Master thesis

The implementation of segmented contracting

A study on the legal and organizational aspects of segmented contracting in infrastructure projects

By

JOB MICHIEL VERSANTVOORT

TU Delft

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Job Michiel Versantvoort

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Thesis committee:	Dr.ir. A. Straub	TU Delft, chair
	Prof.mr.dr. E.M. Bruggeman	TU Delft, first supervisor
	Ir. L.P.I.M. Hombergen	TU Delft, second supervisor
Host organisation:	AT Osborne B.V.	
	Ir. D. Dortmundt	Supervisor
	Ir. W.J.P. de Rooij	Supervisor

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Preface

This thesis marks the conclusion of my Master's programme in Construction Management and Engineering at Delft University of Technology. The past months have been both intellectually stimulating and personally rewarding, and I am grateful for the guidance and support I received throughout this process.

I would like to sincerely thank my academic supervisors at TU Delft for their indispensable contribution to this thesis. Your guidance in selecting a suitable methodology, your constructive feedback during each phase, and your help in clearly framing the research problem have been critical. I especially appreciated your in-depth knowledge and sharp insights that challenged me to refine my thinking.

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To my friends, thank you for your encouragement when things felt overwhelming, for thinking along with me about how to structure my work, and for helping me convey my story more clearly. Your support made a real difference.

I hope this thesis contributes to a better understanding of segmented contracting and inspires further research and practical development in this area.

Job Versantvoort
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Summary

The Dutch infrastructure sector is facing major challenges: clients and contractors increasingly struggle to manage the scale and complexity of projects, risk allocations are often skewed, and market capacity is under pressure. Traditional integrated contracts place high responsibilities and risks on contractors, sometimes discouraging participation or leading to disputes and inefficiencies. Meanwhile, public clients are under pressure to attract specialized expertise, involve SMEs, and retain control over strategic decisions without overburdening their internal capacity.

In response, segmented contracting is gaining attention as a way to divide large, complex infrastructure projects into manageable parts. By segmenting design and execution responsibilities across different phases, scopes, or delivery methods, clients aim to regain control, and allocate risks more proportionately. However, segmented contracting also introduces new challenges related to responsibility boundaries, inter-contractor collaboration and legal coherence. These challenges raise the need for clearer guidance on how to structure segmented projects and accompanying agreements.

This thesis addresses the following research question:

How can clients adopt segmented contracting in complex infrastructure projects by making appropriate segmentation choices, and structuring contractual frameworks to support these choices?

To answer this question, a qualitative research strategy was applied. A literature study was conducted to explore segmentation concepts and relevant legal frameworks. Four Dutch infrastructure projects were analysed as case studies: the Uithoornlijn, Schiphol Baggage Basement, AWS Zwanenburg, and Amsterdam Central Station. Finally, three semi-structured interviews were held with legal experts to understand how segmented contracting is applied and what coordination agreements should include.

Results

The results demonstrate that clients can segment projects along several axes. First, segmentation can be horizontal or vertical. Horizontal segmentation refers to dividing the project spatially or functionally, enabling different contractors to work simultaneously in separate zones. This approach supports speed and contractor autonomy but requires clearly defined interfaces and robust integration management. Vertical segmentation, in contrast, separates tasks by discipline, such as between design and execution or between different technical systems within the same space. While this allows specialization and staged contracting, it often leads to fragmented processes and blurred accountability, especially if assumptions made in early design phases are not well aligned with execution needs.

Second, segmentation can be phased or parallel. Phased segmentation creates a temporal separation by letting one contractor complete their scope before another begins. This offers more control and interface clarity, particularly when dealing with vertical segmentation, but may increase overall lead time. Parallel segmentation enables simultaneous work on multiple segments, which can be advantageous in horizontally segmented projects where activities in distinct zones can proceed independently. However, it requires a high degree of coordination and trust, as misalignment in parallel design and execution can lead to costly rework or safety issues.

When combining horizontal or vertical segmentation with either a phased or parallel delivery strategy, distinct implications emerge for how design and execution responsibilities are distributed, and how interfaces must be managed.

Horizontal and parallel segmentation is particularly effective when project segments are physi-

cally and functionally independent. Each contractor assumes full responsibility for both design and execution within its zone, which promotes autonomy, speeds up the timeline, and reduces mutual interference. However, because these contractors rarely interact, coordination does not occur naturally and must be structured proactively. The client must take a central role in interface coordination, enforce data sharing standards, and ensure early identification of technical dependencies to prevent design misalignment or late-stage clashes.

