of the Maastunnel renovation show that the focus on coordination towards a contractor shifts towards the coordination on the clients' side and within the

municipality. The alignment of the organization from the client is a challenge.

6.5 Results of Rotterdam Centraal Station

This paragraph shows the results of the Rotterdam CS case. The experienced coordination and the perceived experience around every theme (contractual, relational, personal, organizational) of the Rotterdam CS project are elaborated on using interviews and document research.

Legal Context

Both the documentation and the interviews of Rotterdam CS express the traditional PDM of the municipal contracts. All communication structures, consultation structures, and organizational structures were formally laid down. PM4-A explained that the formal setup worked for this project, and the size of it. If issues arose, this was dissolved within the legal spheres.

> *" There was a lot of falling back on the contract at Centraal Station."*
> ~ PM4-A

The coordination role was fulfilled by the municipality itself. PM4-C explained that this was the best option, due to the high societal value of the area around Rotterdam CS. PM4-A, PM4-B, and PM4-C all described the coordination process as good. They explained that through 'comic strips' the whole project was elaborated on. It showed all the activities that had to be done by all parties, what the rules were during that period, which interfaces occurred, and who was involved. This was discussed during weekly coordination meetings with all parties involved. The municipally was perceived as very directive.

Between the interfaces of OVT-city and the OVT-tracks, 'division documents' were made, which was seen as a big pro by PM4-A. A division document shows where the interface is location wise, and how it influences both parties. Both contractors of the municipality and ProRail knew how to deal with the interfaces and who was responsible for what, because of the documents. PM4-A explained that this gave a lot of clarity for all parties involved and made the collaboration on the interfaces easier.

The results within the legal context of Rotterdam CS show that the client had a hands-on management setup. The coordination set-up of the client worked, and interfaces were explicitly managed. All parties knew what was expected of them, which made the collaboration easier.

Relational context

The relational context was described as formal, by PM4-A and PM4-C. They explained that the contracts were used as the guideline during the whole project. If something happened or an issue arose, everyone fell back on the content of the contract. Meetings were formal and based on the content, as shown in both the document research and the interviews of PM4-A, PM4-B, and PM4-C. The 'human' side was not the main focus, according to the interviewees PM4-A and PM4-C. The interviewees also stated that this formal setup was not negative to say so. It worked for that project and did the job, was explained. If additional work was needed, the client did not back out into paying. The contractors worked together on the interfaces in order to achieve success and realize the overall project in a neat way, according to PM4-B and PM4-C.

"Then it gets a pretty traditional communication. Construction meetings, that's it."
~ PM4-A

OBRgw tried to make considered decisions by taking into account the interests of all parties involved in the interfaces, as stated by PM4-B. PM4-B said that with a considered decision you create the willingness to cooperate with all contractors and get a good work mindset, which worked well.

The attitude of ProRail was also perceived as very formal by the interviewees. During meetings, it was hard to find a middle ground that worked for both parties sometimes, according to PM4-A. Especially since they had another contract form. On ProRail's side, the contractor was the point of contact and the communicator due to the D&C contract. This was perceived as a struggle by PM4-A since the contractor of ProRail was mainly focused on their own interest. ProRail was involved in testing the construction, not in managing the execution.

The results within the relational context of Rotterdam CS show that the relations were formal. The focus was on results, rather than relations. This was not always received as pleasant. Due to different contract forms, the communication about the OVT ran through the contractor of ProRail. The contractor's interests were different, which made the collaboration harder.

Personal context

The people working at Rotterdam CS were mainly chosen because of their experience and network relations. Also, because people were involved during the design phase, it made sense to have those people involved during the execution. PM4-B stated the continuance of people of the design phase in the execution phase as a big pro. To not lose too much knowledge between the design and execution phases, some project managers came on board in the last part of the design phase. This helped them to get acquainted with the project and the content of the contracts, according to PM4-B. Also, their experience can be used for the design. The quote below is about bringing project managers on board during the design phase.

"You actually get a kind of cross-pollination of performance experience and preparation people."
~ PM4-B

Within this project, the interviewees stressed the importance of a project manager needing to know the technical content of a project. Especially when the client has a big role in the project, like coordinating all sub-projects, according to PM4-B. A client should be a worthy sparring partner for the contractors. What came second, was having an eye for others and seeing the bigger picture, and with that seeking alignment with one another, according to PM4-A. All interviewees saw being honest as an important characteristic for a project manager. Not just about decisions, but also in terms of not understanding something or indicating that something happens in an unpleasant way. This creates openness.

"First of all, it is important that you know the content of the work."
~ PM4-B

An interesting note of PM4-A on the personal traits of a project manager was that the traits have to match with the project characteristics. PM4-A explained that some people like repetitive work and

some people like variational work. When selecting a project manager, both the characteristics of the manager and the project need to be taken into account.

The results within the personal context of Rotterdam CS show that the selection of people was based on experience and network relations. By having people involved in both the pre-execution and execution phases, knowledge is used more optimally. Knowing the technical content of a project appeared to be the most important quality of a project manager. The characteristics of a project manager have to fit the project's characteristics.

Organizational context

The organization of the municipality was set up tightly with Rotterdam CS. All the communication structures, organizational structures, escalation structures, and consultation structures were pre-arranged, which can be seen in multiple project plans of Rotterdam CS. This was perceived as pleasant and clear by the interviewees. Everyone knew who they could go to in case of issues, communication had relatively short lines, and the governance from the municipality was perceived as clear.

An interesting note is the pre-execution phase of Rotterdam CS. During the design, all different disciplines like project management, steel construction, concrete construction, and architectural engineering worked together on one physical location. This created short lines of communication. This made the coordination of the design and planning, and the estimation of the interfaces easier, according to PM4-B. Also, misinterpretations were removed by the shorter communication lines and by the opportunity to explain everything in person. The next quote is about being together during the design phase.

> *"The big advantage was that everyone was housed together and that coordination in terms of work preparation and the development of the project had very short lines."*
> ~ PM4-B

The results within the organizational context of Rotterdam CS show that it is important to have clear governance set out by the client. By working together on one location during the design phase, shorter communication lines are created and interfaces are uncovered more easily.

6.6 Summary of case results

In Table 11 below a summary on each case is given for every context.

Table 11. Summary of case results

Case #	Legal context	Relational context	Personal Context	Organizational support
1	No unambiguous contracts Coordinator is insufficient Unfacilitative in coordation	'Island-culture' Closed and rigid Mismatch of people, unambiguous clients	Selection based on experience, network Human aspect was lacking, values not pursued Content-based	Unclear responsibilities Escalation unclear Clients were not cohesive
2	Misinterpretation of specifications Coordinator is insufficient Changes in personnel had negative effect	Closed and rigid Unaligned common goals Lack of willing to change Negative sphere of Hoekse lijn was continued	Selection based on experience, network Human aspect was lacking High pressure was felt, lowering jo satisfaction Content-based	Unclear responsibilities Lack of attention to start, integrality Clients were not cohesive Escalation not effective
3	Focus on collaboration, make explicit Tailormade, which caused unrest Incentives in contract for both client and contractor	Have start-up sessions with contractors Also expose conflicting interests One location created short communication	Selection based on experience, network psychological safety is important intrinsic motivation is needed for 'soft' management Content-based	Within municipality conflicting interests
4	Due to different contracts, communication with OVT-tracks was harder Hands-on management of client	Formal Focus on results Difference in interest made alignment harder	Selection based on experience, network Use people through multiple phases PM's characteristics have to match project Content-based	Clear lines of control Short communication lines One location during design helped

7. Cross-case results

The case study shows multiple issues with coordination when executing a multidisciplinary project with co-contractors. However, the overarching coordination issues and their origins have yet to be found. This chapter compares the cases and describes the origin of the problems of coordination within multidisciplinary projects. In paragraph 7.1 the case study cases are compared and a fishbone diagram is developed to find the origin of the issues and analyze the causal-relations. Paragraph 7.2 elaborates on the overarching phenomena causing coordination problems. Paragraph 7.3 elaborates on the specific phenomena causing coordination problems for the cases. This chapter also aims to answer *SQ3: 'Where do problems occur hampering the effect on coordination and what are the origins of these problems?'.*

7.1 Comparison of cases

This paragraph compares the case results. Table 12 provides an overview of all the cases and their results within each context; Contractual, relational, personal, and governance. As a guide for the concepts named in the second column, the content of the summary table at the end of Chapter 6 is used. This is done to give a deeper understanding of the concepts and compare them for each case.

Table 12. The comparison of the cases

		Case 1	Case 2	Case 3	Case 4
Contractual	Contract form	Traditional, UAV	Traditional, UAV with a '+'	Integrated, tailor made agreement	Traditional UAV
	Unambiguousness of contracts	Low	Low	High, but a lot within one contract	High, not with ProRail
	Coordinator role & level of role fulfillment	Contractor, Not as expected	Contractor, Not as expected	Contractor, As expected	Client, As expected
	Clear responsibilities	No	No	Yes	Yes
Relational	Common goals	Not aligned	Not aligned	Aligned	Not aligned
	Atmosphere	Reserved, Withdrawn	Reserved,	Open, collaborative	Formal, Reserved
	Mindset	Result-oriented	Result-oriented	Process/collaborative-oriented	Result-oriented
	Values	Honesty, Transparency, Openness	Trust	Mutual trust, Openness	Transparency
	Together?	No	No	During convergence and execution	With internal designteam

Personal	Selection	Experience & network	Experience & network	Experience & network	Experience & network
	Characteristics	Knowledge of content	Knowledge of content	Knowledge of content, Empathy	Knowledge of content
	People work through multiple phases	Partly	Partly, switch had bad influence	Yes, both municipality and contractors	Partly, within municipality
Governance	Inter organizational	Non-cohesive	Non-cohesive	Cohesive	Partly cohesive
	Intra organizational	Non-cohesive	Non-cohesive	Non-cohesive	Cohesive
	Escalation	Unclear	Clear, but no effect	Clear, within project. Unclear within organization	Clear
	Responsibilities	Shredded	Shredded	Clear	Clear

With the comparison of the cases and the extended results of the cases in Appendix G, the causes and effects are analyzed and merged into a fishbone model, see Figure 24. The fishbone model shows multiple effects on coordination issues, and the causes of this within the branches of each effect. The issue is divided into the main causes and the sub-causes. With this model, the four overarching phenomena causing coordination issues are presented.

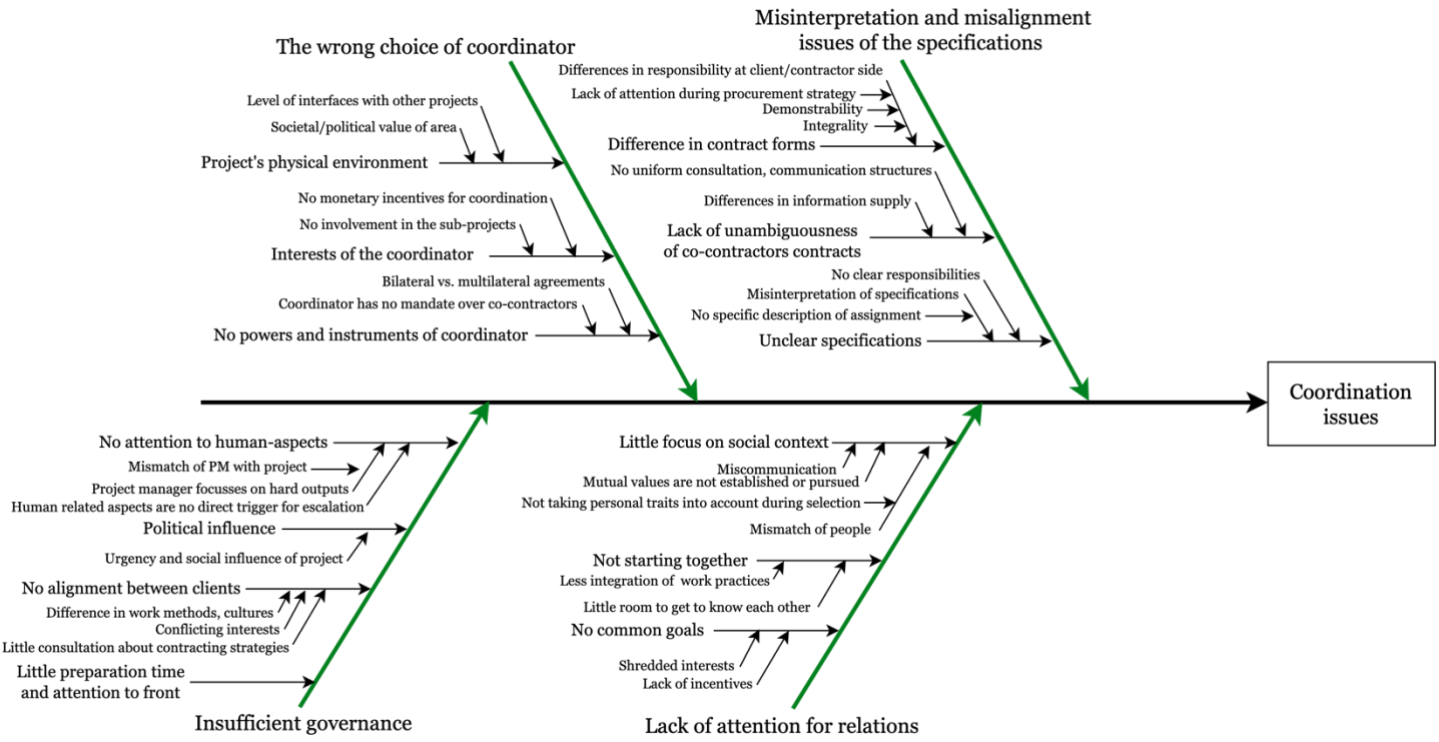

Figure 24. Fishbone diagram for coordination issues

Comparing the cases, four overarching phenomena are seen, concerning coordination problems.

- Misinterpretation and misalignment issues of the specifications of an agreement
- The wrong choice of coordinator
- Lack of attention to relations
- Insufficient governance

If these four phenomena are not taken into account when a project is executed with co-contractors, it is almost impossible to not have any coordination issues. This is why these four phenomena are overarching and are important to think about before a project is executed.

7.2 Overarching phenomena for coordination issues

This paragraph elaborates on each phenomenon causing coordination issues. As shown above, the issues with coordination are directed back to a few core problems:

- Misinterpretation and misalignment issues of the specifications of an agreement
- The wrong choice of coordinator
- Lack of attention to relations
- Insufficient governance

7.2.1 Misinterpretation and misalignment issues of the specifications of an agreement

A standard building contract contains the description of what has to be realized with a set of requirements, the sum with payment terms, the start and delivery date, and the general terms and conditions. A coordination agreement could be added to boost collaboration and coordination within a project with co-contractors. The coordinator is named and other parties are obligated to cooperate on the interfaces of a project. Some standard coordination obligations emanate from the agreement, like coordination meetings. A client sets up a list of requirements of specifications for the physical retaliation of the work. It has to look a certain way or be able to carry a certain amount of weight. The level of detail of these specifications differs with the chosen Project Delivery Method.

The list of requirements or specifications creates a certain perception on the expectations of the client. When the requirements are not pre-specified or discussed in the right way, a contractor might have another idea or perception of the realization compared to the client. Misinterpretations could follow and the client might not get delivered what he had in mind.

This could also be the case for the coordination process of a project. If the client describes the coordination role to a contractor, a certain expectation on how that role is fulfilled arises. Due to requirements in the coordination agreement, the EMVI criteria, and the EMVI plan of the contractor, an idea is created on how the client wants to see the coordination, and how this is intended to be fulfilled by the contractor.

The case study shows that misinterpretation of how this coordination role has to be fulfilled happens often. Both Hoekse lijn and Metro aan Zee had issues with this. Due to different expectations on how coordination has to be arranged during execution, the coordination might not come off the ground as intended. This can lead to misalignment of co-contractors and in the end a lower project success. That is why it is very important to make sure misinterpretation is avoided.

Also, coordination issues arose due to the misalignment of specifications supporting coordination, like coordination meetings, information sharing, and communication between the co-contractors. This appeared to be one of the main reasons why parties did not coordinate properly on interfaces in multiple cases.

7.2.2 The wrong choice of coordinator

Is the client best suited to coordinate or is the contractor best suited? This appeared to be a very important question during this research. The case study showed that this needs to be given more attention during the pre-execution phase of the project, especially if the project is divided into sub-projects. What appeared to be important factors in this decision, are:

- The interests of the contractor
- The level of influence of the coordinator
- The project's physical environment

The interests of the contractor

A contractor's main goal is to meet the requirements of his contract with the client and finish his part on time. When the contractor is given the coordination role, he might not be objective enough to make fair considerations with co-contractors involved, since the contractor's main goal is his contract. Next to this, he might not give the coordination role the attention it needs. When a contractor is given the role of coordinator, finishing the complete project must be part of the intrinsic motivation and goals of the contractor. Here incentives come into play. As a client, you might have to incentivize the contractor into taking the coordination role seriously. With the Maastunnel, the contractor got a bonus when reaching certain milestones and an even bigger one when delivering before the end date. This helped to collaborate more and not to stay in the conflict modus too long, since you have to work together to complete the project in time.

The level of influence of the coordinator

If coordinating is part of a contractor's job, a contractor has to have a certain level of direct influence on the project. When the contractor is not able to influence the project's processes directly, it is shown that coordination will fail. A contractor needs some sort of mandate to get the other co-contractors to collaborate on the interfaces. Be it giving a fine when not attending a meeting, or not delivering information on time. However, abuse of power should be avoided at all times. Nowadays most coordination agreements only come with legal obligations between the contractors and client. This also applies to the case studies. An important question is whether you want to create a coordination agreement that results in legal obligations between co-contractors. This provides the coordinating contractor with more instruments to steer on good coordination and involve all contractors. Another important note on the level of influence on the contractor is the scope of his contract in comparison to other contracts. This is intertwined with the level of interest of the contractor. If the scope of the contractor's contract is major in comparison to the other contracts, he has a more direct influence on the overall project. If he has interfaces with all other contracts, he will be incentivized to coordinate with all co-contractors. He is able to directly influence the project, because of this mutuality. If multiple important interfaces arise between co-contractors who are not coordinators, the coordinator has no direct influence on that interface. This might accommodate the coordinator into being reactive, instead

of proactive. The bigger the contract of a contractor, the more coordination responsibility he might be able to carry.

The project's physical environment

The environment of a project is another factor that needs to be taken into account when deciding who is the most suitable coordinator. If a project is located in an area of high societal value and importance, it is important to assess the project's external interfaces with this area. Also, the party responsible for the whole area around the project needs to be taken into account throughout the project's life cycle. For example, the environment of Rotterdam CS has a high societal value because of the labor, residential, and logistical functions of the area. Since the municipality of Rotterdam is responsible for the overall area, they have a big interest in the project environment and realizing Rotterdam CS without too much interference with its surroundings. Next to this, the municipality has a bigger interest in tuning Rotterdam CS with its surroundings. If a contractor might coordinate here, he does not have a big interest in the project's external environment. So, the environment and its functions need to be taken into account when assigning a coordinator.

7.2.3 Lack of attention to relations

The third phenomenon is about the more human aspect of coordination and working together with other parties. If the focus is mainly on the result, and not on the process of working towards that result together, the connection with the parties involved might be forgotten. Collaboration is one of the key factors to project success, as explained in the previous chapters. But to get to a good collaboration and have a proper relationship with the contractors involved, some effort is needed.

The case study shows that once you get to know your contractors, it is easier to create processes within a project that suit multiple parties. Parties have multiple perspectives, cultures, work processes and methods, and different preferences for interacting with others. This requires alignment of all parties involved. Especially with Hoekse lijn and Metro aan Zee this was done too little. Once you get to know each other, you find out how they think and what their values are within relationships. As a client, you are able to respond to this with a suitable way of interacting with them.

What also stood out within the cases, is the importance of the mindset of people within the project. When people felt the need to collaborate in order to make the project a success and also believed that this was a key element, they were able to overcome their differences in opinion for the greater good. When people did not feel connected, the 'island culture' grew and people just focused on their own work.

7.2.4 Unclear governance

The last phenomenon is unclear governance. This refers to the client's-side of a project and its organization. Both the client-client relationships and the client's internal organization are part of this. The cases uncovered that these aspects have a big influence on the coordination process and are key elements in whether issues arise.

The client-client relationship involves public commissioning, inter-organizational relations, and a decision-making process on the client's side. The cases have shown that when clients are not aligned,

do not have a clear view of the division of responsibilities, and do not provide an unambiguous approach, issues come into play. At the start of a project, it is important that a client together with other clients involved, makes sure an alliance of clients is formed.

7.3 Specific phenomena for the cases

This paragraph describes the specific phenomena for the cases. These phenomena are directed back to the municipality of Rotterdam itself and are not sector-wide phenomena.

Intra-organizational setup

The intra-organizational relations and decision-making processes of a client have to be set up sufficiently. If the client is not organized the right way and responsibilities within the organization are unclear, coordination becomes harder for the project managers representing the client. As seen in the cases, escalation was ineffective due to an unclear escalation process. Also, it was not always clear who had the mandate to make certain decisions and who was ultimately responsible within the client's organization. An upcoming issue is the differences in interests within the client's organization. This was a problem within the Maastunnel renovation project. When multiple departments want different things, making a unanimous decision is more difficult.

Network-based organization

What stands out in the results of the cases, is that the selection of a project manager is mainly based on network relations. When people are selected to work on certain projects, this is mostly done by looking at suitable people within one's network.

The network relations are also the main source for knowledge retention and lessons learned on previous projects or advice. Although some knowledge is captured in physical data, most knowledge stays within the minds of project managers.

Content-based organization

The main focus of the projects within the municipality of Rotterdam is the technical content, which is the basis for the outcome of the project. However, to get to the end with a good relationship with other parties and make it a pleasant work environment is not a primary need. It makes the job easier and is seen as a tool to finish the project.