Horizontal and phased segmentation is suited to situations with spatial separation but temporal dependency, where early segments must be completed before others begin. This approach enables clear responsibility per contractor and supports structured execution planning. However, it introduces misalignment risks in the design phase, as downstream contractors may rely on outdated or uncoordinated designs. Interface validation and milestone-based handovers are essential, and the client must enforce shared design assumptions and active knowledge transfer between phases to avoid scope gaps and inefficiencies.

Vertical and phased segmentation separates design and execution both functionally and chronologically. Typically, a central party designs multiple components, while execution is carried out later by specialized contractors. This supports quality control in design and avoids site interference, but creates a strict dependency on detailed, correct, and timely designs. Contractors have little room to adjust or optimize if inconsistencies arise. This segmentation form therefore demands mature design packages, tightly managed interfaces, and contractually secured handover protocols to maintain clarity of scope and accountability.

Vertical and parallel segmentation is the most complex configuration, where multiple technical disciplines are designed and executed simultaneously by different contractors. It enables fast delivery and domain-specific expertise but severely tests planning and coordination. Because systems physically and functionally intersect, unclear responsibilities, concurrent access to the site, and misaligned schedules can quickly result in conflicts. This form requires the strongest possible coordination structure, including integrated planning, mandatory interface alignment, and clearly assigned lead roles. Without this, vertical and parallel segmentation risks fragmentation and contested liabilities during execution.

To effectively implement segmented contracting, clients must carefully select and align the project delivery methods applied to each segment. Rather than relying on a uniform approach, clients are advised to adopt a modular contracting strategy, combining traditional contracts (UAC), integrated contracts (UAC-IC), and consultant agreements (TNR) where appropriate. This enables customization per segment based on market characteristics, risk profiles, and the need for early contractor involvement. However, this flexibility requires that all contracts are legally and operationally harmonized. Clients should ensure that responsibilities for design, execution, and integration are explicitly assigned and contractually secured, especially at interfaces. Standardized clauses across contracts, a shared risk allocation strategy, and consistent terminology regarding deliverables and dependencies are essential to avoid ambiguity. The success of segmented delivery methods depends not on variety alone, but on coherence across segments and a shared framework of expectations.

Equally important is the structuring of coordination across segments. In segmented contracting, coordination should be viewed as a formalized project function rather than an informal role. Clients are recommended to appoint a coordination entity early in the process either internally or externally, and to provide it with a clear mandate, authority, and contractual recognition. This role must extend beyond technical interface management and include planning alignment, information sharing, conflict resolution, and monitoring of interdependencies. Coordination should be embedded through concrete mechanisms, such as shared milestones, regular multidisciplinary coordination meetings, decision-making protocols, and joint risk reviews. Importantly, coordination must be enforceable: it should be backed by clear roles and responsibilities, linked to performance incentives where possible, and protected from dilution by conflicting contract regimes. Only when coordination is recognized as a binding and structured function can the complexity of segmented projects be successfully managed.

To give formal structure to coordination and inter-contractor collaboration, a coordination agreement should be used as an overarching legal instrument. This agreement complements the segmented contracts and ensures alignment across scopes, timelines, and responsibilities. It should define the coordinating party and specifically define its mandate, tasks, and decision-making powers. Additionally, the agreement must detail how coordination will be operationalized through joint planning milestones, interface management procedures, shared communication protocols, conflict escalation ladders, and data exchange rules. It should also specify who is responsible for resolving design inconsistencies or delays at interfaces. The main conclusion is that without such a legally recognized and content-rich coordination agreement, segmented contracting risks becoming fragmented and ineffective. Clients must therefore treat the coordination agreement not as a soft commitment, but as a critical contractual tool with real enforceability.

Discussion

Several discussion points arise from this study regarding its methodology and scope. First, while the combination of literature review, case analysis, and expert interviews provided rich insights, the qualitative nature of the research limits the ability to generalize findings across all infrastructure projects. The selected cases were diverse but not exhaustive; they represent large, publicly managed projects and may not fully reflect the dynamics in smaller or privately-led initiatives. Second, the findings depend partly on interpretations of contract documents and interview responses, which introduces subjectivity, particularly in evaluating the effectiveness of coordination. Third, the development and assessment of coordination agreements remain context-specific; what works in one segmented configuration may not be directly transferable to another. Lastly, the evolving nature of segmented contracting in the Netherlands means that both legal practice and organizational routines are still in flux, limiting the ability to draw fixed conclusions. These limitations do not undermine the relevance of the study but do call for cautious interpretation and further validation in future research.

Recommendations

Based on these insights, several recommendations are proposed. Clients should explicitly define the form of segmentation early in the process and ensure that their contractual choices reflect the technical and organizational logic of that segmentation. They should embed coordination through a legally binding agreement, supported by clear instruments for planning, conflict resolution, and interface control. Furthermore, selection and award criteria should account for the segmented structure and reward contractors who demonstrate integration capacity. Lastly, sector-wide guidance such as model clauses or templates, should be developed to professionalize the use of coordination agreements and improve legal certainty in segmented contracting.