7.4 Conclusion of cross-case results

This chapter aims to answer the third sub-question. The question is *SQ3: 'Where do problems occur, hampering the effect on coordination and what are the origins of these problems?'.*

Taking into account the case study results, the comparison of the cases, and the fishbone model, four main phenomena are identified as hampering coordination. These are:

- Misinterpretation and misalignment issues of the specifications of an agreement
- The wrong choice of coordinator
- Lack of attention to relations
- Insufficient governance

PHASE 3: The preliminary framework

8. Preliminary framework

With the results of the case study, a preliminary framework is set up in this chapter. First, the steering mechanisms of the theoretical framework are compared to the findings of the case study in paragraph 8.1. With the gap between these two, measures are introduced that will be part of the preliminary framework in paragraph 8.2. After this, the structure of the framework is determined in paragraph 8.3, with the preliminary model as result. This Chapter also provides a provisional answer to SQ4, which was: *What are the instruments of a public client to tackle coordination problems, within a client's boundaries?*

8.1 Comparison with theoretical framework

This paragraph compares the steering mechanisms of the theoretical framework with the case study results in Table 13. The identified gaps of the comparison are de foundation for the measures that are introduced.

Table 13. Gap analysis between theory and practice

Theory		Current practices	Gap
Contractual	a.	Power & tools are missing when contractor coordinates, misalignment	Appoint power and tools to contractor, explicate what is expected
	b.	Not explicitly, depends in who is coordinating and level of role fulfillment	impicility <-> explicitly
	c.	Depends mainly on contract form	With interfaces
	d.	According to UAV/UAV-GC, not seen as main contributor	No gap
	e.	Due to bilateral agreements, mainly through client. not seen as main contributor, but could support	Co-contractors do not have a contractual relation, principally.
Relational	f.	Only when contractor is involved before execution as an obligation, otherwise not main interest (PDM dependent)	Is recognized as important, but not utilized
	g.	The common philosophy is seen as a big pro, but is not established as much as wanted	Is recognized as important, but not utilized
	h.	Only necessary things are communicated, trust needs to be built first	Next to obligated communication, build on values like trust
	i.	Tasks of parties are clear, but with the coordination this is lacking	Make explicit expectations, establish this at the start
Personal	j.	High experience	No gap
	k.	Yes	No gap
	l.	Less focus, but understanding of the personal traits having to match the project's entities	Social level needs more attention, theory is more about personal traits matching the other persons

	m.	Focused on content of project in the first place, if not specifically mentioned in contracts	Attention to process, how to deal with involved parties
Organizational	n.	Not clear between clients and within the client's organization itself	Alignment of inter and intra organizational set up
	o.	More bureaucratic, relatively slow processes	Actively involved in processes, short communication lines, feeling of urgency
	p.	A lot has to be arranged during execution	Core is arranged, interfaces and explicit coordination processes are arranged during execution

Differences

What stands out when looking at the gap, is that a practical application with physical instruments is lacking primarily. As seen in Chapter 4, general measures are introduced to improves coordination on multidisciplinary project with co-contractors, like provide training and schedule regular meetings. To create a more practical approach, the interviews are used to set up measures.

Next to this, the steering mechanisms on settling disputes and dealing with conflicts do not seem to be a main contributor to the problems on the interfaces and coordination. This is why these will not have a dominant place within the final model. It is important to arrange this pre-execution, however, it is not a direct cause for issues.

A considerable difference between theory and practice is the human aspect within projects. Theory explicitly shows the importance of having a good relation in order to collaborate. This is lacking in practice. However, what is remarkable is that people do understand the importance of the human side, but fail to implement this within the projects. This is why the theory will be leading in the model on this aspect.

Another gap is the implicit work methods of the client. A lot of activities and processes, like interface management and decision-making, are done implicitly.

8.2 Measures

This paragraph provides the measures that are implemented in the preliminary framework. The measures are divided into the contractual, relational, personal, and governance measures.

8.2.1 Contractual measures

Within the contractual measures, there are two targets, the contracting strategy and the content of the contract.

Contract strategy

SMART EMVI criteria. Make sure the tender has stated SMART EMVI criteria on coordination and collaboration. This lowers the chances of misinterpretation and misalignment with co-contractors and gives a practical approach to steering mechanism a and i.

> *"What do you expect from that coordination obligation? Make that concrete. You can say yes you have to coordinate, but how often? How many times? Try to make that SMART."*
> ~ JU-1

Uniformity on requirements. When a project is divided into sub-projects, take into account the multiple contract forms and the uniformity/ambiguity between them. With different contracts, it is important to align the preconditions of the demonstrability responsibilities between clients and contractors, the differences in responsibilities of tuning with co-contractors, and create the same requirements around joint meetings, information sharing, and communication with all parties involved. If a client facilitates this throughout all contracts, those subjects will align better during execution. This is connected to mechanisms f and n.

Contractual content

Install incentives. To make parties move, incentives are needed. Monetary incentives have the biggest effect on parties. Monetary incentives can be in the form of a bonus or a fine. If possible, add incentives for both clients and contractors to make coordination and collaboration a priority. This deals with the lack of interests of a possible coordinator, and the bureaucracy within the client's organization, like what was done in Case 3.

SMART contract paragraphs. Next to making a SMART tender, it is important to also make the paragraphs within a contract SMART. Especially the collaboration and coordination paragraphs. This can also be led back to the quote of JU-1. The mechanism i supports this.

Clear responsibilities and expectations. Make sure the notation of responsibilities from the client's and contractor's perspective is clear and comprehensive, as mechanisms i and n state. To make this more practical, it is good to discuss the responsibilities and expectations before the project's execution phase starts during a 'start-up session'. This allows all parties to explicate what is expected and in which ways.

Install instruments and give mandate to coordinator. Within the legal context, the coordinator has to have instruments to have 'good coordination'. A coordinator needs to have the mandate to steer co-contractors. Either through a multilateral agreement or addendums about the powers and instruments, for all parties involved. This Mechanism a.

Monitor compliance with requirements. The contract's content is already established before the execution. So, unless you want to change this, the content is fixed to a certain extent. During execution, however, it is important to monitor to which extent the SMART requirements are met by the parties. If they are met, no action is required. If the requirements are not met, the client can address the shortcomings of a party. In the worst case, a client can prove that a party is in default and take legal action.

8.2.2 Coordination role considerations

To decide who is best able to fulfill the role of coordinator, the client or the contractor, three requirements are set up, using the results of the case study and the literature review. Figure 25 shows the decision process on who should coordinate. These requirements are needed if the coordination role is being fulfilled by a contractor:

1. The environment of the project is not of high societal value and is not politically complex.
2. The contract of the contractor has direct interfaces with co-contractors. The contractor has to feel involved and has to have intrinsic motivation to take on the coordination role.
3. The contractor has instruments to steer the coordination with co-contractors. This refers to mechanism a.

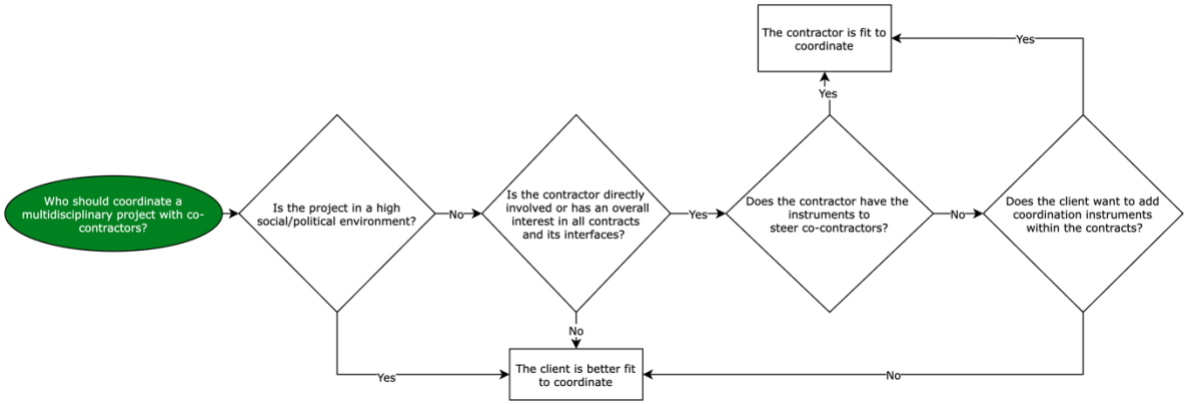

Figure 25. Decision process of the coordination role

8.2.3 Relational measures

Start-up sessions with parties involved. Before the execution starts, it is important to have start-up sessions with all clients and co-contractors who have a decent contribution to the project. During these sessions, it is important to establish the common goals and values of all parties, as mentioned in mechanism g. Also, the conflicting interests have to be discussed. This is all about knowing who you are working with and what can be expected.

Next to the social side of start-up sessions, the practical aspect of aligning the different work methods and having clarity about what to expect from each other is a pro. This is also stated in mechanism f and i.

Create right mix of people. Next to this, people should find out whether there is a 'good mix'. A good mix implies that the people of the different parties can work together well and are a good match. This can be done through coaching sessions and workshops.

Ensure transparency, openness, equality, and honesty. The relational context during execution is influenced by how parties interact and how a project team steers the co-contractors. To have a good relational setting, a project team has to ensure the values of transparency & openness, equality, and honesty to create trust. With transparency & openness, you have to let contractors know what is going on, even if this might not be positive. If changes need to be implemented, you should communicate this as soon as possible to the parties that will experience the consequences. Equality is important to show the contractors you are in it together. If anything goes wrong, you try to fix it together and if anything goes right, this is a win for everyone. Pain & gain are shared. With honesty, you have to be upfront about decisions and their basing, how you feel about certain courses of action, and be honest about how someone's actions influence you. With this, you create more understanding. This also stimulates mechanism h.

Work at one Location. To improve coordination and collaboration, all parties have to work on one physical location. Having one physical location from where all co-contractors and clients operate, close to the construction site, creates shorter communication lines and more human interactions, and provides easier access to face-to-face discussions and meetings. In the interviews, this was given as a reason why collaboration was experienced as harder.

"Being together on one location appeared to be very valuable." ~PM3-A
"We worked on three different locations" … "Then you get an island culture." … "Being together on one place would have made a big difference in my opinion." ~PM1-A

Check-ins with contractors. Next to the plenary meetings with all parties, you have to schedule regular meetings with your co-contractors on an informal basis. Check how everything goes, outside of the project itself. See what is going on with them. This gives a better idea of their background and underlying reasons why they might act a certain way within in project. This shows empathy.

8.2.4 Personal measures

Selection of right people. On a personal level, the municipality of Rotterdam must select the right people for a project. The first important trait a person needs to have is having general knowledge of the technical content, or being able to understand this within a certain timeframe. This is connected to mechanism k. Secondly, understanding the social context was named as an important trait. Within the large-scale projects de relations become more complex. A project manager should be able to deal with this. This relates to mechanism l.

Next to knowing the content, it is important that the character of the person fits the characteristics of the project and the contract form used. If a person does not like change or uncertainty, it is probably not a good idea to match this person with a highly complex multidisciplinary project. If a person can deal with uncertainty and likes more integral projects with a dynamic environment, it might be a better fit. This is the measure that is not spoken of in the literature but came forward in the results.

"Not every project manager can deal with every project and its contractual set up." ~ PM4-A

Healthy project team. Within a project team, it is important to function well. You have to create a healthy project team in which the team roles are divided equally and in which people complement each other.

Reflect and evaluate people's well-being. During execution, the personal context of the project team is about how the individuals work, both in the project itself and a project manager's personal setting. You have to reflect and evaluate people's work within the project team. With regular meetings with people who have a dominant role within the project, they are being checked upon their well-being. Are they able to deal with the workload? Are they in good health? Is there something else that might influence their work? If needed, follow-up actions are set up.

Reflect and evaluate people's work. Next to their well-being, it is good to know to which extent a person is still working in service of the greater project goal. If a person might let their personal feelings towards someone take the upper hand, an unobjective decision might be the result. This should be nipped in the bud.

8.2.5 Governance measures

Clear responsibilities between clients. Before the execution phase starts, clients should have their organization in order. Especially with multiple clients, a clear division should be made of who is responsible for what part of the project.

Clear approach on process and methods. To deal with the amount of data a project has, it is important to have a clear approach and process about how you want to deal with this in a project. To manage the interfaces, an integral interface registry has to be set up to which all clients and contractors have access. In this registry, the interfaces should be mapped and assigned to a responsible party. Next to mapping them, the methods on how to deal with the interfaces should be systematically applied by all parties.

Next to the interfaces, demonstrability is an important deliverable within the infrastructure sector. An integral approach should be used by all parties to do this, within an integral system/software. A system engineering approach makes this easier.

Have 1 admiral. With the governance aspect, the foremost guideline is to have 1 admiral. If a project has multiple clients, it is important to have one client who oversees and steers the overall project. This sets a clear and coherent example for the parties within the project. Also, the parties know where they stand with this.

Specifically for the municipality of Rotterdam: Have an information team. To have a grip on the information flows, a team overseeing document, information, and integrated systems should be installed within the client's organization. This team focuses on how the information within a project is processed and controlled, and how all sub-systems are integrated into one.

Specifically for the municipality of Rotterdam: Clear escalation routes. If project teams run into problems, they need to have a way in which they can explain this and ask for help. Clear escalation routes need to be set up for them.

8.3 The structure of the framework

The above stated measures have an effect on different contexts within the project. Although the effects of coordination on co-contractors mainly become visible during the execution, a lot of measures can be installed in an earlier phase. Section 8.3.1 shows the structure of the framework and the division into multiple phases. Section 8.3.2 shows the finalized preliminary framework.

8.3.1 Structure of the framework

Groups

As shown in both the literature review and the case study, contractual, relational, personal, and governance-oriented issues arise connected to the coordination. This is why the measures are divided into different groups:

- The contractual context: This group shows the measures and takeaways that affect the contractual setting.
    - Coordination role: This group is about who should be given the role of coordinator, depending on the characteristics of a project. One could also see this as a part of the contractual environment, but this decision is so important this it has its place within the framework.
- The relational context: The measures within this group have an effect on the relations of the parties involved
- The personal context: This group contains measures that affect the individual people within the project team representing the municipality of Rotterdam in a project.
- Governance: This group revolves around the organizational setup of a client or clients and how they steer the project.

Division in phases

The measures to create better coordination through the pre-set contractual context and the managerial context during execution belong to different phases of the project. The measures apply to different phases. This is why the final framework is divided into multiple phases. Firstly, the contracts and acquaintances happen pre-execution. That is why this is the first division.

During executions, a manager has to manage the project and a coordinator has to coordinate co-contractors. The measures they use in their day-to-day work are applied in the execution phase. So, this is the second one.

When applying the different groups and the division of phases, an overall structure for the framework arises. Figure 26 shows the structure of the framework.

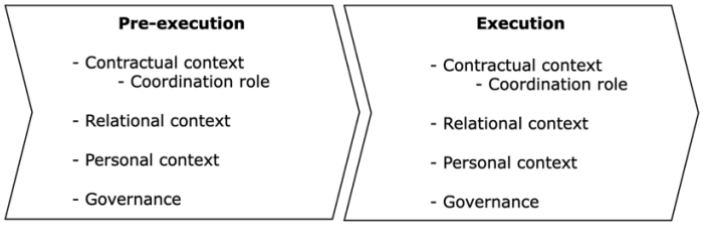

Figure 26. The structure of the framework

8.3.2 The Preliminary Framework

With the earlier-stated measures and structure a preliminary framework is set up, see Figure 27. To show what parts of the framework originate from the theoretical framework, different colors are used. The grey texts represent parts of the previous theoretical framework. The black texts are iterations from the results. The green texts are specific measures to be taken by the Municipality of Rotterdam.

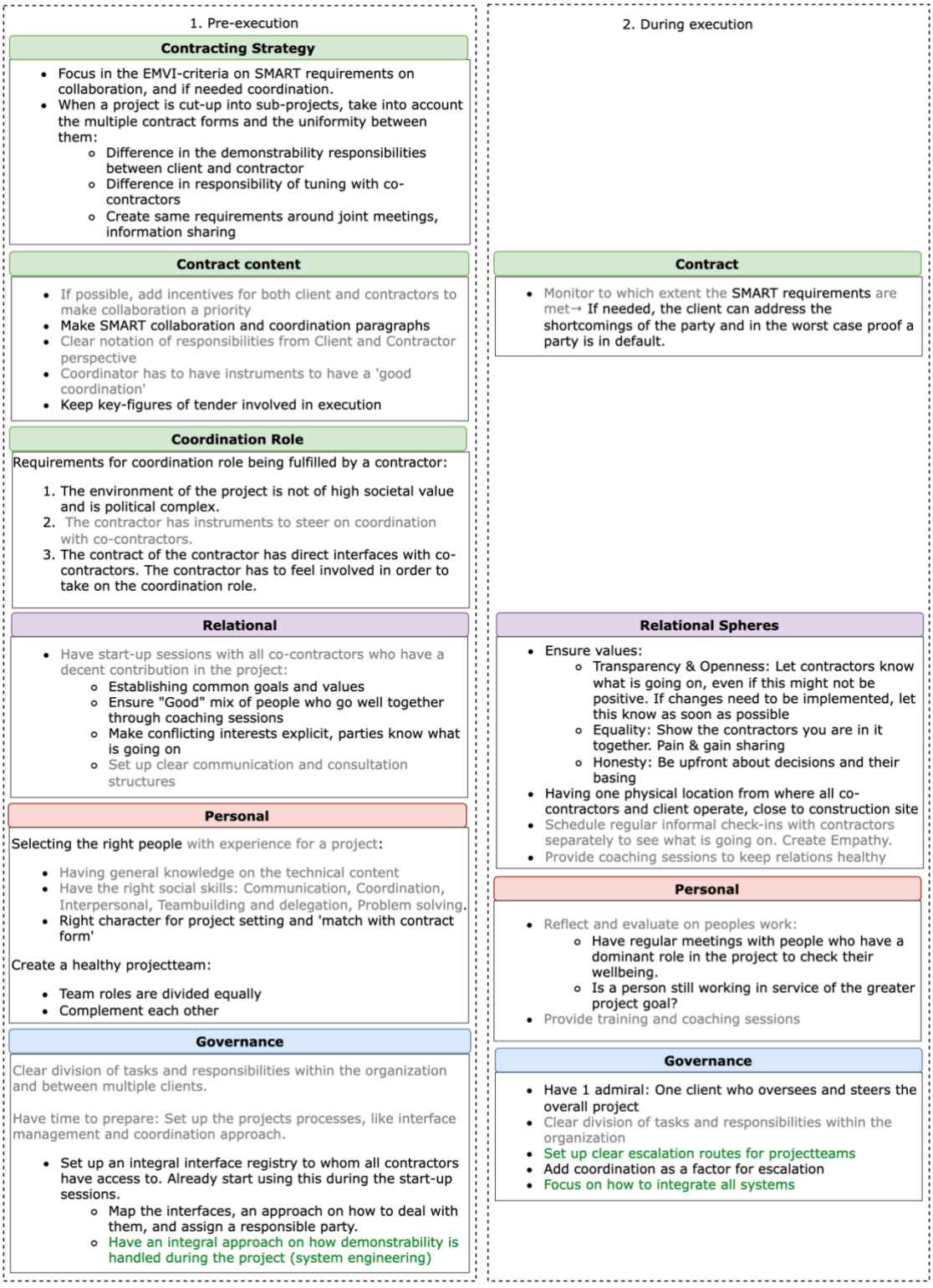

Figure 27. Preliminary framework

8.3 Conclusion of the Preliminary Framework

This Chapter aimed to answer SQ4, which was: *What are the instruments of a public client to tackle coordination problems, within a client's boundaries?*

This chapter divided the instruments into the contractual, relational, personal, and governance contexts. This is why the table with the instruments below has the same layout.

Table 14. Instruments of Clients to steer on coordination

Contractual	Relational	Personal	Governance
Requirements in contracts: – SMART coordination – SMART collaboration – Demonstrability – Retaining people	Agreements: – One location – Values	Training and coaching sessions: – Technical content (IQ) – Social content (EQ & SQ)	Inter and intra organizational set up
Contracting strategy: – Finding right coordinator – Suitable PDMs	Start-up sessions	Selection procedures	Add coordination as escalation factor
Incentives	Leading by example	Evaluations	SMART escalation routes
Monitoring	Schedule meeting	Facilitate project team: – Add or remove people – Shift responsibilities	Set up integral systems
Make parties liable in case of non-compliance	Consultation and Communication structures		Install enough preparationtime
	Coaching sessions		Assign one representative for all clients

PHASE 4: The final framework

9. Synthesis

This Chapter revolves around the development of the final framework for this thesis. By iterations on the theoretical framework and the preliminary framework, and the validation through expert sessions, a framework is developed that shows the mix of the measures that needs to be taken into account when a multidisciplinary project with co-contractors is carried out. Paragraph 9.1 shows the outcomes of the expert sessions. With these outcomes, the final framework is presented in paragraph 9.2.

9.1 Outcomes of the Expert sessions

During the expert sessions, the preliminary outcomes stated in Chapter 8 were discussed with four experts. Information on the participants of the expert sessions is shown in Table 15. The measures of every category within the pre-execution and execution phase were discussed with the experts. The comments of the experts are discussed in detail in Appendix I. This paragraph shows which alterations are done to develop the final framework, based on the expert sessions.

Table 15. Expert session participants

Expert	Role	Years of experience	Session #
E1	Procurement expert + Legal tender specialist + Contract manager	20+	1
E2	Legal advisor + Contract specialist	10+	2
E3	(head of) Procurement lawyer + Public commissioning	20+	3
E4	Contractor, experience with public clients	20+	4

Although there were no fundamental differences between the preliminary results and the views of the experts, some points of discussion were raised. Table 16 shows which part of the framework the experts had comments on.

Table 16. Comments of experts on framework

	Expert number			
Pre-execution	1	2	3	4
Contractual context	x	x	x	
Coordination role				x
Relational context	x		x	x
The personal context			x	
Governance	x	x		
Execution	1	2	3	4
Contractual context			x	x
Relational context		x	x	x
The personal context			x	
Governance	x	x	x	

NOTE: A detailed elaboration of the comments of the experts can be found in Appendix I.

Looking at the comments of the experts, some alterations are made to the preliminary framework. The alterations are discussed below. Also, the justification of the alteration is explained.

Smart EMVI << SMART requirements

To add stronger legal instruments, the measure of creating SMART EMVI criteria has to be reformed into creating SMART requirements within the tender. This gives a client more support, in comparison to EMVI criteria, as they seem to be less compelling and have less legal grounds to come back to.

Contract can fail, so add addendums

It is good to keep in mind that a contact can fail. It might not have the proper content of coordination or collaboration for how a project is turning out in the execution phase. This is why this should be considered in the framework.

Collaboration agreement between clients

To support the cohesion between clients and make sure they have their goals aligned and responsibilities figured out, a collaboration agreement is advised. This stimulates good governance and makes sure the client's side is in place, causing no distinctive and unaligned governance.

Reciprocal values to create trust

A relationship comes both ways. This is why it is important to have reciprocal values. Next to this, trust is the overarching value, as mentioned in both the literature and case results.

Nuance equality and remember role of authority

Equality is a good aim; However, the client-contractor relation should not be forgotten. Primarily, the client instructs the contractor to carry out a certain job. The role of authority should not be diminished within these relations.

Scarcity of employees

Due to scarcity in the labor market, there is not an infinite pool of employees to pick from. An organization might not have the luxury of finding the right person for a project. They have to work with their resources. This is why this part is added to the framework. To make your employees a better fit, you can provide training.

Add SMART processes for escalation routes and increase functionality

During the interviews it became clear that escalation routes are not always functioning as they should be. Next to issues with coordination not being a direct trigger for escalation, the escalation fails to help a project manager due to too late feedback, no directive answers, and unclarity of who the right person is for a certain decision. To make this better, a SMART escalation process should be installed. It should be clear who makes the decisions, how to react to those people, and get a time-bound reaction.

9.2 Final framework

This paragraph shows the final framework in Figure 28. To show what parts of the framework represent the theoretical framework and the preliminary framework different colors are used. The grey texts represent the outcomes of previous frameworks. The dark grey texts represent the preliminary framework and the light grey texts represent the theoretical framework. The black texts are iterations from the expert outcomes.

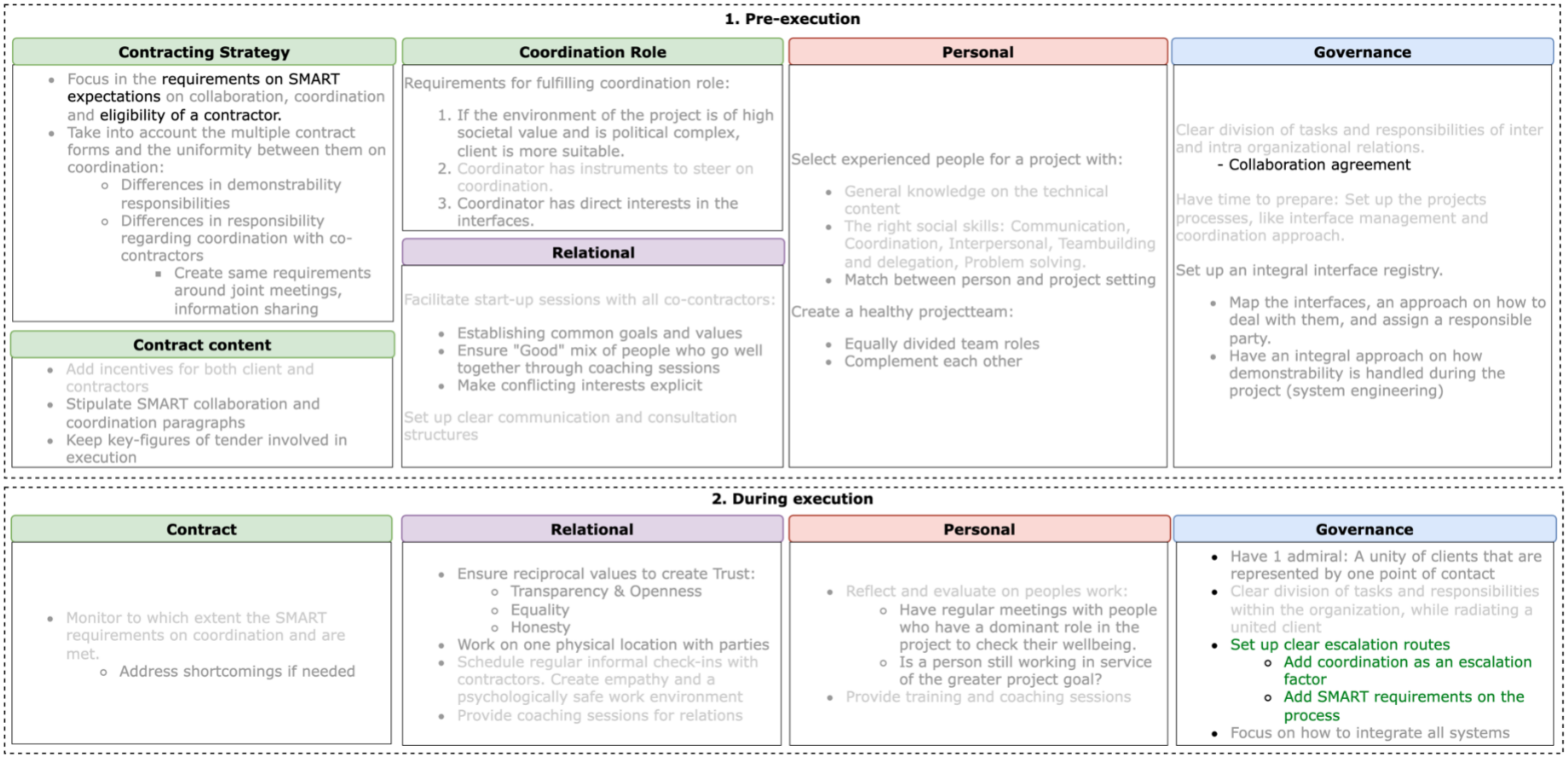

Figure 28. Final Framework

The upper part of the framework is about pre-execution measures. The lower part is about measures during the execution of a project. The green fields are connected to the contractual context. The purple parts are connected to the relational context. The red parts are connected to the personal context. The blue parts are connected to the governance context.

NOTE: Compared to the preliminary framework in Figure 27, Figure 28 contains more specific measures that focus on strengthening the coordination. This is why this framework is smaller. The more general measures are left out, but can still be found in the preliminary framework and should not be forgotten.

Explanation of thesis Framework

Contracting strategy:

To enhance coordination during the execution, it is important to take into account two things when deciding on what type of contracts will be used. These are:

- The way a client stipulates requirements on collaboration, coordination, and the eligibility of a contractor.
- How to connect different contract forms and create uniformity between the contracts on the responsibilities of demonstrability and coordination: To facilitate coordination, the same requirements on consultations, communication structures, and information sharing are needed throughout all the contracts.

Contract content:

To create clarity around the expectations on the coordination assignment and what is expected of the parties, a client has to steer on parties meeting the requirements stipulated in the contract. This is done by:

- Incentives for both clients and contractors: By adding incentives, both parties will be stimulated to meet the requirements. These incentives can be either bonuses for performing beyond expectations or a fine due to not meeting the requirements. By adding incentives for the client too, a certain equality is established. Next to this, it stimulates the client to overcome the bureaucratic organizational setup and accelerate its processes.
- SMART collaboration and coordination paragraphs: By stipulating the collaboration and coordination requirements SMART (Specific, Measurable, Acceptable, Realistic, and Time-bound), misinterpretations or unclear expectations are prevented.
- Keeping key figures involved during multiple project phases: To retain the knowledge of the people involved during the tender, stipulations on requirements for people continuing their work during the execution phase are needed.

Coordination Role:

To decide whether the client or contractor is better suited to coordinate, three factors need to be taken into account:

1. The environment of the project: If the environment of the project is of high societal or political value, the client is better suited to coordinate the project.
2. The instruments of the coordinator: If it is not possible to give a contractor instruments as a coordinator, the client is better suited to coordinate.
3. The interests of a coordinator: If a contractor is not directly involved in all the interfaces of a project, or a contractor does not have a contract overlapping with other contracts, a contractor does not feel integrally responsible and does not have a prime interest in coordinating the project. In this case, the client is more suited to coordinate.

Relational during pre-execution:

To create a good relational atmosphere and have healthy relations, the client has to organize Start-up sessions. Within these start-up sessions it is important to:

- Establish common goals and values: By finding a common goal with the project, parties are more willing to work together to reach those goals. Next to this, it is important to establish the values of the relationships you want to have within the project. Once it is clear to all parties which values are of worth, the standard of the relationship in the project is set.
- Think about the 'mix of people' involved in the project: Not all people might have the same way of collaborating and the softer aspects around this. To know each other and how every person is,

coaching sessions are advised. These coaching sessions will show how every party desires to collaborate and which communication styles follow.

- Also, enlighten the conflicting interests between parties: Within a project, parties will not always have the same interests. By making these interests explicit, parties know what to expect of each other and also understand why parties make certain decisions and act a certain way.

Next to this, the client needs to set up clear communication and consultation structures to facilitate coordination and not make it depend on coincidence.

Personal during pre-execution:

As shown in the research, people have a major influence on projects. This is why it is important to select the right people with a certain amount of experience for a project with general knowledge of the technical content, and the right social skills, consisting of Communication, Coordination, Interpersonal, Teambuilding and delegation, Problem-solving, and matching the character of a person to the project setting and 'match with contract form'. To stimulate the knowledge of people on both hard and soft skills, training is advised. By testing what type of person you have working on a project, you can see which competencies of a person are advanced and which are insufficiently developed. With this, training can be set up and adapted to every single person.

Next to this, a client has to create and maintain a healthy project team. Before the execution starts, make sure that:

- The team roles are divided equally: All the activities of the client during execution need to be fulfilled. This needs to be taken into account, and if needed extra people have to be employed to the project.
- People complement each other: To have a good work environment and get the best out of your project team, you have to select people who complement each other. Keep in mind both hard and soft skills here. NOTE: Due to the scarcity in the labor market it is not always possible to find the right mix. This is why it is important to provide training and coaching sessions that focus on working better together and see what the capacity, collaboration profile, and competencies are of each person. The IQ, EQ, and SQ are of importance.

Governance during pre-execution:

Before the execution phase starts, a client needs to have a clear division of tasks and responsibilities within the organization and with other clients.

Next to this, a client has to take the time to prepare and set up the project processes, like interface management, and coordination approach, and create an integral interface registry to which all contractors have access. Also, map the interfaces, stipulate an approach on how to deal with them, and assign a responsible party before the start of the execution.

Keep in mind that an integral approach to demonstrability is needed during the project (system engineering).

Contract during execution:

To check it which extent the SMART requirements on coordination are met, it is important to monitor the progress regularly. This gives the client the possibility to intervene in time, if necessary. The client could facilitate the coordination process, or remind the coordinating contractor of the requirements. If a contractor does not comply with the coordination requirements, a client could take legal action. By demonstrating to which SMART requirement the contractor comes up short, a client can prove the negligence of the contractor.

Relational during execution:

During execution, a client should ensure the following values to create Trust:

- Transparency & Openness: Let contractors know what is going on, even if this might not be positive. If changes need to be implemented, let it know as soon as possible.
- Equality: Show the contractors you are in it together. Pain & gain sharing. Note: Take into account the relationship of authority.
- Honesty: Be upfront about decisions and their basing.

By highlighting the fact that these values need to be reciprocal, the contractor is partly responsible for the relation. To stimulate good relationships and keep them healthy, a client should provide coaching sessions. The sessions should not only be focused on conflicts but also on how to make the relationships even better.

To improve the relations, all parties should work on one physical location. This creates shorter communication lines and lowers the risks of misalignment and misinterpretation. This is crucial for the coordination process.

To find how each contractor is doing, regular informal check-ins need to be scheduled. In these check-ins it should not be about the activities of a contractor connected to the project, but more about how the contractor individually is doing. This creates empathy and stimulates a psychologically safe work environment.

Personal during execution:

To check the performance of the project team, a client has to reflect and evaluate people's individual work. By checking this, the client knows to which extent each person is still working in favor of the project and its goals. Next to the performance, the well-being of each individual needs to be monitored. This is done by having regular meetings with people who have a dominant role in the project. If people have too much workload or do not feel well, a client should take action. This could be in the form of hiring more people, providing training to strengthen the knowledge of people, or providing coaching sessions that focus on people's mental health.

Governance during execution:

During execution, the client has to have a clear governance in place to not undermine the coordination process. This is done by having one figurehead representing all clients involved. One client has to oversee and steer the overall project processes and facilitate the needed coordination. Clients have to be aligned, before they can expect this from contractors. Leading by example is important.

Next to this, a clear division of tasks and responsibilities within the cliental organization is needed. The internal organization has to be aligned too and has to have the same overall interests for the project. Within the organization a client has to set up clear escalation routes for project teams and add coordination as an escalation factor for proejct managers. Also, the escalation routes have to be functional. This is stimuled by adding SMART requirements on the processes of escalation. A proejct manager has to receive a time-bound anwer, with realistic and spesific measures/actions in place.

Lastly, a client has to focus on how to integrate all systems used during project execution.

10. Discussion

In this research, different measures are brought to light to deal with coordination issues on multidisciplinary projects with co-contractors. These measures influence the contractual, relational, personal, and governance aspects of a project. Previous research mainly focused on contractual and organizational measures. This thesis provides new insights by mainly looking at the client's influences in finding the balance between the contractual, relational, personal, and governance contexts of multidisciplinary projects.

This chapter presents the discussion of this research. Paragraph 10.1 addresses the validity of this research. In paragraph 10.2 the results are interpreted. The limitations of this research are discussed in paragraph 10.3. In paragraph 10.4 the implications are elaborated on. Lastly, in 10.5 recommendations for further research are given.

10.1 Validity of the research

The validity of each phase of this research is explained in the methodology chapter (Chapter 3). This paragraph gives a summary on what is done to create a higher validity of this research. With a case study design being used, the construct, internal, and external validity have to be taken into account, as well as the reliability (Yin, 2009).

Construct validity

The construct validity of a research is based on multiple sources and using multiple perceptions within case studies to measure a certain construct (Yin, 2009; Quintão et al., 2020). In this research, this is the origins of the coordination problems and the effects of the contractual, relational, personal, and governance contexts. To increase the construct validity, multiple cases are used and each case consists of multiple participants. This shows to which extent the construct is measured within multiple cases and by multiple participants.

Within the research, multiple sources are used as input for the final model. The literature review, the case study with both interviews and document research and the expert sessions are used.

Internal validity

The internal validity depends on whether the outcomes of the research are grounds for plausible causal arguments that follow (Yin, 2009; Quintão et al., 2020). Easier said, do the results of the case study represent the truth for the overall population. The interview questions are chosen carefully in such a way that the influence of other factors and subjectivity is minimized. To keep the interviews objective, semi-structured interviews are chosen. The primary questions are asked to all participants, under the same circumstances.

This is also done for the expert sessions. The same framework is shown to every expert, and every expert has the same time to reflect on each part of the framework.

External validity

The external validity of a research is based on the extent to which the conclusions of a research can be generalized outside of the context of the research (Yin, 2009; Quintão et al., 2020). For the cases of the case study and the participants of the interviews, selection criteria were set up. This was done to choose the cases and participants fairly and to have a good representation of the population.

To validate the results of the case study, expert sessions were done. The experts were chosen, based on their experience within the construction sector and their occupation.

Reliability

The reliability of research is about the consistency of the results and whether the research could be replicated by others (Quintão et al., 2020). To ensure reliability, multiple steps throughout the research are laid down. As explained in the methodology, the literature search and review processes are presented in Appendix A. This shows the used que-strings, the filters used to sort out the right articles, and the number of articles that came out of every step.

To increase the reliability of the interviews, the interview protocol is laid down in Appendix E. To make sure the interviews contained everything the participants mentioned, the transcribed interviews were sent back to the interviewees to be verified and to limit wrongful interpretations. This strengthens the reliability of the transcribed interviews. An attempt has been made to do all the interviews under the same conditions, with the same interview questions, the same amount of time, and the same attitude from the researcher's side. Also, a protocol was set up for the expert sessions. This can be found in Appendix H.

10.2 Interpretation of results

The results of this research show the importance of the softer side within projects and their relational atmosphere. As the literature shows, the need for collaboration and good coordination is increasing with the development of more large-scale and complex multidisciplinary projects. The contractual, relational, personal, and governance contexts need more alignment with the individual projects on the concepts of coordination and collaboration, as expected. However, some additional findings arose. These are explained below.

Awareness vs execution: Structural change is needed

What was found within the municipality of Rotterdam, is that people are aware of the importance of the softer side of project management. However, the main focus point stays with the technical content of the projects. People are aware of the importance of the human aspects, but implementation is harder. The question is whether this is due to the bureaucracy of the municipality which makes structural changes hard, or whether the people themselves struggle with change management. This would need further research. What is clear, it that a structural change is needed to also implement and use the human aspects of project management more within execution.

Drivers of behavior and influence on project results

As the research shows, the organization of the coordination process and the collaboration process is one of the key elements in project success. However, the attitudes of parties involved will always have a great influence on the project result. The outcomes of this research implicate that intrinsic motivation is needed to collaborate and a closed and rigid attitude are the recipe to failure. No matter how well the processes are thought through and set up, the underlying drivers of behaviors of the parties involved will affect the overall attitude and willingness to collaborate. These drivers will always result in the coordination being different than expected or intended to.

Strict separation or towards partnering

The mix of different PDMs creates confusion about the responsibilities of multiple important aspects of projects in the infrastructure sector. Clear agreements on the aspects of demonstrability, consultation, decision-making, etc. have to be made to mix multiple DPMs in one project. The outcomes of this research show that if this is not done, coordination becomes harder. This raises the question of whether a strict decision should be made on mixing multiple PDMs or sticking to one single PDM for all the sub-projects. Mixing is not an option if the parties cannot cope with the shredded responsibilities it causes.

Pain in relationship with other clients

Public commissioning and the relations between the clients played a more dominant role than expected. The scope of this research mainly focuses on the client-contractor relation. But a lot of pain can be found in the client-client relationship. This might even be a bigger problem. The results show that when public commissioning is not arranged properly, the rise of issues in the execution phase is almost unavoidable. A client cannot expect a contractor to do the right things if the clients themselves are not able to align and lead by example.

10.3 Limitations of the research

This research has several limitations. The limitations are explained below.

Potential bias because of participant pool

The interviewees were all (previous) employees of the Municipality of Rotterdam who were involved in the projects of the case study. Since a part of the interviews is about personal views and more subjective views on the projects, sampling bias might arise. This could make the outcomes of this research not generalizable. To mitigate this, a contractor was used in the expert sessions. However, in the future, it would be better to include a more diverse pool of participants in the interviews, like contractors or employees from other clients involved in the projects.

Ethical limitation due to confidentiality

The interviews were anonymized and confidential. This was strengthened by informed consent forms. As this gives the interviewee the room to speak freely and honestly, an unintentional limitation of the research followed by making it harder to objectify the research.

Sampling and process of expert sessions

The expert sessions were held with four experts on an individual basis. The individual sessions did serve the goal of the expert sessions, which was validating the preliminary model. However, a plenary session with all experts would have given more room for discussion on the topics of this research. This could have led to a bycatch of insights, broadening the research outcomes. This would be a consideration for future research.

Validation of framework in practice

Due to time constraints, it was not possible to test the final framework of this research in practice. This affects the validity of the framework.

10.4 Implications of the research

As can be seen within this research, the relational aspects of projects have a major influence on the project's processes and results. It is important to take this into account during a project start-up and throughout all the following phases of a project. The way coordination is arranged influences the way parties collaborate with each other.

This research established not only the contractual and organizational measures taken to improve coordination but also zoomed in into the relational context and how this is defined in the contracts and operations. It showed that the relational aspects are often seen as less important from a client's perspective. In future project of public clients, they will know how to approach the coordination process, and which measures in the contractual phase and in the execution phase of a project can support this process.

If the outcomes of this research are not taken into account in the future, projects would still operate in a suboptimal form. Coordination from a public client would not be aligned to the projects needs and insufficient coordination, which could result into high failure costs, like the Hoekse lijn project and the Noord-Zuidlijn project.

Looking at the current literature, the main question that arises is whether the scope of the thesis should be on avoiding dividing in sub-projects and interfaces, rather than looking at ways to mitigate the consequences of interfaces.

10.5 Recommendations for further research

To complement this research, multiple recommendations are made for further research. These recommendations are shown below.

Inter-organizational relations (client-client)

The results showed the unexpected importance of the intra-organizational setup and relations at the client's side. The way coordination is set up within a client's organization, and the organization between clients is a big factor in the extent to which collaboration is supported and the project is a success. This research has underestimated this contribution. This is why it is recommended to research the effects of commissioning on the coordination of interfaces between co-contractors.

Next to this, large-scale multidisciplinary projects often involve multiple clients. This research showed that with multiple clients involved, unclarity and indecisiveness arise from a client's side. It showed the importance of the alignment of public commissioning. That is why it is recommended to focus on client-client relations in large-scale multidisciplinary projects which are divided into multiple contracts.

Practical tools

As this research mainly focused on coordination problems, the practical application to deal with these problems has gotten limited attention. To support this research, it is recommended to further investigate the effects of the practical tools in the final framework, especially within the relational context. By looking at what the effects are of the instruments, and which instruments have the biggest effect, a more suitable approach can be made for each individual project.

Balance between intrinsic and extrinsic motivation

As indicated in the outcomes of the results, a problem that might occur when requirements on collaboration and coordination are written down in contracts is that the intrinsic motivation of parties is overshadowed by the extrinsic motivation. One of the interviewees already expressed their concern of making collaboration an obligation, rather than a driving force or one's desires or motivations. This has some effect on the trustworthiness and will to cooperate of parties. To uncover what the effects are of writing down 'softer aspects' in contracts and making it a 'hard requirement', it is recommended to research this phenomenon. This would clarify what the effects of potential emerging problems are, by implementing the results of this research.

11. Conclusion & Recommendations

This chapter aims to answer the main research question of this thesis. First, the sub-questions are answered, using the literature review, case study, and expert sessions. After this, the main research question is answered, using the sub-questions. The second part of this chapter provides recommendations for practice, in particular the municipality of Rotterdam.

11.1 Conclusion

The goal of this research was to find the balance of different instruments within the contractual and organizational context, divided into the relational, personal, and governance contexts to improve the coordination of multidisciplinary projects with co-contractors. To do this, 4 sub-questions were set up. These sub-questions are answered below.

SQ1: How is 'good coordination' established? What are the current barriers?

Good coordination is established by having accountability through having one suitable coordinator with mandate, project managers with the right skills, and arrangements on liabilities and duty to warn. Also, predictability should be established through agreements on planning and techniques. The third one is having common understanding through not hindering each other, consultation and communication structures and expressing information needs of all parties, including feedback.

The found barriers are: the coordinator having no mandate, having the wrong coordinator, having no agreements concerning the alignment of planning and techniques, no consultation structure, parties having no room to express their information needs, no duty to warn, unnecessary hindrance of activities, and having no liability arrangement between parties. Next to this, the failure factors of coordination are conflicts, insufficient investment in project management, bureaucracy, distrust during procurement and execution, and insufficient preparation time. These are closely related to the barriers stated and are taken into account too.

SQ2: What are the theoretical steering mechanisms of coordination with co-contractors?

SQ2 is answered using the literature review. The steering mechanisms within each context are shown in Table 17 below.

Table 17. Steering mechanisms

Contractual	Relational	Personal	Governance
a. The scope of the coordination assignment and the associated powers and tools	f. Early formation of integrative work practices	j. Experience	n. Clear responsibilities
b. The way decisions are made about coordination	g. The development of a common philosophy	k. Competent on a technical level (hard skills)	o. Proactive attitude within organization

c. The distribution of risks associated with coordination	h. Open communication	l. Competent on a social level (soft skills)	p. Preparation time
d. The way in which the parties deal with conflicts	i. Early and clear role expectations	m. People-oriented characteristics	
e. The way in which the parties settle disputes			

SQ3: Where do problems occur hampering the effect on coordination and what are the origins of these problems?

Using the results of the case study in combination with the literature review, the following problems were uncovered.

1. Misinterpretation and misalignment issues of the specifications of an agreement

When a client procures a project, specifications are set up to translate what the client's wishes are. However, a contractor might have a deviated interpretation of those specifications and how to fulfill them. This could also be the case with a coordination assignment. Next to this, misalignment of the specifications between co-contractors occurs due to the differences in contracts of the co-contractors. Specifications on consultation, communication, planning, etc. affect the level of collaboration and the difficulty of coordination.

2. The wrong choice of coordinator

If the wrong coordinator is chosen (client vs. contractor), the coordination will be sub-optimal. The (external) environment of the project, the mandate of the coordinator, and the interests of the coordinator in the overall project need to be taken into account.

3. Lack of attention to relations

With the division of a project into multiple contracts, a lot of different parties have to collaborate on the interfaces between the different contracts. This requires more attention to the human aspects of the parties you are working with. This research shows a lack of attention to the relations with other parties. The focus is mainly on the technical content of a project.

4. Insufficient governance

A lot of issues with coordination occur due to insufficient alignment of the governance, especially when multiple clients are involved. The scattered division of responsibilities between clients creates an unclear and not-cohesive atmosphere during the execution of a project. Next to this, intra-organizational governance is seen as bureaucratic and underperforming. Within the organization, a lot of different interests and opinions result in an uncoherent client.

SQ4: What are the instruments of a public client to tackle coordination problems, within a client's boundaries?

The instruments of a public client to tackle the coordination problems are presented in Table 18. The instruments are divided into contractual, relational, personal, and governance measures. They can all

be used to avoid or minimize the risks of coordination issues. Figure 30 shows how the instruments are incorporated into the framework of this thesis.

Table 18. Instruments of a client to steer coordination

Contractual	Relational	Personal	Governance
Requirements in contracts: – SMART coordination – SMART collaboration – Demonstrability – Retaining people	Agreements: – One location – Values	Training and coaching sessions: – Technical content (IQ) – Social content (EQ & SQ)	Inter and intra organizational set up
Contracting strategy: – Finding right coordinator – Suitable PDMs	Consultation and Communication structures	Facilitate project team: - Add or remove people - Shift responsibilities	Add coordination as escalation factor
Incentives	Leading by example	Evaluations	SMART escalation routes
Monitoring	Schedule meeting	Selection procedures	Set up integral systems
Make parties liable in case of non-compliance	Start-up sessions		Install enough preparationtime
	Coaching sessions		Assign one representative for all clients

MQ: How should the coordination of a multidisciplinary project with co-contractors be organized through the front-end contractual arrangements and the managerial context during execution, by a public client?

By using the previously answered questions, the final framework was created. This is seen in Figure 30. It displays what has to be taken into account during the pre-execution and execution phase to achieve a better coordination process and better collaboration and which measures support this. To read the explanation of the framework, see Appendix K. Figure 29 below summarizes the outcomes of the framework. The content of each box needs to be taken into account when organizing coordination for a multidisciplinary project.

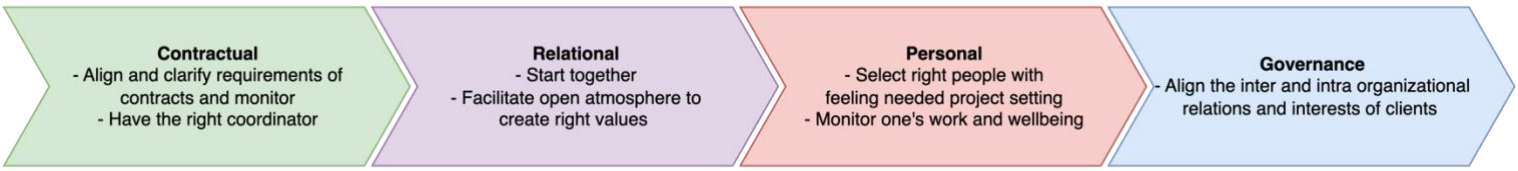

Figure 29. The organization of coordination in the different contexts

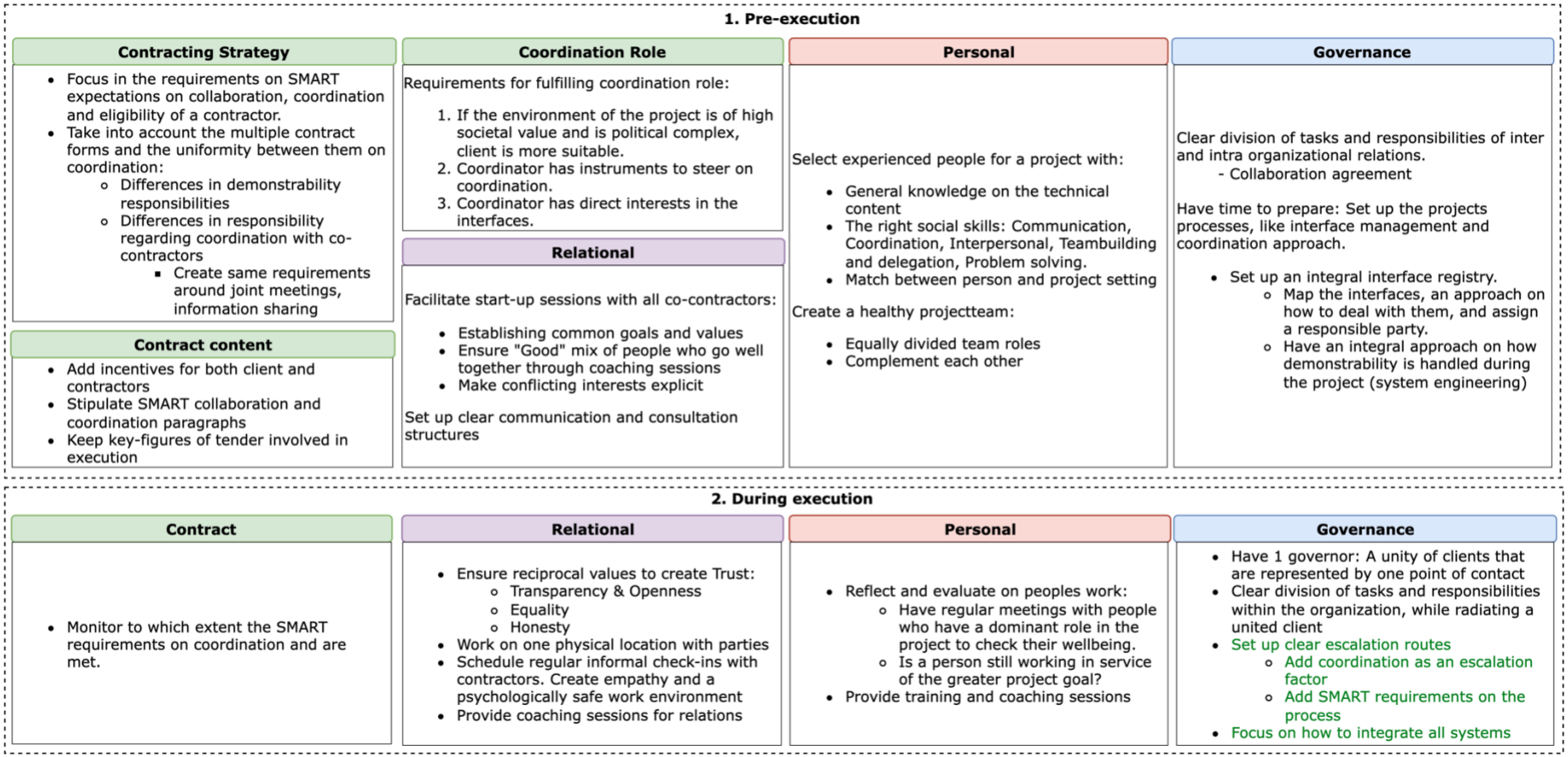

Figure 30. Thesis framework

The upper part of the framework is about pre-execution measures. The lower part is about measures during the execution of a project. The green fields are connected to the contractual context. The purple parts are connected to the relational context. The red parts are connected to the personal context. The blue parts are connected to the governance context.

11.2 Recommendations for the Municipality of Rotterdam

This paragraph provides recommendations for the municipality of Rotterdam based on the outcomes of this thesis. By having a critical look at the processes and the outcomes, four recommendations are made for the municipality in specific. The recommendations are elaborated on below.

Work towards partnering with co-contractors

If a project is split up into multiple contracts, a client could do two things. A client can either take total control through DBB contracts and set up clear specifications. Here, the client takes total control over coordination and does interface management starting in the project's pre-execution phases. However, the municipality of Rotterdam does not have the capacity in-house to accomplish this. This is one of the reasons why partnering with contractors and integrated contracts become more popular. Looking at the outcomes of this research and taking into account the current market forces in the construction sector, it is advised to the municipality of Rotterdam to further explore partnering options with contractors. By involving the contractors earlier, having better alignment from the start, and focusing more on collaboration and the human side of working together, coordination and interface problems would be minimized or even avoided. Taking the renovation of the Maastunnel as an example where collaboration with the contractor was centralized, the municipality could make big wins.

Revise the organizational setup when working on large-scale multidisciplinary projects

The municipality of Rotterdam has to fulfill a lot of different tasks for society. This requires the municipality to have multiple different departments and sections within the organization. With multidisciplinary projects, multiple departments are involved. However, every department has its own procedures and work methods. This leads to a fragmented intra-organizational decision-making process and unintegrated systems. Also, those departments appear to have different interests in the projects, which leads to unaligned and non-cohesive attitudes. To create alignment within the municipality and integrate the municipal procedures, another setup to work with multidisciplinary projects has to be found.

Use consciousness of the importance of relations in practice

Employees of the municipality of Rotterdam are aware of the importance of relationships and human aspects within projects and project management. However, the harder technical content is seen as the most important. This is why it is advised to the municipality of Rotterdam to strike a blow on collaboration by giving the human aspects and relations a prime place within the RSPW and supporting this by providing training on how to incorporate this into day-to-day project management.

Work towards partnering with other clients

With today's large-scale public multidisciplinary projects, it is almost the standard that multiple clients are involved. Generally, these clients have a different end game and engage individually within the projects. During execution it appears that this leads to unclear responsibilities between clients and not striving for the same project result. With this, public commissioning still has room left for improvements. Looking back at this research, it is advised to the municipality of Rotterdam to first figure out the relations with other clients, before looking at the involvement of contractors. Clients have to form one cohesive entity that functions well and that acts as a professional, cooperative, and trustworthy client.

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Appendices

Appendix A: Literature review process

This appendix provides an overview on the literature review process for scientific literature. The query strings for each search are shown for each topic. After this, the search is filtered by using including criteria. After this, the abstract of each paper is analyzed. Lastly, a complete analysis for each paper is done. After every step the number of found papers is provided (n).

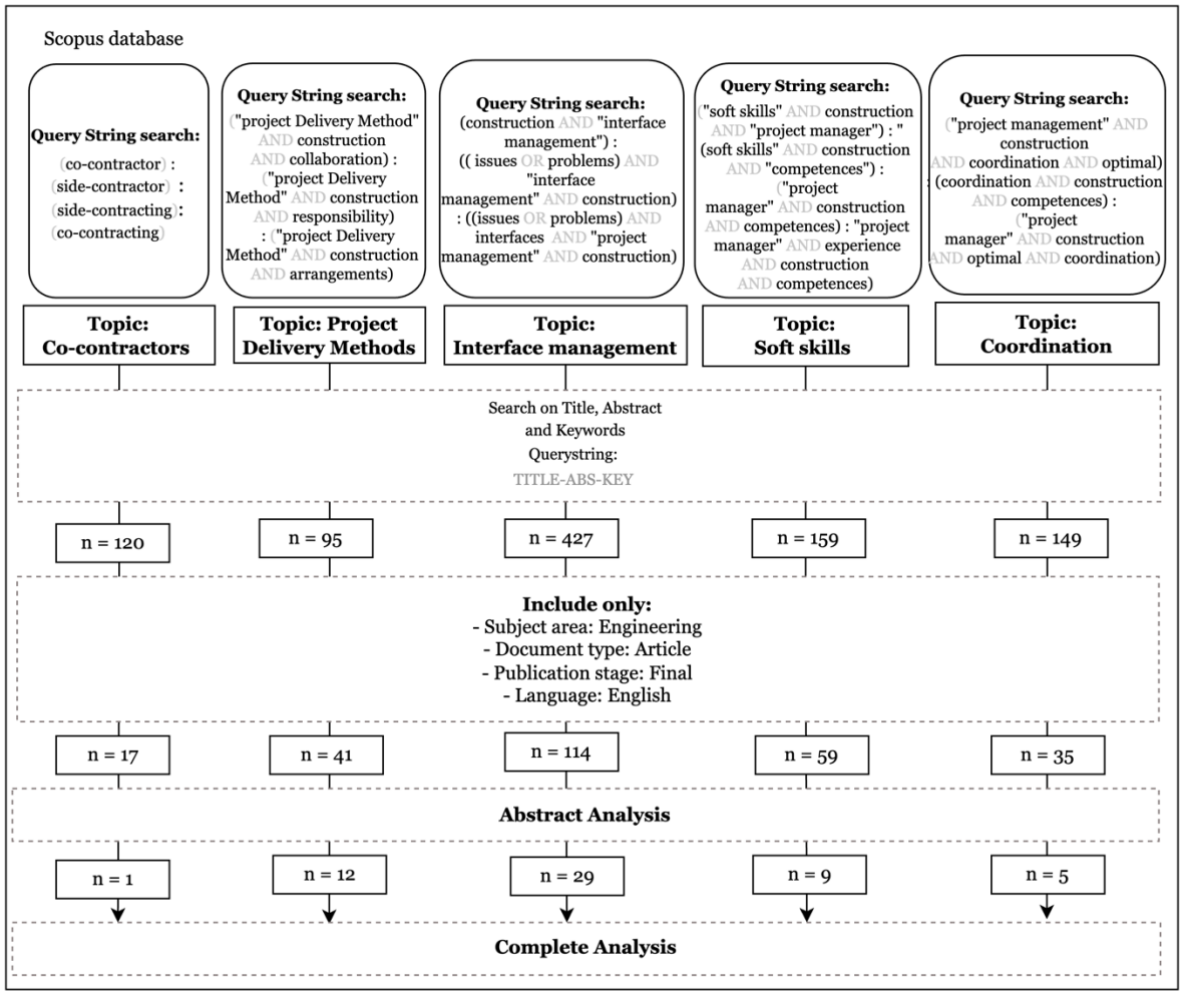


Figure 31. Literature review process of scientific literature in Scopus

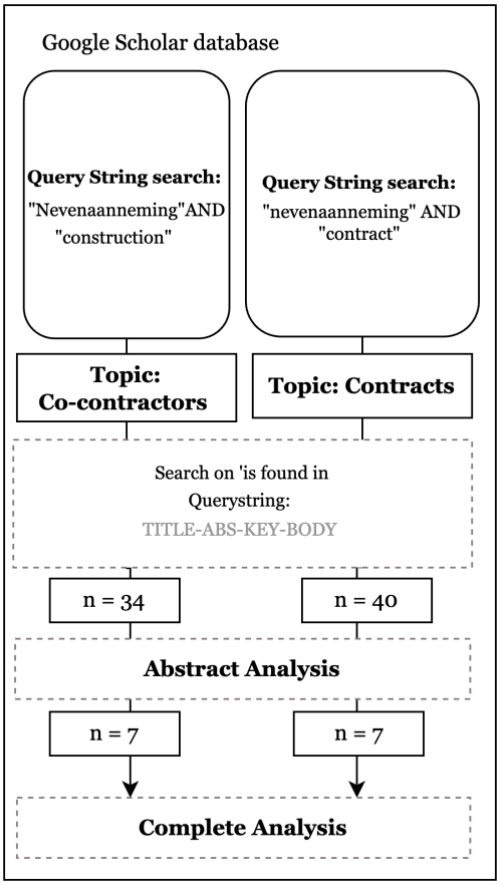


Figure 32. Literature review process of scientific literature in google scholar

Appendix B: Cut motives from the client by Winters (2014)

Table 19 displays the multiple motivations of clients to divide a project into sub-projects.

Table 19. Stimulating and obstructive reasons to divide a project (Adapted from Winters, 2014)

Stimulating	
Set products, suppliers and consultants	Known contractors
External knowlegde, experience	Use of specialised contractor
Procurement Law	Steers on more contracts
Construction culture	Every party uses their own think processes and contract preferences
Capacity	Contractor is able to work independent, MKB companies can bid
Price Assurance	Market approach is efficient, most advantageous for every discipline, more bids
Influence on politics and society	Better alignment with environment, quicker delivery of sub-projects
Support creation	Lowering of total price by avoiding extra risks
Phase of project	Certain design and execution activities can be accelerated or delayed
Architectural quality	Aesthetic value can be increased by appointing separate architect
Quality assurance	Every sub-project has higher quality assurance
Influence on architect	Architect is able to make a separate design
Obstructive	
Geological characteristics	Geoscientific discipline necessary because of different undergrounds
Projectmanagement costs	Higher procurement, monitoring, and management costs
Function of systems	Wanted lead time during execution
Internal knowledge, experience & capacity	All knowledge lies within the contract parties, no learning curve internal
Stimulating the market	Less integral approaches, so innovation can be hold back
Procurement law	In contrast with most company guidelines, who want less contracts and more integral projects

Appendix C: The Dutch translations of the UAV-2012 & UAV-GC

This appendix shows the Dutch translations of the articles used in the legal context of the literature review of this research. First the translations of the UAV-2012 are shown. After this, the UAV-GC 2005 translations are presented.

UAV-2012

Chapter 9, par. 31 states:

1. *Indien verschillende werken in elkander grijpen, wordt dit in het bestek vermeld.*
2. *Tenzij in het bestek anders is bepaald, geschiedt de coördinatie van in elkander grijpende werken door de directie.*
3. *De aannemer gedoogt – zonder aanspraak op andere vergoedingen dan de in het volgende lid bedoelde – dat door derden, aan wie de directie zulks toestaat, tegelijkertijd en te zelfder plaatse wordt gewerkt.*
4. *Hij gedoogt, dat daarbij gebruik wordt gemaakt van reeds gemaakt werk en gemaakte hulpwerken. Voor dit gebruik kan de aannemer aanspraak op bijbetaling doen gelden, indien meer van hem wordt verlangd dan redelijkerwijs van hem kan worden gevergd.'*

Chapter 2, par. 3, section 4 states:

'Zolang en voor zover de opdrachtgever niet schriftelijk aan de aannemer van het tegendeel doet blijken, vertegenwoordigt de directie de opdrachtgever in alle zaken het werk betreffende. In de gevallen echter, waar in de UAV uitdrukkelijk de opdrachtgever is genoemd, is alleen deze bevoegd.'

Chapter 2, par. 3, section 6 states:

'De directie oefent het toezicht uit op de uitvoering van het werk en op de naleving van de overeenkomst.'

Chapter 9, par. 26 explains that a planning is to be made by the contractor and needs approval of the client. Section 1 states:

'De aannemer stelt zo spoedig mogelijk een op de aard van het werk afgestemd algemeen tijdschema op.
In dit algemene tijdschema wordt duidelijk aangegeven op welke wijze, in welke volgorde, met welk materieel en met welke hulpmiddelen de aannemer voornemens is het werk en zijn onderdelen uit te voeren alsmede welke tijdsduur hij voor elk onderdeel nodig acht.
Tevens wordt daarin aangegeven op welke tijdstippen de aannemer ten behoeve van de voortgang van het werk en de volgorde van de onderdelen ervan zal dienen te beschikken over datgene waarvoor de opdrachtgever of de directie volgens de overeenkomst dient te zorgen. Het algemene tijdschema dient te voldoen aan de eisen, die ten aanzien van de uitvoering van het werk in de overeenkomst zijn gesteld, en wordt door de aannemer van een behoorlijke toelichting voorzien.'

Par. 26, section 7 states:

'Wijzigingen door de directie in het goedgekeurde algemene tijdschema of gedetailleerde werkplan aangebracht geven de aannemer aanspraak op bijbetaling, indien van hem meer wordt verlangd dan redelijkerwijs van hem kan worden gevergd.'

Chapter 9, Par. 27, section 1 states:

'De directie maakt weekrapporten op. Hierin worden onder meer aantekeningen opgenomen betreffende:
– de vordering en de stand van het werk;
– de onwerkbare dagen en het verleende uitstel van oplevering;
– de aan- en afvoer en goedkeuring van bouwstoffen;
– de aan- en afvoer van materieel en hulpmiddelen;
– bestekswijzigingen, meer en minder werk, verwerkte hoeveelheden en stelposten;
– opneming, goedkeuring en oplevering van het werk;
– de verstrekking van tekeningen;
– voorvallen betreffende de veiligheid en/of gezondheid van personen.'

Chapter 9, Par. 27, section 9 states:

'Indien is overeengekomen dat tijdens de uitvoering van het werk bouwvergaderingen worden gehouden, maakt de directie daarvan verslagen. De verslagen worden zo spoedig mogelijk aan de aannemer ter ondertekening voorgelegd. Indien de aannemer zich met de inhoud van het verslag niet kan verenigen, wordt aan het verslag een aantekening toegevoegd waaruit blijkt tegen welke gedeelten en om welke reden hij bezwaar heeft. Het verslag wordt in de daarop volgende bouwvergadering vastgesteld.'

UAV-GC 2005

How the general responsibility of coordination is laid down in integrated contracts, is stated in Chapter 4, par. 8 *'relation to other works'.* This paragraph states:

1. *Indien tijdens de nakoming van de Overeenkomst in opdracht van de Opdrachtgever werkzaamheden door nevenopdrachtnemers worden verricht, die van invloed kunnen zijn op het Werk en/of het Meerjarig Onderhoud, vermeldt de Opdrachtgever in een bij de Vraagspecificatie gevoegdeannex de aard van deze werkzaamheden, het voorziene tijdstip waarop zij worden verricht, alsmede de coördinatie daarvan.*
2. *Bij het verrichten van de Werkzaamheden houdt de Opdrachtnemer rekening met de in lid 1 bedoelde werkzaamheden van nevenopdrachtnemers.*
3. *De Opdrachtnemer is verplicht toe te laten dat nevenopdrachtnemers de in lid 1 bedoelde werkzaamheden verrichten op de in dat lid bedoelde tijdstippen. Hij is verplicht toe te laten dat nevenopdrachtnemers daarbij gebruik maken van resultaten van Werkzaamheden.*
   De Opdrachtnemer wordt geacht in zijn Aanbieding rekening te hebben gehouden met het feit dat de in lid 1 bedoelde werkzaamheden door nevenopdrachtnemers worden uitgevoerd. Hij kan daarnaast echter recht doen gelden op kostenvergoeding en/of termijnsverlenging, met inachtneming van het bepaalde in § 44 lid 1 sub a.

Chapter 4, Par. 7, section 1 states:

'De Opdrachtnemer is verplicht bij de uitvoering van de Overeenkomst de in de bij de Vraagspecificatie gevoegde annex opgenomen planning en de overeengekomen mijlpaaldata in acht te nemen.'

Appendix D: List with steering mechanisms

This appendix present a list of the found theoretical steering mechanisms of coordination in Table 20.

Table 20. Steering mechanisms lined up

Contractual
a. The scope of the coordination assignment and the associated powers and tools b. The way decisions are made about coordination c. The distribution of risks associated with coordination d. The way in which the parties deal with conflicts e. The way in which the parties settle disputes
Relational
f. Early formation of integrative work practices g. The development of a common philosophy h. Open communication i. Early and clear role expectations
Personal
j. Experience k. Competent on a technical level (hard skills) l. Competent on a social level (soft skills) m. People-oriented characteristics
Governance
n. Clear responsibilities o. Proactive attitude within organization p. Preparation time

Appendix E: Interview strategy

This appendix explains the interview strategy in Dutch, since all the interviews are conducted in Dutch. It shows the interview set-up, as well as the model questions that serve as a basis for the semi-structured interview.

NOTE: The interview questions and its sequence can deviate from the set-up below for the participants. This depends on the flow of the interview with every single participant.

Interview set-up:

- Introductie
    - Aanleiding voor interview
    - Privacy en dataverwerking
    - Interview opzet
- Interviewvragen over de onderwerpen
    - Ervaring en selectie van participant voor projecten
    - Coördinatie, raakvlakken en samenwerking tijdens executie van project
    - Skills van een project manager in multidisciplinaire projecten
    - Contractuele inrichting
- Afsluiting

1. Introductie (5 minuten)

1. Aanleiding voor interview

Mijn naam is Josje Gerlag en ik doe dit onderzoek als afstudeerder van de TU Delft voor de opleiding Construction Management & Engineering. Ik doe dit in samenwerking met de Gemeente Rotterdam IBR, wat ook mijn stageplek is.

Het doel van mijn onderzoek is om in kaart te krijgen hoe de coördinatie vanuit de opdrachtgever verloopt en waar dit wellicht misgaat in de praktijk, om zo tot een beter coördinatieproces te komen. Hierbij staat de zachte kant van een projectmanager centraal in combinatie met de ondersteuning van het contract.

Zeker bij complexe en multidisciplinaire projecten waar veel partijen betrokken bij zijn, is coördinatie cruciaal. Alle activiteiten moeten goed op elkaar afgestemd worden, helemaal wanneer men te maken heeft met een beperkt gebied waarin het project gerealiseerd dient te worden. Als er verschillende aannemers verschillende delen van het werk moeten uitvoeren, krijg je raakvlakken, ofwel interfaces. Deze raakvlakken moeten beheerst worden. Dit is de scope van het onderzoek.

Daarbij worden vandaag de dag 'soft skills' steeds belangrijker in projectmanagement. Echter is hier nog relatief weinig aandacht voor in onderzoek en op projectgebied. Met soft skills wordt vaak verwezen naar communicatieve vaardigheden, samenwerken en flexibel denken. Je emotionele intelligentie is hier heel belangrijk.

Ook de manier waarop coördinatie en de soft skills worden ondersteund in een contract is nog marginaal belicht. Daarom wordt er ook gekeken naar hoe het contract kan ondersteunen hierbij.

Ik hoop, door middel van dit interview, een beter beeld hierop te krijgen.

2. Privacy en dataverwerking

Het interview wordt, met uw toestemming, opgenomen en getranscribeerd. Mijn doel is om al uw antwoorden vertrouwelijk te houden. Dit doe ik door uw persoonlijke data zo snel mogelijk te verwijderen, zoals de opname van het interview. Als de opname getranscribeerd is, vraag ik uw goedkeuring op het transcript. Na goedkeuring zal de opname verwijderd worden en wordt het transcript anoniem gemaakt. Alleen ik zal weten welk transcript tot u behoort.

Dit brengt echter risico's met zich mee in de vorm van data breuk. Alle data zal worden opgeslagen in mijn persoonlijke map op de server van de Gemeente Rotterdam om de veiligheid van de data zo veel mogelijk te waarborgen. De anonieme transcripten zullen worden gecodeerd. De gecodeerde transcripten zullen uiteindelijk de basis zijn voor mijn onderzoek. De transcripten zelf zullen geen onderdeel uitmaken van mijn Thesis die gepubliceerd wordt in de Education Repository van de TU Delft.

Mocht u zich niet comfortabel voelen met deze aanpak, dan kunt u dit ten alle tijden aangeven waarna we samen kijken naar waar u zich comfortabel bij zou voelen. Daarbij kunt u zich altijd terugtrekken of vragen niet beantwoorden. Uw deelname aan het interview is volledig vrijwillig.

3. Interview opzet

Het interview zal ongeveer 1 uur duren. De data die uit het interview komt zal gebruikt worden om de huidige coördinatieproblemen en coördinatie successen bloot te leggen en wat de invloed van zachte

vaardigheden en het contract hierbij is, en om te onderzoeken hoe dit in de toekomst wellicht beter kan. Het interview is semi-gestructureerd en bevat dus veelal open vragen die u zo veel mogelijk naar eigen ervaring dient te beantwoorden. Dit houdt in dat de vragen sturend zijn voor het onderwerp, en u zelf open kan antwoorden op de vragen.

De onderwerpen van het interview zijn:

- Ervaring en selectie van participant voor projecten
- Coördinatie, raakvlakken en samenwerking tijdens executie van project
- Skills van een project manager in multidisciplinaire projecten
- Contractuele inrichting

Deze onderwerpen zijn naar voren gekomen in de literatuurstudie die ik vooraf aan het interview heb gedaan. Over de onderwerpen kunt u volledig uw eigen visie en gedachten uiten. Hierbij is geen fout antwoord mogelijk. Zo nodig, zal ik u sturing geven richting de informatie over de onderwerpen die voor mij interessant is.

Na afloop kunt u eventueel een eigen invulling geven aan het interview. Dit is het moment dat u extra toelichting kan geven op bepaalde onderwerpen of dingen waarvan u vindt dat deze nog niet goed genoeg aan bod gekomen zijn tijdens het interview.

-- start interview opname –

- Naam en functie participant
- Datum en locatie

2. Interviewvragen (50 minuten)

Onderwerp	Doel van vraag
Ervaring en selectie	
1. Kunt u iets vertellen over uw achtergrond in de projectenwereld? a. Hoe is uw interesse ontstaan voor de projectenwereld?	· Gesprek op gang brengen · Open sfeer creëren
2. Hoe is het project begonnen en wat is de rol van u hierin? a. En hoe bent u hier in beeld gekomen?	· Rol duidelijk kregen · Hoe is participant op het project gekomen
3. Hoe bent u benaderd voor dit project? a. En hoe zag dit proces eruit?	· Selectieproces in beeld krijgen
Coördinatie, raakvlakken & Samenwerking	

4. Hoe heeft u de coördinatie op uw project ervaren in het algemeen? a. Welke factoren bepaalden hoe de coördinatie van alle partijen verliep?	· Coördinatie van project in kaart brengen · Belangrijke factoren die hierin meespeelde
5. Wat zijn voor u de belangrijkste aspecten van coördinatie met veel aannemers? a. Hoe was dit in uw project? Wat vond u het meest uitdagend?	· Belangrijke onderwerpen bij coördineren met aannemers · Blootleggen wat de bottleneck was op het punt van coördinatie
6. Hoe zorgt u voor effectieve samenwerking tussen de verschillende belanghebbenden in het project? Welke acties zijn ondernomen om samenwerking te bevorderen? a. Was het proces van tevoren vastgelegd? Zo ja, heeft dit waarde gehad voor u?	· PM's mogelijkheden om samenwerking te stimuleren · Maatregelen om samenwerken te bevorderen inzien · Procesvastlegging van samenwerken inzien en mate van functionaliteit
7. Hoe zijn de raakvlakken tussen de verschillende activiteiten dan de partijen in het project gemanaged? a. In hoeverre zijn raakvlakken inzichtelijk aan de start van het project? b. Waren de verantwoordelijkheden bij de raakvlakken duidelijk?	· Interface management in kaart brengen · Verhouding van raakvlakmanagement vooraf en tijdens executie inzien · Problemen met verantwoordelijkheden bij raakvlakken blootleggen
8. Hoe beheerst u risico's en onzekerheden bij deze raakvlakken?	· Maatregelen op raakvlak problemen
9. Was er flexibiliteit en begrip bij alle partijen wanneer er veranderingen nodig waren en de activiteiten en verantwoordelijkheden veranderden? a. Hoe bent u hiermee omgegaan?	· Houding van partijen inzichtelijk maken · Sturen van partijen · Flexibiliteit · Aanpassings- en bestuurlijkvermogen PM
10. Welke conflicten tussen de partijen hebben voor de grootste problemen gezorgd? a. Wat waren de maatregelen hierop?	· Knelpunten in project blootleggen · Maatregelen in kaart brengen die hierop genomen zijn · Oplossingsvermogen PM
Skills	
11. Hoe zorgt u ervoor dat alle betrokkenen dezelfde visie hebben op het project en dat deze visie gedurende het project behouden blijft? (Bron: Liu et al., 2016) a. Hoe houdt u alle partijen gemotiveerd? Was de sfeer goed?	· sociaal en leiderschapsvermogen PM in beeld krijgen · Sfeer en mindset van partijen blootleggen

12. Hoe gaat u om met veranderingen in de scope of doelstellingen van het project? a. Hoe worden deze veranderingen gecommuniceerd en beheerd? (Bron: El-Sayegh, 2014)	· Flexibiliteit PM · Communicatievermogen PM
13. Wat zijn de belangrijkste competenties die een projectmanager moet hebben die van belang zijn voor dit project met veel raakvlakken?	· Belangrijke competenties voor complex project in relatie tot problemen die project ondervonden heeft
Contractuele inrichting	
14. Hoe waren de coördinatie, raakvlakken en samenwerking contractueel vastgelegd? Denk aan overlegstructuren, verantwoordelijkheden, escalatielijnen.	· Overzicht krijgen van inrichting van contract op genoemde punten
15. Heeft u contractuele beperkingen gehad met betrekking tot de coördinatie? a. Is er een coördinatieovereenkomst gebruikt? Welke contractvorm?	· Starheid van contract in kaart brengen · Contractvorm scherp krijgen
16. Zou u, terugkijkend op het project, iets aan de contracten anders willen hebben zodat dit betere ondersteuning zou bieden?	· Verbeterruimte in contract blootleggen
17. Wat zijn de positieve toevoegingen in het contract geweest?	· Toegevoegde waarde van contract onderdelen blootleggen
Afsluiting	
Wat is de belangrijkste les die u heeft meegenomen uit het project?	· Kernboodschap meenemen · Open afronden van gesprek

Afsluiting (5 minuten)

Dit is het interview vanuit mijn kant. Heeft u zelf nog inbreng ter afsluiting van het interview? [Ja, uitleg/Nee] Of dingen die u nog wil weten vanuit mij?
Hoe vond u het gesprek? Heeft u nog tips & tricks voor mij en het interview?

– Einde interview opname –

Bedankt dat u mee wilde doen aan dit interview. Ik zal zo snel mogelijk het transcript opsturen. Daarmee kunt u ons hele interview nogmaals doornemen en eventuele aanpassingen doen hierop. Mochten er uitspraken instaan waar u zich toch niet comfortabel bij voelt, kunt u dat altijd aangeven.

Appendix F: Number of times codes were mentioned in the interviews

The table 21 below shows in how many interviews the 1st cycle codes were mentioned.

Table 21. Number of interviews in which the codes are mentioned

Values for cooperation			
being together	8	communication	7
flexibility	7	equality	4
common goals	10	openness	4
collaboration	7	trust	4
Cooperation support			
agreements		measures	6
monitoring	4	consultation	5
planning	6	methods	5
directing	4		
Behaviour			
goals\ethos of parties	8	attitude	9
mindset	6	opportunistic behavior	1
underlying problems contractor	2	reputation	1
atmosphere	9		
Coordination approach			
controlling parties	4	coordination/alignment of contractors	10
coordination assignment	10	suitability of coordinator	6
interfaces	9		
Emotional intelligence			
honesty	2	understanding	8
long-term vision	3	humane	5
Choice for people			
competences	7	fitness of parties	6
content-oriented	4	being skilled	5
level of fulfilling role	7	personality	5
selection procedure	8		
Contract properties			
contractual arrangement contractor	5	coordination agreement	3
clarity and precision	6	humane representation	5
incentives	4	collaboration agreement	2
responsibilities of parties	10		
Contractual approach			
D&C	4	traditional agreement	3
two-phase agreement	2	UAV	2
UAV-gc	1		

Procurement approach			
tendering	6	contractual strategies	9
unambiguousness	6	division in contracts	9
[project/client] organization			
alignment of clients	7	organization	10
Knowledge management			
evaluation	4	knowledge retention	3
Multidisciplinary approach			
working integrally	3	system integration	4
uniqueness of project	3		
Pre-execution stage			
project preparation	9		

Appendix G: Extended elaboration on case study results

Hoekse lijn

Legal context of Hoekse lijn

To deal with the complexity and the distance between the client and some of the co-contractors, it was advised to have an integral coordination team in the form of an 'alliance' with the clients and co-contractors. This was shown in a report of a market consultation session (October 6, 2014). This was advised to also pursue the common 'best-for-project' goal.

Next to this, it was advised to have a point of contact at the client's side that focuses mainly on interface management, due to the overlap of the contracts. Hereby it was important that the interface manager would be decisive and have a mandate to make decisions.

During the project execution, it became clear that the different types of contracts, and the responsibilities that flow from them, created issues. Both the interviews and the study of Gemeente Rotterdam on the Hoekse lijn (2018) showed that due to the differences in contracting, issues arose. The main issues were related to interface management, demonstrability, and contractors' obligations related to attending meetings and coordination.

When a project is delivered, you have to demonstrate that the project functions according to the pre-set requirements, also concerning safety and usability. This means that certain tests need to be done and documents have to be handed in. The responsibility of this with more traditional contracts lies with the client. With more integrated contracts, this responsibility shifts to the contractor. This is also what happened on the Hoekse lijn. Issues with demonstrability and permits arose and it was not clear who was responsible for what. This remained to be an issue during the whole project.

> "In that sense, in retrospect, it is better to choose within the contracting strategy of doing everything within D&C," … "Or you simply make specifications like we have, but preferably all with the same contract form."
>
> ~ PM1-A

With a lot of contractors, it is important to have clear guidelines on collaboration and coordination. Through attending meetings, sharing information, and coordination with co-contractors the alignment of all contracts is possible. Due to the differences in contracts and the content, it was not unambiguously stated how, when, and to whom the contractor had obligations concerning attending meetings and providing the needed information to create an integral planning. This was differently stated for a lot of contractors. When the right preconditions are not provided, collaboration and coordination are even harder.

> "... what didn't go well at the Hoekse Lijn is that this was not clearly stated in all contracts due to the lack of unambiguousness."
>
> " If you know that there are several contractors in succession and have to work in each other's construction, yes, then you have to make time for that and also include that in your planning and in

your contract, what those parties want from each other, you know" … "I think that is only possible If you have also made that clear in the contract in advance, what you expect from the people in such a situation." ~ PM1-B

Interface management between the different contracts was not prearranged well. The interfaces on the contracts with the RET and the engineering office of the municipality of Rotterdam (part of PbHL) were not mapped systematically, let alone managed. Due to the differences in responsibilities and task distributions, one being on the client's side and one being on the contractor's side, this did not come off the ground. The interfaces were managed within a contract internally, but the interfaces between multiple contracts, the inter-project interfaces, were 'not part of anyone's job'.

This was, however, one of the recommendations of the market consultation session (2014). Although the main contractor was in charge of interface management (see heading 'coordination'), it was advised to have someone on the client's side who is in charge of the interfaces.

"If you have the same contract philosophy, it is easier to manage those interfaces than when the philosophy is completely different." ~ PM1-A
" We do interface management implicitly and do not lay it down." "... it was not part of your job"…"That is why interface management never really got off the ground." ~ PM1-C

Coordination

The contractor of the Stations and tracks, the biggest contract, was assigned as the coordinator during the execution of the Hoekse lijn. This implies that the contractor has to coordinate the other co-contractors. This was also stated in the description of the job and part of the EMVI-criteria project approach. This entails that the contractor has to give a description of how he will fill in the coordination role during execution. During the execution, the coordinator is responsible for the integral planning of the overall project. So, the coordinator has to involve all parties and create a feasible planning, in which all activities are integrated. Also, progress reports on coordination have to be reported to the client every four weeks after the awarding. During the important conversion phase of the project, coordination meetings have to be done daily, according to the project plans of the municipality.

To let all contractors accept and conform to one contractor being the coordinator, a coordination agreement is set up for the Hoekse lijn. By signing the agreement, the contractors declare to be willing to align the activities. The contracts of the contractors involve an obligation to fully cooperate with the coordination, as also stated in the UAV. The coordination agreement does not give co-contractors the right to claim damages, due to a fault of another co-contractor. This is only possible through the client, as stated in Section 9.2 of the coordination agreement. Some other parties who have interfaces with the project are also included in the agreement.

As stated in Section 1 of the coordination agreement Hoekse lijn, the scope of coordination of the coordinator is:

- The coordination of interfaces/ interface management
- Planning and logistical coordination
- V&G coordination (Safety & Health)

The coordination had to be handed over to the project team of the Hoekse lijn after the testing period. During the completion phase, the project team (PbHL) would be the coordinator.

During the execution of the Hoekse lijn, the coordinating contractor came up short in his responsibilities. He did not meet the expectations of how the coordinating role would be fulfilled. That is why later in the project the municipality took over the coordination responsibility. A report document of the Steering Committee, 2017, and a progress report on the Hoekse lijn of March 17, 2017 showed that the coordination role of the contractor has not been fulfilled up to standard. The contractor has not been able to deliver an acceptable integral coordination planning in time. This is in conflict with the contract and coordination agreement. Not having this planning made the delays of the Hoekse lijn even worse. Next to this, the interfaces between the designs of the different contracts have not been mapped and managed properly (physical interfaces). Another issue was the deficiency of updates from the contractors' side.

Next to not meeting the requirements on coordination, it also becomes clear that the contractor had a lack of interest in the overall project. This comes forward in correspondence between the project manager of the Hoekse lijn and the alderman of mobility, sustainability, and culture on May 3, 2017. The contractor focuses a lot on his own activities, above others. He moves his own activities, not considering the effect it has on other activities and co-contractors. The role of the coordinator conflicts with his own interest. This, amongst other reasons, has been under the attention of the organization and was monitored.

Also, when you lay down the responsibility of coordinating with a contractor, you need to think about the extent to which they are involved in other activities. If they do not feel responsible for multiple parts of the execution, coordination will not come off the ground. The contractor will manage the interfaces that fall within his scope and coordinate the co-contractors who are directly involved. But a contractor is not as involved or affected by the project result as a client is for this project. This can result in a minimal level of coordination on the parts where the contractor is not directly involved.

" …They do not feel integrally responsible."
~ PM1-A

Another problem for the coordinating contractor was the lack of instruments and control on the co-contractors. He did not have the mandate nor the right to force other contractors to align. This made it hard to incentivize or force other contractors to be on time with their activities, share information, cooperate, and help each other to finish the project.

One of the preconditions that were given for 'good coordination' was the coordinator having the instruments to have an effect on coordination. This was missing in the Hoekse lijn.

"...and then you put it into practice. Then you find out that the party that has the coordination role cannot actually fulfill it, because he does not have any mandate over the other contracts."
"In hindsight, we were not able to give sufficient preconditions to such a coordinating party. It all has to do with mandate."
~ PM1-A

However, it is questionable to which extent you want to give a coordinator the instruments to incentivize other co-contractors. The coordinator being a contractor, multiple goals arise that might get entangled. One being a coordinator in the light of the overall project, and one being a contractor in the light of the subproject and finishing that. Looking at the correspondence between the project manager of the Hoekse lijn and the alderman of mobility, sustainability, and culture, a coordinator might even force another contractor in such a way it is only convenient for the coordinator himself. A more ethical issue might arise here.

Relational context of the Hoekse lijn

Atmosphere

The Hoekse lijn project was set up with the idea of relational spheres of 'best-for-project'. This is stated in multiple project documents of the Hoekse lijn, like the project plan and project approach. 'Best-of-project' should enhance all parties to commit to the project and help it be completed on time. Even if this would mean you had to take an extra step or help another party without getting something in return immediately.

However, the overall relations within the Hoekse lijn Phase 1 were complex and there was no particular focus on the human side of the relations, also within the contracts. Everyone was focused on their own tasks and parts of the project. As shown in the literature review, it is important to have common goals between parties and also carry this out as an organization or client. This was not established during the project.

The common thought on the project interest leaked. The commitment of all parties is needed to complete the project on time. This, however, failed. An 'island culture' existed. Both leadership and the culture itself were not stimulating the 'best-for-project' mentality and were not propagated to the parties involved. This is also one of the findings of an external report of AT Osborne on the feasibility of planning of the Hoekse lijn in September 2017.

With the coordination role not being fulfilled as expected, the co-contractors did not have the feeling of working together on the project. With little interactions between all co-contractors, everyone focused even more on their own sub-projects. Nor the client, nor the coordinating contractor tried to enhance the collaboration of all parties involved by carrying out a vision and focus on the common goals.

"Nowadays you also see a poster on the wall with team principles about how you want to work together. We never really made that explicit. Everyone did it a bit from their own angle."

"We didn't have a mix of people who also paid attention to the relational atmosphere and the work ethic and how everyone was in the game."
~ PM1-A

"... at Hoekse Lijn there was actually little attention for mutual goals and collectiveness. You also noticed that in the working method, little attention was actually paid to the soft side. That has paid off in massive delays and poor working relationships…"
~ PM1-B

Also, a part of the atmosphere being tense was the pressure that was put on the project. Early on it became clear that delays would occur and the pre-set end date would not be met. The planning of the Hoekse lijn was very tight and any delay would cause a series of other delays due to the sequenced scheduled activities. No buffers were added. This was also one of the findings of an external report by AT Osborne (2017).

"At the Hoekse Lijn it was really crammed together. So, if a party delayed, everything delayed and nobody gave any favors to each other, so to speak."
~ PM1-B

Trying to make the relations and atmosphere better and because of the delays within the project, people on certain critical roles were switched up, coaching sessions were set up and meetings focusing on the relation and collaboration followed. To some extent, both the client and contractors showed willingness. The result, however, was not as hoped. People fell back into their old behavior and the wanted change was not reached.

"We've had coaching sessions, 3 or 4 times, and then we actually fell back into the old division of roles and old attitudes and behaviors"… "Then it has to be put into practice, but then those things were no longer filled in."

'... the project manager of the civil part and the project manager of the RET part also grew apart somewhat. There have also been personnel changes because it was under pressure " … "That doesn't do the mutual atmosphere and trust any good."
~ PM1-A

Attitudes

The mindset within the Hoekse lijn was very fixed. Everyone only focused on what they were doing themselves. If problems would occur, everyone kind of pulled back and did not feel the need nor the engagement to help and fix it. Especially since all parties worked physically separately on the project location, no one felt the need to interfere with another one's work.

Here it became clear how important it is to work in the same location and have one place where all co-contractors come together. Both for the mindset being changed into a positive one where people feel involved, and to accommodate coordination and collaboration.

"I have noticed that in those kinds of integrated large projects, the more you see each other, the better it works." … "These kinds of preconditions are essential for the success of a project. So, make

> sure you have enough facilities where you can all sit together and that you can simply do the daily coordination there."
>
> ~ PM1-A

The attitude of the contractors was also influenced by the way the RET and PbHL worked together as clients. Between the RET and PbHL there was no cohesion on how to execute the project and who was responsible for what. Discords between the clients resulted in the co-contractors also being hesitant. As a client, it is important that show unity, set a standard, and provide clarity to your contractors. If this is not happening, how can you expect it from your contractors? As a professional client, you have to steer everyone in the right direction. At the Hoekse lijn, unclear guidance of both clients also contributed to the 'island culture', as shown in the report by AT Osborne (2017).

Personal context of the Hoekse lijn

Selection

The selection of people on the Hoekse lijn was mainly because of their experiences. The people from the municipality were (technically) skilled to execute the Hoekse lijn. Some of the people were also involved in the Randstadrail project, which had a lot of similarities. Both projects involve the conversion of a track and the construction of subway stations and having multiple contracts with different contractors. Overall, the execution of the Randstadrail project was seen as positive. So, the thought of having the same people doing Hoekse lijn was not crazy. Also, the report on the Hoekse lijn by the Gemeente Rotterdam (2017) saw the project managers of Hoekse lijn as skilled and experienced enough.

> "... it was logical because of my experience in the conversion part and at the stations from a past project, to use again at the Hoekse Lijn.
>
> ~ PM1-A

Also, the network of people appeared to be of importance during the selection process. Via via, people were asked to join. The Dutch phrase "Ons kent ons", translated as "Us know us", is something that is popular within the project world. Knowing how people work and what their value is, is seen as a pro. The softer skills of a person did not seem to have a big influence on the selection process. There were also no open vacancies with selection rounds for the roles that had to be filled in.

Competences & characteristics

From a client's perspective you have to show a certain example of how you want to associate yourself with others and how you want to be seen. Your attitude and actions have to be in line with this. The attitude of the client was seen as rigid and not compassionate. The interviews showed the lack of connection between the mutual clients and the contractors. The people of the RET and PbHL did not seem to click. They were not able to set their personal feelings aside and move forward. This radiated toward the contractors and the overall project environment. There is a need for unambiguous leadership, also stated in the progress reports of Hoekse lijn, 2017.

> "In the future, if such a relationship is not good, I can perhaps more easily say that someone else is better able in such a situation and deal with the characteristics of the counterpart. You will know soon enough whether there is a click yes or no."
> ~PM1-A

As a client it is important to have a deeper understanding of your contractors and their behavior. When issues occur, you have to know what you are dealing with. This requires openness, transparency, and in the end trust. They were seen as very important for the relationship with the contractor, but also as a critical factor for project success. This goes both ways, from client to contractor and from contractor to client. Pursuing this within Hoekse lijn has not been a priority.

> "It also requires a bit of transparency. How are things under the bonnet? The car has a nice shine and new paint, but if the underside rusts out, we have a bigger problem. So just tell what's going on and we can deal with that. "
> ~ PM1-A

> "... They didn't have a goodwill in the game. They were not willing to think along with contractors, not willing to compromise as a client."
> ~ PM1-B

Organizational support of the Hoekse lijn

The responsibilities, tasks, goals, and organizational lines need to be clear on the client's side. This benefits both the clients and contractors. Especially in the case of Hoekse lijn with multiple clients involved during execution. Hoekse lijn phase 1 had both the RET and the municipality of Rotterdam as clients for different contracts of the project.

During execution, it became clear that the governance was not in place. Both the RET and the PbHL did not succeed in creating a governance structure that fits a big multidisciplinary project like the Hoekse lijn. It was not obvious who was in charge of what and who would take the lead during execution. Therefore, all contractors only focused on their activities, and the 'best-for-project' culture was never pursued.

Especially since the RET and PbHL had different opinions because of their differences in goals, PbHL delivering a working transport system and the RET having a usable metro, it was hard to find an unambiguous approach. The governance structure of the project is unclear, which led to a lot of issues, which was shown both in the interviews, in the progress reports of the Hoekse lijn, and in the study of Gemeente Rotterdam (2017).

> "The difficult thing about the Hoekse lijn was that you had two cliental organizations and also contractors"… "There were a lot of opinions. The difficult thing was that it was unclear to everyone who was in charge."
> ~ PM1-C

> "... things went wrong mainly in the organization of the clients. What you saw was that both parties had insufficient knowledge to understand what you need to organize to make such a project a success" … "when we get multiple contracts and multiple organizations together, you notice that we think about it too easily."
>
> ~ PM1-C

The unclear governance structure had two results:

- The project's environment: The project with all the contracts and contractors
- The client's environment: Within the organization of the client

Project's environment

Within the project's environment, the contractors feel the conflicted clients. This was also represented in the differences in work cultures and dynamics of the RET and PbHL. The RET was perceived as a more pragmatic client that was more focused on the construction itself, rather than the demonstrability of an integrally safe and functional system, which was perceived as the focus of PbHL. Here is where the differences in goals also came to play. It was hard to get an environment in which the two could complement each other, instead of supplement.

Due to that unclear governance, the 'island culture' became bigger. Contractors were only focused on their own activities. They did not have the incentive, nor were they willing to, help others in favor of the project outcome.

> "You have a dynamic within the RET that is different from the dynamics of the municipality of Rotterdam when it comes to working methods."
>
> ~ PM1-C

> "... If you are going to do that conversion with two captains, it will not work. So, everyone kind of retreated to their own territory."
>
> ~ PM1-A

Client's environment

Not only the contractors had a difficult time with the governance structure, but also the project team on the client's side had issues. The escalation lines were unclear. There were a lot of people involved on different levels and there were a lot of groups to report to, like steering groups, directive groups, and organizational groups. There were no clear organizational lines within the municipality. This resulted in also not having clear who had the mandate to make certain decisions. Audits, notes, and mail traffic showed the unclarity through multiple questions: Who do I have to report to? What are the escalation routes? Who is my point of contact for which issue? Who is responsible for this part? This was also a topic in the interviews.

> "You see stuff happening, you report it, but not enough is done with it."
>
> ~ PM1-A

Metro aan Zee

Legal context of MaZ

Contractual output

A big issue within Metro aan Zee appeared to be the demonstrability of the safety and functionality of all parts of the project, both through reports on progress meetings from the MaZ between 2020-2021 and the interviews. Verification and validation of all parts were necessary and to deliver a 'working system', systems engineering is used for Metro aan Zee. This is done to guarantee integrality and to demonstrate that the project meets the requirements.

However, due to the differences in contracts, the responsibility for this differs. For the traditional contracts, it was clear that the responsibility was on the client's side, apart from C8 with the 'plus'-contract. This was however not the case for the more integral contracts of the RET. The D&C contracts shift the demonstrability to the contractors. To create an integral system that functions as a whole, this also has to connect seamlessly. The client uses different ways to demonstrate, the C8 contractor used something else, and the D&C contracts also. This requires a lot of coordination on the way this is established.

> "Then there is always the question of how was that set out and how is that secured in the other contracts. If those two large contracts are D&C contracts, then it was requested differently."
>
> "If the contractor only builds an environment for the demonstrability of the C8 contract in relatics, and the other contracts are D&C and they demonstrate in a different way, then this is not the responsibility of the main contractor, but the client."
>
> "But that relatics system does not contain those plans of other contracts." … "But that has been the biggest challenge, to set it up for all contracts integrally."
>
> ~ PM2-C

> "All contracts were from long before that time, so nothing was included about that: for system integration and for the burden of proof, we work in this way, and you as a contracting party will have to provide this. That wasn't in any of those contracts."
>
> "So, it was a very complex situation in the relationship, the contracts, the noses were not directed the same way."
>
> ~ PM2-A

Within your contracting strategy you need to take into account how you want to achieve your demonstrability and testing process, especially in the last decades with the changing rules and regulations on this. When choosing a more traditional contract, this responsibility belongs to the client. Unless an addendum is added to the contractor's contract, like Metro aan Zee. This responsibility is also about arranging the right structure to document and managing it. With a more integral contract, this demonstrability and testing process shifts to the contractor. He is responsible for delivering a demonstrable safe and functional system to the client.

With a contract that gives more responsibility to the contractor, you can also build in more contractual incentives. This only works when a contractor also has a direct influence on the work he has to deliver.

> "That contract covered much more than the V." (About the renovation of the Maastunnel) "Then

you can also build completely different incentives into the contract. You can make someone responsible and stimulate them on things that they can also influence."
~ PM2-A

Coordination

During execution, the coordination was laid down by the contractor of C8. A coordination agreement was used to substantiate this and to make the responsibilities clear to all contractors involved. Also, the coordination was part of the requirements of the job of C8, next to the demonstrability factor named earlier. The EMVI, or MEAT (Most Economically Advantageous Tender), plan of the contractor was very impressive for C8. Everything was explained very well and the plan fitted perfectly in the picture of MaZ for the project. The plans for coordination looked impressive and would take a lot of the plate of the client. One of the requirements of the tender was that the people working on the tender also had to work on the project during the execution phase. This requirement was set up to keep the knowledge of the tender and the whole plan in-house and use it during the execution.

"That EMVI plan was really good, they also won with that, this combination."
~ PM2-C

However, during execution, it became clear that there was a difference in the expectations of MaZ And how they described the requirements and the way in which the contractor fulfilled his role. The coordination of all co-contractors did not seem to come off the ground. There were limited meetings with all contractors involved, the integral coordination planning came up short, and it seemed like the communication with the contractors was minimal. MaZ dealt with this by taking on a facilitative role. They made sure meetings were planned and took part in this. The contractor of C8 did a minimal coordination effort. Also, MaZ addressed the issues with the coordinating contractor. Here, the discussion started about the misinterpretations of the requirements in the contract. MaZ addressed the issues and discussed what has not been done on coordination. As shown in reports of construction meetings in 2020, the client explained their concern about the EMVI requirements not being fulfilled. This led to the contractor being monitored. However, it was hard to give the contractor a fine because of the default. It was hard to prove the contractor did not fulfill his role.

"You have discussions about how it is written in a contract, and not focusing on coordination itself. You write something down in the contract and you mean something by that, how is that interpreted and taken over?"
~PM2-C

"From day 1, it did not come off the ground. They did not do what we asked and that consumed a lot of energy."
~PM2-D

This shows how important it is to have the same expectations on certain tasks. When misinterpretations come up, the discussions are not about the content of the issue anymore, but more about how it was laid down and what legal foundations come from it. This is why it is advocated to have a SMART (Specific, Measurable, Achievable, Realistic, and Time-bound) description of what you expect as a client. Make

sure you show what your vision is and how it is done. This gives the coordinator a clearer picture of what is expected of him. It also gives the client more possibilities to monitor the coordinator and judge the extent to which the role has been fulfilled correctly. Next to this, it gives the client more legal ground to intervene, since the demonstration of being in default by the contractor is easier proved. It makes it easier to create a file with evidence of default.

> "What do you expect from that coordination obligation? Make that concrete. You can say yes you have to coordinate, but how often? How many times? Try to make that SMART."
> ~ JU-1

The coordination of co-contractors was a part of the tasks of the contractor up until January 7, 2022. This date would shift to a later date due to delays within the project itself, but because the contractor did not meet the expectations, MaZ took over on that date.

Another factor that was named as a contribution to the differences in expectations and execution was the switch of one of the front people of the contractor's combination. A person who was involved during the tender phase, who would also be a part of the execution was switched after just a few months after the execution started. The person who pitched the project plan to the client and who was one of the main contributors to the EMVI plan left. In his place came another person with a different knowledge level of the project, different overall experience, and a different personality. This shows how important a person can be within an organization and within a project.

> "He was one of the gurus of the entire offer and tender phase."
> ~ PM2-C

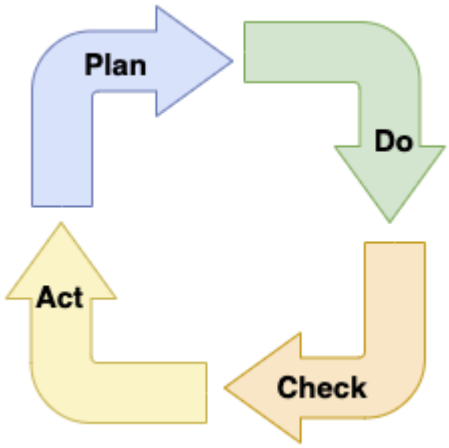
Interfaces

The interfaces are managed through an integral interface registry and matrix for the overall project. In the registry the interface is explained, the contracts involved are described and the responsible party is named. Also, the status of the interface is described with the measures that can be/are taken to accept, transfer, and minimize the risks or even remove the risks of the interfaces. The matrix gives an overview of the WBS parts of the project and with which other WBS parts it has interfaces with.

The responsibilities on the interfaces are divided into two categories:

- Leading: The leading party is the one who has the biggest responsibility on an interface. He maps the interface and consults with the following party on measures and which activities flow from it.
- Following: The following party is involved in an interface but has less responsibility. They 'follow' the other party.

Most interfaces are contributed to the contractor of C8, ABS, since this is the biggest contract and has the most internal, mutual, and external interfaces. On interfaces where C8 has no influence, the leading party is the one with the biggest contract and is best capable of managing it.



ABS used the Plan- do-check-act approach for interface management.

1. Identify and adopt the interface (PLAN)
2. Assign responsibilities, establish the needed activities, and planning of the interface (PLAN)
3. Elaborating the interface (DO)
4. Protect and control the interface (CHECK)
5. Adjust the interface (ACT)

In practice, it appeared that all parties went their own way in managing the interfaces. The pre-set-up plan was there, but not all parties operated by it. Every party has their own way of dealing with interfaces. The overall interfaces were mapped in the registry, however, how all parties acted was different. An integral approach on how to deal with the interfaces in a structured way was missing.

> "... interface management has not really got off the ground. You can put a lot of energy into it, but in the end, everyone goes their own way."
>
> "The municipality of Rotterdam will also make something in its own way, in accordance with its own working method. But it all has to fit together."
> ~PM2-D

Relational context of MaZ

Atmosphere

There were a few factors that had a big influence on the atmosphere of Metro aan Zee:

- The continuance of people from the Hoekse lijn
- Mismatch in common goals
- Covid-19

A lot of people who worked on the Hoekse Lijn continued working on Metro aan Zee. Hoekse lijn had a lot of challenges on a relational level for almost all parties involved. A negative atmosphere became 'normal'. This did not change throughout the whole execution phase. What was noticed, is that some people kept that same mindset of Hoekse lijn while starting on Metro aan Zee. People still tried to focus on their own tasks and responsibilities and did not put effort into finding common grounds and goals to create a better environment.

The rigidity partly came from Hoekse lijn within the mindset and throughout Metro aan Zee itself. A progress report of April 2019 shows also the need for extra attention to collaboration during the execution. Extra budget went to coaching sessions and focus on collaboration. Even with coaching sessions, this did not change. How people come to work and the state of mind they have appeared to be one of the main causes for defining the kind of relationship there was and continued to be.

" … there are programs with coaches for joint team goals and so on. But that was too soft in the end."
~ PM2-A

Advices, reports, and warnings seem to be counterproductive. It resulted in an irritated sphere and distrust between parties. This resulted in other issues, following an evaluation of management team MaZ on 30th May, 2023. The common goals were not put together in a good way. The RET had a different objective from the municipality, which resulted in segregated beliefs and goals.

The goals of the parties involved were not aligned. This already started at the client's side. The RET and MaZ did not have the same overall goal. Where MaZ had to deliver a demonstrable safe and functional system, the RET had as its goal the exploitation and management of the public transportation line. The end goal was not the same. This gave a lot of problems during execution. Everyone will act in favor of their own goal. Also, the contractors.

"If you want to work together, then those goals, the highest level of abstraction, you must have in common. If that is not the case, you can organize all kinds of sessions and drinks, but then everyone will continue to set their own goals." … "That is perhaps the most important part where it went wrong, those goals."
~ PM2-A

Covid-19 made collaboration harder. A whole plan was set up to have common sessions with all contractors to start up in a nice way. Covid-19 made this impossible. Everything had to be done online and through MS Teams meetings. This put even more pressure on the organization, and the coordination and collaboration. Also, the collaboration between MaZ and the RET became harder through Covid-19.

"It would have been easier if we were just physically together."

"When working together, it is very important that you are together, physically, in the shack and on the construction site."
~PM2-C

Attitudes

During the execution, somewhat the same attitudes arose as during the Hoekse lijn. Everyone focused on their own tasks and somewhat withdrew. Also because of the above-named factors, the attitudes of the parties became closed. Within the municipality, this attitude was also felt. When a project manager tried to get through to the directives about the problems with the RET and their non-collaborative attitude, the interests of the RET and the municipality were weighted carefully.

The clients together never really created a cohesive environment. This was reflected to the contractors. Also not being together physically, due to Covid-19 amongst other things, created a closed attitude by all parties. Here the human aspect also became an important factor. When you can relate to someone on a personal level, your attitude becomes more open and you are more willing to help a person.

Showing empathy towards one another helps on a personal basis, but in the end also on a professional basis when you have to help each other. Having a deeper understanding of what is going on with all parties involved, you can also act on it.

To see how everyone feels and what they think, the Engager-app was used. In this app, an employee within Metro aan Zee is able to show how they feel, what goes well, and what goes not so well. This is done every couple of weeks. After, an overall overview is given. This gives the client a better insight into how everyone feels.

> "It is useful if you can look into each other's worlds."
> ~ PM2-C

> "Because you also met at the coffee machine with: oh, how is your dog, it was also a human."
> ~ PM2-A

Another factor that appeared to be an influence on the attitudes of parties was trust. With mutual trust, people tend to listen to each other better and feel like you will help them when needed. Being honest and open makes sure all issues come to light before those issues become bigger problems.

Progress report on a construction meeting of July 2021 shows that the contractor had a bit of distrust towards the client. Due to not conforming with earlier made agreements and the disapproval of dossiers. It is very important as a client to also conform to agreements.

When the project became to an end, and Covid restrictions were lifted. The parties did not align anymore. People felt like the project was almost over, so no one wanted to put effort into creating a better relationship with others. Everyone was focused on finishing their own part.

> "Then the end seems to be in sight and it won't happen anymore. That has not come together either."
>
> on getting the same vision of all contractors and moving forward together.
> ~ PM2-C

Personal context of MaZ

Selection

The selection of the people working on Metro aan Zee was mainly based on experience. The team representing the municipality covered together all the facets of the project. Also, like the Hoekse lijn, people were selected based on their network links. By knowing someone who might be willing to work on the project and is specialized in a particular subject, people were signed to the project.

> "In this case it is a, I call it an 'us knows us'."
> ~ PM2-D

The part of the project that made it extra complex as a project manager was the need for an integrally aligned system to deal with the requirements regarding a safe and functional subway track. This needed to be demonstrated by multiple tests. All parts of the overall project have to be aligned in order to

achieve this, also through documentation. Because of the different contract types, the responsibility of that demonstrability belonged to different parties. And the parties might use a different way to show this. Here the need for an integrality guarantor was raised. System engineering, a term which is upcoming, is needed to abide by all the requirements when delivering a project and the verification and validation process. System engineering is about using an integral and transdisciplinary approach to achieve the intended purpose of a project (INCOSE, 2019).

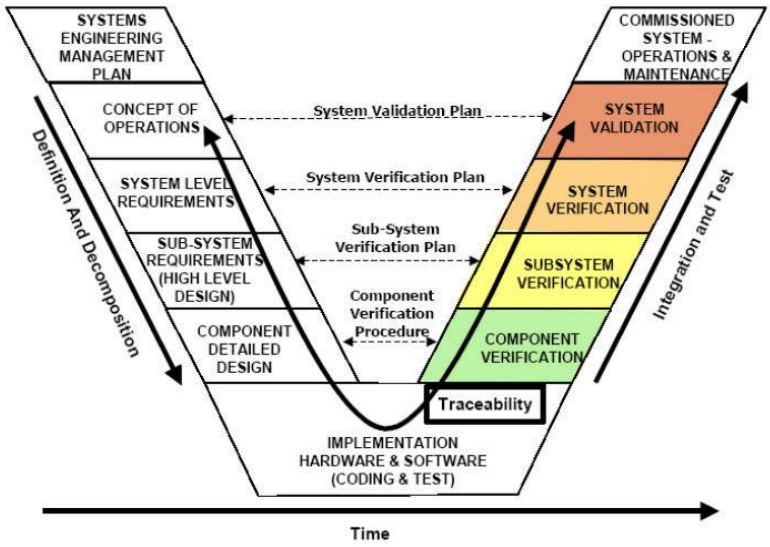


Figure 33. System engineering V

To help with reaching these requirements, a team was set up that mainly focused on the demonstration of this process.

The attitude towards this process was mainly seen as tiring by the pragmatic people within the project. They did not understand the importance of the documentation that came with the demonstration and integrality of the overall systems. The overall atmosphere was also influenced by this. People felt like they were held back by the municipality at some times, because of this process. It is important to feel like you are working together on something, not against each other.

Personal feelings

A note about an evaluation on the HH OPS team on April 14, 2022, showed that because of the high working pace and the pressure, job satisfaction went down, including the health of some of the team members on Metro aan Zee. One of the reasons for this was because the milestones of the project were not realistic anymore, but people were still pressured into reaching them, also shown in an evaluation of the management team on the 30th of May, 2023. People wanted to go for the 'quick fix' and micromanaging was part of the daily job. Tackling the underlying issue and fixing the deeper issue did not happen.

A hard part was Covid-19. People were working at home, having no prospects. This resulted in coworkers being dissatisfied and falling into a bad mindset. A progress report of July 17th, 2020, explained that more and more people within the project teams struggle with the situation.

Personal characteristics

Binding people with certain personal traits and knowledge towards the project's multiple project phases is of big importance, as explained in the legal context of Metro aan Zee. Some people have better guidance and vision on how a project should be done and how the process of this has to be fulfilled. It is important to find the right people for this.

The number one thing that appears to be important for a project manager is knowing what you are doing and what you are talking about. You need to have a certain level of knowledge about the technical content of a project, and how to deal with the primal project management skills like analyzing the projects and its processes, and decision-making.

> "Know what you're talking about. That's number one."
> ~ PM2-B

As a project manager, it also appeared to be of big importance to have a feeling for relational spheres and how to communicate upwards and downwards and to reveal things to the right people at the right time. This is something that also comes with experience. It is important to give the right information to the right people, which increases mutual trust. As a project manager, you have to create the right social setting in which people listen to each other and take each other seriously.

Organizational support of MaZ

The organizational set-up of MaZ was supposed to be easier in comparison to Hoekse lijn. That is why the municipality became the responsible party for the overall project politically and financially. The RET only had to govern its own contracts. Due to the problems in the past, the governance of the client's part needed a different setup.

> "The MRDH also commissioned research, when it was concluded in 2018 that governance should never again be organized as in the Hoekse lijn."
> ~ PM2-A

In practice, some of the same problems of Hoekse lijn happened at Metro aan Zee. It was still not always clear who was responsible for what during the execution. Especially on certain critical milestones, such as the first test ride of the subway, it was not clear who would make that decision. A lot of people felt like they could say something about it, which eventually led to not having a decision at all. The organizational part was seen as one of the main problems of this project.

> "...things went wrong mainly in the organization of the clients."
> ~ PM2-D

Next to the unclarity of responsibilities, there was no common goal between the RET and MaZ, as said before. The municipality was in charge of the realization of MaZ and the RET is in charge of the exploitation of the subway. A deviation is seen between a working infrastructure for the RET and a working transportation system for MaZ. These two together would form the overall goal of Metro aan Zee. But this was put into two different jobs. This gave hick-ups during the execution. MaZ and the RET had different ways of operation, due to the differences in goals, but also different work cultures,

different work ethics, and different people. Next to this, the RET had a lot of people still in place back from Hoekse lijn. Those people still had the same negative attitude from before. This created a hard collaboration environment for the project teams of the project.

A problem within the municipality of Rotterdam itself is pigeonholing. The whole organization is divided into divisions. For most of the activities of the municipality, this works. However, with a multidisciplinary project, integrality is needed. The organization is not designed to deal with this. A lot of unknowns occur with a multidisciplinary project like Metro aan Zee, especially with the integration of all subsystems.

Maastunnel renovation

Legal context of Maastunnel renovation

Contractual outcome

The collaborative character of the contract was overall perceived as very good. Due to the focus on collaboration, people got closer during issues, instead of withdrawing. The tailor-made agreement was really positive for the relational context of the project. However, during the project, and in the evaluations, it became clear that the tailormade agreement took a lot of extra effort for market parties, especially for the lawyers to understand every part of the contract.

> "For us, the Maastunnel was actually an expression of cooperation as a guiding principle."
> ~ PM3-A

To involve the multiple parties involved in the project (contractors/suppliers/consultants), a 'collaboration table' was set up. Here, all parties could join in an informal sphere. The interfaces between the multiple parties were also discussed here. Due to the relatively few inter-project interfaces, very formal and intense interface management between co-contractors was not necessary. However, the extra-project interfaces with the project's environment and the intra-projects interfaces within the contract of CAM were bigger.

An interface manager within the municipality was appointed to deal with the extra-project interfaces like the interference on the traffic flows around Rotterdam. Within the contract of CAM, the combination was responsible for the interfaces.

Being together on one location appeared to be very valuable. Having the contractor involved in an earlier stage, especially to build a longstanding relationship.

Relational context of maastunnel renovation

Atmosphere

The overall relational atmosphere was perceived as pleasant. Due to the focus on collaboration and working together to a common goal, the relations between all parties were good. There were three pillars for collaboration:

- Mutual and joint effort?
- What has to be made?
- Relational side in order?

Next to the pillars, a collaboration ladder was created to get a better result together and to have higher job satisfaction. This involved:

- Knowing: Know what the other is doing
- Understanding: Understand how the other thinks and how the other looks at things
- Appreciate: Value the input from the other and the opinion of the other
- Trust: Dare to leave things to the other
- Collaborate: The end goal is to create a better result together and have a higher job satisfaction

With these aspects of collaboration, it became easier to get together and understand what needed to be done in order to deliver the project. What helped was the urgency of the project. The maastunnel had concrete that was rotting. Together with the tunnel being a national monument, which gave legal pressure. And the laws and regulations changed around tunnel safety. So, the renovation reality needed to happen. Next to this, the Maastunnel is seen as a tunnel to be proud of, with it being the first sunken tunnel in the Netherlands. So, it has a lot of value and people feel connected to it. An enticing perspective in the form of having pride for the maastunnel. This is why every party was extra dedicated to making the project a success.

Although there were no major problems or misalignments of parties, coaching sessions were done to get to know each other better and to learn about how the collaboration can be improved even more.

A very important part of the relational context was to create a safe work environment, both physical and psychological. This is supported by openness and trust.

> "We became kind of a joint entity, really us together with the combination. We were therefore able to become like-minded relatively easily. We really understood each other and we understood that a certain assignment would lead to success."
>
> ~ PM3-A

Personal context of the Maastunnel renovation

Selection

The people on the Maastunnel were mainly selected based on their experiences and through their network connections, just like the Hoekse lijn and Metro aan Zee.

Personal traits

On a personal level there was also more attention to the softer side of people. It was not only about the collaboration going well, but also about the people themselves. Next to collaboration, empathy was also aimed at.

An interesting aspect of this project are the personal coaching sessions. Here, the focus was on an individual themselves and how they can grow and improve as an individual within the project and their relations.

Organizational support within the maastunnel renovation

The municipality of Rotterdam was the only client for this project. The municipality had a clear organizational structure set up within the project. This helped with the clarity of the responsibilities on the client's side towards the involved contractors.

However, there were a lot of different interests within the municipal organization itself. The urgency of the maasunnel renovation and it being a national monument caused more pressure from the municipality itself and the political field. A lot of people had different opinions, departments had different interests, which led to the municipality being less directive. The biggest discussions were mostly within the organization itself.

> "It was sometimes more difficult to keep the municipal department/background involved in such a process."
>
> "You see that the discussion is now shifting from how do you work together with contractors to how do you work together within the clients field. How can we better fulfill that commissioning role?"
>
> "Then that attention on coordination or control actually perhaps shifts to something that you look at within public commissioning itself. Inside the organisation."
>
> ~ PM3-A

Rotterdam CS

Legal context of Rotterdam CS

Contractual outcomes

The project turned out as it was supposed to within the contractual environment. Some additional work had to be paid, but other than that no big problems or changes happened.

Coordination

Due to the number of sub-projects of Rotterdam CS, but also their interfaces with the project Randstadrail, coordination played a big role. During the execution of the project, Rotterdam CS had to stay open for travelers. This made the coordination assignment an even bigger one. The municipality and OBRgw took on the coordination role and the coordination obligation. To coordinate the multiple sub-projects of Rotterdam CS, a team was set up that focused mainly on the coordination and the communication that comes with it. They mainly focused on guiding all sub-projects to one final result and coordinated the interfaces of all projects. They were also responsible for making an integral execution planning for the overall Rotterdam CS project. During the execution, the project leader 'Execution' from the municipality of Rotterdam was responsible for the coordination of all contracts on the municipal part. Also, coordination between the municipal part and ProRail part of Rotterdam Centraal is part of his job. ProRail did the coordination within their own project.
The different parts coordinated by the project leader execution were:

- The public terminal on the side of the city, coordinating with the terminal on the trackside
- Cables and pipes
- Metrostation Centraal Station
- The bike parking

- Weenatunnel
- Kruispleingarage
- Outdoor space arrangement

There was also a coordinator appointed for coordination with the project external environment. He coordinated with the outside.

Overall, the coordination role of the municipality was perceived as pleasant and clear. OBRgw had a big interest in the overall outcome of the project, and also in aligning the sub-projects. In comparison to a coordination role being fulfilled by a contractor, the municipality is better able to determine what has to be done and when without being biased with such a big project. Especially when looking at the high societal and political value of the external environment of the project. A contractor's own interest might conflict with the overall interest of the project and the environment and is less able to make objective decisions.

> "I also thought that was very strong, that the directive role was taken by the municipality."
> ~ PM4-C

> "But the moment you put that responsibility away, it's very difficult for a builder to start "talking to another builder and determine who goes first. No, actually the municipality should determine that, because they have cut the project. And if pain has to be suffered somewhere, be it financially or in terms of time, then a client must be able to make those choices."
> ~ PM4-B

To make the coordination and alignment of all contractors easier, a 'comic strip' was made. This comic included a map of the project during different phases of the execution. Monthly, weekly, and daily activities, depending on what was needed. It showed all the activities that had to be done by all parties, what the rules were during that period, and which interfaces occurred. During coordination meetings, this was received as very convenient. Everyone knew what to do and when, but also who they might encounter and how to deal with that. Those meetings were weekly, following the guidelines of the communication structure by the municipality.

If coordination was needed between the OVT-city and the OVT-tracks, both ProRail and the project team of the OVT-city did this mutually. This was not a regular meeting, only when needed.

> "For example, there were a kind of comic strips in which it became clear in which construction period certain agreements apply to the environment. Then everyone knew where they stood."
> ~ PM4-C

Interfaces

Most interfaces were managed by OBRgw. During the designing phase, a lot of interfaces can be discovered. So, management can already be arranged in a way this is taken into account too. You already know where the clashes are between the sub-projects and you are able to think about possible solutions. An interface manager was assigned to monitor the interfaces and control them, and operate in an unambiguous way. During the interface meetings, which were weekly, the upcoming interfaces were discussed. But also, the unexpected interfaces were discussed here. Within the contracts of the

contractors is also written down that they have to participate in interface meetings and contribute to a smooth collaboration on these interfaces.

Also, the 'comic strips' showed the interfaces. During the coordination meetings, they were discussed. For example, OBRgw explained what the order of activities was and which of the contractors had priority within an interface. If interfaces occurred during execution that were not accounted for, the interface manager dealt with it. If unexpected interfaces turned into additional work for a contractor or caused contractors trouble, it was up to the municipality to look into it and decide what measures had to be taken. OBRgw was able to analyze the situation in an objective way and make a fair consideration of who needed to be first, in the interest of the overall project.

> "... there was also a consideration of what are the consequences for all parties and on the basis of that balance it was said Hey guys it is now wiser to give him priority."
>
> ~ PM4-B

Between the interfaces of OVT-city and the OVT-tracks, 'division documents' were made. A division document shows where the interface is location wise, and how it influences both parties involved. Both contractors knew how to deal with the interfaces, because of the documents. This gave a lot of clarity for all parties involved and made the collaboration on the interfaces easier.

Relational context of Rotterdam CS

Atmosphere

The relations between all parties were formal and focused on the result. This does not have to be a bad thing. The contracts were the guideline during the whole project. If something happened or an issue arose, everyone fell back on the content of the contract. Meetings were formal and based on the content, as shown in both the document research and the interviews. The contact with the contractor was mainly about what they had to do and when. The people's side was not the main focus.

If additional work was needed, the client did not back out into paying. The contractors worked together in order to achieve success and realize the project in a neat way.

> "Then it gets a pretty traditional communication. Construction meetings, that's it."
>
> "There was a lot of falling back on the contract at Centraal Station."
>
> ~ PM4-A

Attitudes

All parties were mainly focused on their own tasks. The contractors did their job, the client did his. Everyone was quite formal and gave attention to the technical content. OBRgw tried to make considered decisions by taking into account the interests of all parties involved. With such a considered decision, you create the willingness to cooperate with all contractors and get a good work mindset.

The attitude of ProRail was also perceived as very formal. During meetings, it was sometimes hard to find a middle ground that worked for both parties. Especially since they had another contract form. On ProRail's side, the contractor was the point of contact and the communicator due to the D&C

contract. This was perceived as a struggle since the contractor was mainly focused on their own interest. ProRail was only involved to test the construction, not to manage the execution.

Personal context of Rotterdam CS

Selection

The people working at Rotterdam Centraal station were mainly chosen because of their experience and network relations. Also, because people were involved during the design phase, it made sense to also have those people involved during the execution. Here you see the importance of knowledge retention.

To not lose too much knowledge between the design and execution phase, some project managers came on board in the last part of the design phase. This helped them get acquainted with the project and the content of the contracts. Also, their experience can be used for the design still.

> "You actually get a kind of cross-pollination of performance experience and preparation people."
> ~ PM4-B

Personal characteristics

Within this project it became clear that a project manager first needs to know the technical content of a project. Multiple project managers vouched for this. Especially when the client has a big role in the project, like coordinating all sub-projects. A client should be a worthy sparring partner for the contractors. What came second, was having an eye for others and seeing the bigger picture, and with that seeking alignment with one another. Knowing when to decide what. But also, being honest came forward as an important characteristic. Not just about decisions, but also in terms of not understanding something or indicating when something happens in an annoying way. This creates openness and also shows your boundaries.

> "First of all, it is important that you know the content of the work."
> ~ PM4-B

> "That balance between content and soft skills and more businesslike skills is the future for the project manager of Rotterdam."
> ~ PM4-C

An interesting note on the personal traits of a project manager was that it also has to match with the project entities. Some people like repetitive work and some people like variational work. When selecting a project manager, both the characteristics of the manager and the project need to be taken into account.

Organizational support within Rotterdam CS

The organization from the side of the municipality was set up tightly. All the communication structures, organizational structures, escalation structures, and consultation structures were pre-arranged. This was perceived as pleasant and clear. Everyone knew who they could go to in case of issues, communication had short lines, and the governance from the municipality was clear.

An interesting note is the pre-execution phase of Rotterdam CS. During the design, all different disciplines like project management, steel construction, concrete construction, and architectural engineering came together into one team. The whole team worked together on one physical location. This created short lines of communication. This made the coordination of the design and planning easier. Also, misinterpretations were removed by the shorter communication lines and the opportunity to explain everything in person.

> "The big advantage was that everyone was housed together and that coordination in terms of work preparation and the development of the project had very short lines."
> ~ PM4-B

When knowledge is certain on certain topics of projects, the network of a project manager is used most. People within the organization are called often to explain certain experiences and share knowledge. You see a knowledge network arise. The knowledge is sometimes laid down in lessons learned reports, but they get lost in the documents folders within the municipality. That is also why people tend to call sooner, it costs less time and you get the information easier.

> "It's more like a network of people you know who then say look for your answer there and there, rather than it being actually stored somewhere."
> ~ PM4-A

Appendix H: Expert sessions strategy

This appendix explains the expert sessions strategy in Dutch, since all the expert sessions are conducted in Dutch. It shows the expert session set-up, as well as the content of the expert sessions.

NOTE: The expert sessions can deviate from the set-up below. This depends on the flow of the expert session with every single expert.

Expert session set-up:

- Introductie
    - Aanleiding voor expert sessie
    - Gebruik van expert sessie data in thesis
    - Expert sessie opzet
- Expert sessie inhoud
    - Opzet van het onderzoek en gebruikte methoden
    - Voorlopige resultaten van case study over coordinatie problemen
    - Presentatie van voorlopig Framework
        - Pre-execution
        - Executie
        - Round-up
    - Discussie over inhoud framework
- Afsluiting

Introductie (5 minuten)

- *Aanleiding voor interview*

Mijn naam is Josje Gerlag en ik doe dit onderzoek als afstudeerder van de TU Delft voor de opleiding Construction Management & Engineering. Ik doe dit in samenwerking met de Gemeente Rotterdam IBR, wat ook mijn stageplek is.

Het doel van mijn onderzoek is om in kaart te krijgen hoe de coördinatie vanuit de opdrachtgever verloopt en waar dit wellicht misgaat in de praktijk, om zo tot een beter coördinatieproces te komen. Hierbij staat de zachte kant van een projectmanager centraal in combinatie met de ondersteuning van het contract.

Zeker bij complexe en multidisciplinaire projecten waar veel partijen betrokken bij zijn, is coördinatie cruciaal. Alle activiteiten moeten goed op elkaar afgestemd worden, helemaal wanneer men te maken heeft met een beperkt gebied waarin het project gerealiseerd dient te worden. Als er verschillende aannemers verschillende delen van het werk moeten uitvoeren, krijg je raakvlakken, ofwel interfaces. Deze raakvlakken moeten beheerst worden. Dit is de scope van het onderzoek.

Daarbij worden vandaag de dag 'soft skills' steeds belangrijker in projectmanagement. Echter is hier nog relatief weinig aandacht voor in onderzoek en op projectgebied. Met soft skills wordt vaak verwezen naar communicatieve vaardigheden, samenwerken en flexibel denken. Je emotionele intelligentie is hier heel belangrijk.

Ook de manier waarop coördinatie en de soft skills worden ondersteund in een contract is nog marginaal belicht. Daarom wordt er ook gekeken naar hoe het contract kan ondersteunen hierbij.

Ik hoop, door middel van deze expert sessie, feedback te kunnen krijgen op mijn voorlopige resultaten en mijn framework en uw inzicht te krijgen over de mogelijke instrumenten die de Gemeente heeft.

- *Gebruik van expert sessie data in thesis*

Ik maak notities van de expert sessie en, met uw toestemming, wordt de sessie opgenomen om de notities beter aan te kunnen vullen. Mijn doel is om uw participatie vertrouwelijk te houden. Dit doe ik door uw naam niet in mijn thesis te vermelden. Alleen een algemene functiomschrijving wordt gebruikt, samen met een schatting van het aantal jaar dat uw ervaring hebt binnen het vakgebied van de proejctensector. Indien er een opname gemaakt is, zal deze verwijderd worden zodra alle notities verwerkt zijn. De focus ligt op het gebruik van uw expertise bij het beoordelen en aanvullen van mijn resultaten en framework. Er wordt niet gevraagd op persoonlijke ervaringen of om het delen van informatie die gevoelig kan liggen.

Alle notities worden opgeslagen in mijn persoonlijke map op de server van de Gemeente Rotterdam om de veiligheid van de data zo veel mogelijk te waarborgen. De notities zelf zullen geen onderdeel uitmaken van mijn Thesis die gepubliceerd wordt in de Education Repository van de TU Delft, alleen de feedback op het framework zal gebruikt worden.

Mocht u zich niet comfortabel voelen met deze aanpak, dan kunt u dit ten alle tijden aangeven. Hierna kunnen we samen kijken naar waar u zich comfortabel bij zou voelen. Daarbij kunt u zich altijd terugtrekken. Uw deelname aan de expert sessie is volledig vrijwillig.

4. Expert sessie inhoud

De expert sessie zal ongeveer 1 uur duren. Hierin zal ik eerst uitleggen wat de opzet van mijn onderzoek is en de methoden die ik gebruikt heb. Daarna zal ik de voorlopige resultaten bespreken en het framework wat ik daarbij gecreerd heb. Hierbij is uw expertise en feedback van belang.

De opzet van de sessie is:

- Opzet van het onderzoek en gebruikte methoden
- Voorlopige resultaten van case study over coordinatie problemen
- Presentatie van voorlopig Framework
    - Pre-execution
    - Executie
    - Round-up
- Discussie over inhoud framework

Tijdens de discussie kunt u volledig uw eigen expertise, visie en gedachten uiten.

Na afloop kunt u eventueel een eigen invulling geven aan de expert sessie. Dit is het moment dat u extra toelichting kan geven op bepaalde onderwerpen of dingen waarvan u vindt dat deze nog niet goed genoeg aan bod gekomen zijn in de expert sessie of het framework.

- - - Expert sessie van start met slides waarin framework is gepresenteerd - - -

Afsluiting (5 minuten)

Dit is is alles wat ik wilde bespreken met u. Heeft u zelf nog inbreng ter afsluiting van het de expert sessie? [Ja, uitleg/Nee] Of dingen die u nog wil weten vanuit mij?
Hoe vond u de sessie? Heeft u nog tips & tricks voor mij en mijn onderzoek in het algemeen?

Bedankt dat u mee wilde doen aan deze expert sessie. U kunt mij altijd contracten voor eventeule toelichting op het onderzoek en het gebruik van uw toevoegingen eraan.

Appendix I: Outcomes of Expert Sessions

This appendix provides an overview of the comments made by the experts during the expert sessions. The comments are divided into the pre-execution and the execution parts of the framework.

Comments on pre-execution part

Contractual context

Both experts 1 and 2 explained that EMVI requirements are too soft and do not create a legal basis towards the contractors. EMVI criteria are often translated as nice to have, but not a must with legal consequences. If you want to have legal consequences, it was advised to add the SMART notation of coordination to the list of requirements.

Expert 3 suggested to add something about a requirement on competencies within the tender. The contractor would only do the assignment if he could demonstrate that he has certain competencies connected to collaboration and coordination. Also known as eligibility requirements.

Experts 1 and 3 both said that it is important to incorporate the lessons-learned system within the contracts and as a part of the regular meetings. Do not just lay it down at the end. Facilitate knowledge assurance within contractual arrangements.

Experts 2 and 3 explained that it is important to take into account that flaws within contracts can also be one of the main problems. This could also be a reason for misinterpretation and failure of contracts.

Coordination role

Expert 4 explained that, from a contractor perspective, if coordination is assigned to them with a certain substantial incentive, the interests become higher to coordinate all sub-projects.

Relational context

Expert 3 explained that conflicting interests should also be taken into account. It is important to respect contradictory goals and name them during start-up. This gives more insight into the reasons behind the discussions that are made during a project.

Expert 4 enlightened the importance of a client being a 'role model'. If a client is withdrawn and has a rigid and negative stance, contractors will adopt this.

Personal context

Expert 3 indicated that the municipality does not have an unlimited capacity of people. Sometimes you have to work with what you have. It is important that people learn how to deal with certain characteristics of other people and know each other's flaws. There is no capacity to assemble a winning team, sometimes you have to develop one throughout the process through training and coaching sessions.

Governance

Experts 1 and 2 both explained the need for clients to align. Before good governance can be set up for a project, the involved clients need to be aligned. This can be done on a legal basis through collaboration agreements between clients.

Experts 2 and 3 both advocated for an integral information tool that is also accessible to the contractor.

Comments on Execution part

Contractual context

Expert 2 indicated that contractors can also just fail. Sometimes it is not connected to poor contractual arrangements, poor project management, or poor coordination. Take into account the external factors here.

Experts 3 and 4 explained that a contract can be set up wrongfully. In this case, a contract can be changed through a changing procedure or by having addendums added to it. It is important to note that during execution also should be stated that contracts can be changed if they appear to not be fitting. You are not bound by the pre-set contract if it does not work. For example: if one of the KPIs is not working, you can change it in agreement with the contractor.

Relational context

Expert 1 advocated that trust is the overall value of those named and might be the most important one.

Experts 1, 3, and 4 explained that the named values are reciprocal, and the contractor also has issues that he needs to share. How do you secure this? It is important to create social/mental safety.

Expert 3 advised taking into account performance measurement within the municipality. This already happens every three months on collaboration within projects.

Personal context

A general advice was to connect the personal spheres only within the municipality team. This should not happen crosswise with the contractors, only within the municipality.

Governance

Experts 1, 2, and 3 all had notes on the escalation routes. They advocated adding that roll resistance is preserved. Also, escalation routes need to be functional and working. This has to happen in an integer way. Make this specific through processes and terms in which a certain escalation needs to be handled by superiors. This can be made SMART in terms of getting feedback timely, and fixed moments in which it needs to be discussed.

Expert 1 indicated that BIM might be an option for an integral system for information.

Appendix J: Example of coordination agreement in Dutch

Coordinatie overeenkomst Rijksvastgoedbedrijf

- Algemene tijdschema/Gedetailleerd werkplan wordt door alle partijen ondertekend en toegevoegd aan de overeenkomst art. 1
    - Elke partij dient volledige medewerking te verlenen met het maken hiervan en alle vereiste gegevens tijdig te verstekken en uit te voeren in goede onderlinge samenwerking en overeenstemming met de directie
- partijen moeten bij vertraging iedereen op de hoogte stellen art. 2
    - hierop moet de coordinator een vergadering houden met alle partijen, partijen zijn verplicht om te komen
    - Bij de vergadering een zo goed mogelijk alternatief bedenken waarbij het project zo min mogelijk vertraging en zo min mogelijk extra kosten krijgt
    - coordinator maakt een verslag van de vergadering en wordt met elke partij gedeeld
    - coordinator stuurt gewijzigd algemeen tijdsschema naar opdrachtgever, alle partijen dienen zich hieraan te houden
- Indien de vertraging schade veroorzaakt bij andere partijen, dient de veroorzakende party of leverancier de schade te vergoeden Art. 3
    - Partijen doen afstand van een schade vergoeding bij de opdrachtgever jegens elke juridische grondslag, tenzij grove nalatigheid van de opdrachtgever
- als vertraging op het tijdsschema is aan te rekenen aan de opdrachtgever, moet hij de schadevergoeding aan de partijen betalen Art. 4
    - geldt alleen voor rechtstreekse schaden en dit moet met bewijsstukken worden aangetoond
- bij overmacht worden geen schadevergoedingen door vertragingen op het tijdschema gevorderd worden art. 5
- 1. Het bepaalde in artikel 3 laat onverlet de rechten van de opdrachtgever ingevolge par. 46 van de UAV 2012 om indien vertraging in de uitvoering ontstaat - na schriftelijke aanmaning aan de nalatige partij om zijn werk binnen een redelijk te stellen termijn te bespoedigen en naar de uit de aannemingsovereenkomst voortvloeiende eisen uit te voeren en te voltooien - doordat de nalatige partij in gebreke blijft, voor rekening van deze nalatige partij zodanige maatregelen te nemen als door de opdrachtgever dienstig wordt geoordeeld, waaronder mede te begrijpen het door een derde doen verrichten van de werkzaamheden of doen voortzetten of voltooien van het werk van de nalatige partij. ART 6
    - 2. Het bepaalde in artikel 2 laat onverlet het recht van de opdrachtgever ingevolge par. 42 van de UAV 2012 c.q. het bestek tot het opleggen van kortingen.
- Derden waarbij ook rekening gehouden moet worden ART 7
- Geschillen worden beslecht overeenkomstig de regelen beschreven in het arbitragereglement van de Raad van Arbitrage voor de Bouw. ART 8
    - Indien bij rechterlijk gewijsde een uitspraak geheel of gedeeltelijk niet bindend of nietig wordt verklaard, heeft ieder der partijen het recht het geschil, voor zover het onbeslist is gebleven, opnieuw aan het oordeel van een scheidsgerecht uit de Raad te onderwerpen.
- Handtekeningen ART 9
- Coördinator taken: afstemmen van partijen, activiteiten, locaties, raakvlakken en toezicht houden op de naleving van tijdsplanning.

Appendix K: Usage of the framework

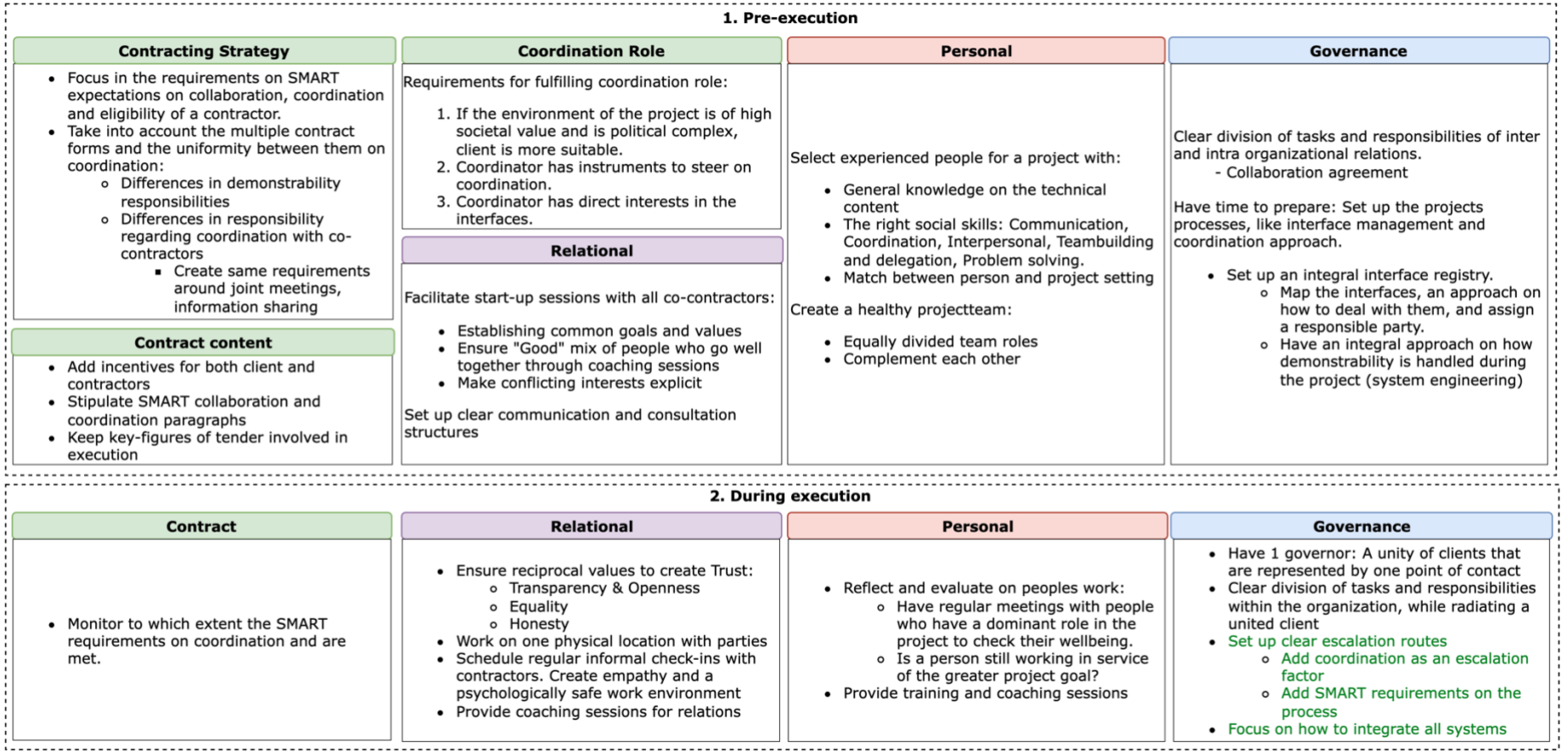


Figure 34. Thesis framework

Pre-execution: This part has to be taken into account during the pre-execution phases while setting up the coordination processes of a multidisciplinary project with co-contractors.

During execution: This pas has to be taken into account during execution while setting up the coordination processes of a multidisciplinary project with co-contractors.

Contracting strategy:

To enhance coordination during the execution, it is important to take into account two things when deciding on what type of contracts will be used. These are:

- The way a client stipulates requirements on collaboration, coordination, and the eligibility of a contractor.
- How to connect different contract forms and create uniformity between the contracts on the responsibilities of demonstrability and coordination: To facilitate coordination, the same requirements on consultations, communication structures, and information sharing are needed throughout all the contracts.

Contract content:

To create clarity around the expectations on the coordination assignment and what is expected of the parties, a client has to steer on parties meeting the requirements stipulated in the contract. This is done by:

- Incentives for both clients and contractors: By adding incentives, both parties will be stimulated to meet the requirements. These incentives can be either bonuses for performing beyond expectations or a fine due to not meeting the requirements. By adding incentives for the client too, a certain equality is established. Next to this, it stimulates the client to overcome the bureaucratic organizational setup and accelerate its processes.
- SMART collaboration and coordination paragraphs: By stipulating the collaboration and coordination requirements SMART (Specific, Measurable, Acceptable, Realistic, and Time-bound), misinterpretations or unclear expectations are prevented.
- Keeping key figures involved during multiple project phases: To retain the knowledge of the people involved during the tender, stipulations on requirements for people continuing their work during the execution phase are needed.

Coordination Role:

To decide whether the client or contractor is better suited to coordinate, three factors need to be taken into account:

1. The environment of the project: If the environment of the project is of high societal or political value, the client is better suited to coordinate the project.
2. The instruments of the coordinator: If it is not possible to give a contractor instruments as a coordinator, the client is better suited to coordinate.
3. The interests of a coordinator: If a contractor is not directly involved in all the interfaces of a project, or a contractor does not have a contract overlapping with other contracts, a contractor does not feel integrally responsible and does not have a prime interest in coordinating the project. In this case, the client is more suited to coordinate.

Relational during pre-execution:

To create a good relational atmosphere and have healthy relations, the client has to organize Start-up sessions. Within these start-up sessions it is important to:

- Establish common goals and values: By finding a common goal with the project, parties are more willing to work together to reach those goals. Next to this, it is important to establish the values of the relationships you want to have within the project. Once it is clear to all parties which values are of worth, the standard of the relationship in the project is set.
- Think about the 'mix of people' involved in the project: Not all people might have the same way of collaborating and the softer aspects around this. To know each other and how every person is,

coaching sessions are advised. These coaching sessions will show how every party desires to collaborate and which communication styles follow.
- Also, enlighten the conflicting interests between parties: Within a project, parties will not always have the same interests. By making these interests explicit, parties know what to expect of each other and also understand why parties make certain decisions and act a certain way.

Next to this, the client needs to set up clear communication and consultation structures to facilitate coordination and not make it depend on coincidence.

Personal during pre-execution:

As shown in the research, people have a major influence on projects. This is why it is important to select the right people with a certain amount of experience for a project with general knowledge of the technical content, and the right social skills, consisting of Communication, Coordination, Interpersonal, Teambuilding and delegation, Problem-solving, and matching the character of a person to the project setting and 'match with contract form'. To stimulate the knowledge of people on both hard and soft skills, training is advised. By testing what type of person you have working on a project, you can see which competencies of a person are advanced and which are insufficiently developed. With this, training can be set up and adapted to every single person.

Next to this, a client has to create and maintain a healthy project team. Before the execution starts, make sure that:
- The team roles are divided equally: All the activities of the client during execution need to be fulfilled. This needs to be taken into account, and if needed extra people have to be employed to the project.
- People complement each other: To have a good work environment and get the best out of your project team, you have to select people who complement each other. Keep in mind both hard and soft skills here. NOTE: Due to the scarcity in the labor market it is not always possible to find the right mix. This is why it is important to provide training and coaching sessions that focus on working better together and see what the capacity, collaboration profile, and competencies are of each person. The IQ, EQ, and SQ are of importance.

Governance during pre-execution:

Before the execution phase starts, a client needs to have a clear division of tasks and responsibilities within the organization and with other clients.

Next to this, a client has to take the time to prepare and set up the project processes, like interface management, and coordination approach, and create an integral interface registry to which all contractors have access. Also, map the interfaces, stipulate an approach on how to deal with them, and assign a responsible party before the start of the execution.

Keep in mind that an integral approach to demonstrability is needed during the project (system engineering).

Contract during execution:

To check it which extent the SMART requirements on coordination are met, it is important to monitor the progress regularly. This gives the client the possibility to intervene in time, if necessary. The client could facilitate the coordination process, or remind the coordinating contractor of the requirements. If a contractor does not comply with the coordination requirements, a client could take legal action. By demonstrating to which SMART requirement the contractor comes up short, a client can prove the negligence of the contractor.

Relational during execution:

During execution, a client should ensure the following values to create Trust:

- Transparency & Openness: Let contractors know what is going on, even if this might not be positive. If changes need to be implemented, let it know as soon as possible.
- Equality: Show the contractors you are in it together. Pain & gain sharing. Note: Take into account the relationship of authority.
- Honesty: Be upfront about decisions and their basing.

By highlighting the fact that these values need to be reciprocal, the contractor is partly responsible for the relation. To stimulate good relationships and keep them healthy, a client should provide coaching sessions. The sessions should not only be focused on conflicts but also on how to make the relationships even better.

To improve the relations, all parties should work on one physical location. This creates shorter communication lines and lowers the risks of misalignment and misinterpretation. This is crucial for the coordination process.

To find how each contractor is doing, regular informal check-ins need to be scheduled. In these check-ins it should not be about the activities of a contractor connected to the project, but more about how the contractor individually is doing. This creates empathy and stimulates a psychologically safe work environment.

Personal during execution:

To check the performance of the project team, a client has to reflect and evaluate people's individual work. By checking this, the client knows to which extent each person is still working in favor of the project and its goals. Next to the performance, the well-being of each individual needs to be monitored. This is done by having regular meetings with people who have a dominant role in the project. If people have too much workload or do not feel well, a client should take action. This could be in the form of hiring more people, providing training to strengthen the knowledge of people, or providing coaching sessions that focus on people's mental health.

Governance during execution:

During execution, the client has to have a clear governance in place to not undermine the coordination process. This is done by having one figurehead representing all clients involved. One client has to oversee and steer the overall project processes and facilitate the needed coordination. Clients have to be aligned, before they can expect this from contractors. Leading by example is important.

Next to this, a clear division of tasks and responsibilities within the cliental organization is needed. The internal organization has to be aligned too and has to have the same overall interests for the project. Within the organization a client has to set up clear escalation routes for project teams and add coordination as an escalation factor for proejct managers. Also, the escalation routes have to be functional. This is stimuled by adding SMART requirements on the processes of escalation. A proejct manager has to receive a time-bound anwer, with realistic and spesific measures/actions in place.

Lastly, a client has to focus on how to integrate all systems used during project execution.