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Glossary

English term	Dutch term	Definition
Client	Opdrachtgever	An organisation that commissions a party to carry out a specific task or project.
Co-contractor	Nevenaannemer	A contractor who has a direct contract with the client but is not the main contractor. The co-contractor works alongside other contractors on the project, each responsible for their own part of the work.
Contractor	Aannemer	A party that undertakes and performs work commissioned by a client stated in a contract.
Project Delivery Method	Bouworganisatievorm	How responsibilities, tasks, and risks are distributed among the various participants involved in the construction process. It establishes the relationships and collaboration structures that shape decision-making, risk allocation, and project execution (Jansen, 2009; Miller et al., 2000).
Segmented contracting	Gesegmenteerd contracteren	Breaking down complex projects into smaller, more manageable components. It is the comprehensive approach to implementing segmentation and a segmented project delivery method in a project, where each segment is individually legally contracted by the client to a contractor (Dortmundt, 2024).
Segmented project delivery method	Gesegmenteerde bouworganisatievorm	An umbrella term for various segmented project delivery methods that result from the application of segmentation to a project delivery method (Dortmundt, 2024).
Small and Medium-sized Enterprises (SME)	Midden- en Klein Bedrijf (MKB)	An independent enterprise with fewer than 250 employees and an annual turnover of €50 million or less (RVO, 2013).
The New Rules 2011 (TNR)	De Nieuwe Regeling 2011 (DNR)	The general conditions for designing, advising, and organizing in the built environment between the client and the contractor (Chao-Duivis et al., 2018).
Uniform Administrative Conditions 2012 (UAC)	Uniforme Administratieve Voorwaarden 2012 (UAV)	The general terms and conditions most commonly used for building contracts in the Netherlands. The UAC are based on the traditional legal relationship between a client and a contractor (Chao-Duivis et al., 2018).

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English term	Dutch term	Definition
Uniform Administrative Conditions for Integrated Contract Forms 2005 (UAC-IC)	Uniforme Administratieve Voorwaarden voor Geïntegreerde Contractvormen 2005 (UAV-GC)	General conditions under which design, execution, and (long-term) maintenance can be awarded within a single contract (Chao-Duivis et al., 2018).

1 Introduction

1.1 Context

In recent years, the procurement and execution of complex infrastructure projects in the Netherlands have become increasingly challenging. Many tenders fail to attract sufficient competition, while others become financially unfeasible due to high-risk pricing and contractual uncertainties (Tweede Kamer, 2024). This results in cost overruns, project delays, and inefficiencies that put pressure on both public clients and market parties (Groot et al., 2021). Simultaneously, contractors are increasingly reluctant to undertake large public infrastructure projects. The risks associated with these projects have become so substantial that contractors bear responsibility for factors beyond their control, making projects financially unattractive (Ebbers, 2019). This shift has not occurred overnight but is the result of decades of evolving procurement strategies.

Since the 1990s, Rijkswaterstaat (RWS), the largest public infrastructure client in the Netherlands, has changed its contracting approach significantly. Inspired by principles such as reducing government involvement, clearly distinguishing policy from execution, and embracing market-driven solutions, the Dutch government adopted the principle of ”the market, unless” (Van der Berg & Riemersma, 2021). Until approximately 15 years ago, projects were procured as fully designed contracts, with contractors competing purely on price. The lowest bidder was awarded the contract, and project execution was relatively straightforward.

However, in an attempt to improve innovation and efficiency, the Netherlands adopted integrated contract models, drawing inspiration from the UK's Design, Build, Finance, Maintain, and Operate (DBFMO) approach. This resulted in a shift: contractors were no longer solely responsible for construction but were required to manage the entire project lifecycle (Ebbers, 2019). This transition significantly increased contractors' risk exposure, particularly during the financial crisis, when already tight profit margins were further compressed. Consequently, many contractors faced growing financial risks while struggling to maintain profitability.

Today, major construction firms are setting clear boundaries regarding their willingness to take on complex projects. For example, BAM, the second-largest construction contractor in the Netherlands (Koninklijke Hibin, 2025), has explicitly stated that it will no longer accept projects exceeding €150 million under fixed-price contracts, as the financial risks outweigh potential returns (Clahsen, 2021). This trend raises concerns about the long-term viability of large-scale infrastructure procurement. The limitations of current procurement approaches are evident in multiple large-scale projects that have experienced significant difficulties. High-profile cases such as the Van Brienenoord Bridge renovation, Schiphol Airport's baggage system overhaul, Zeesluis IJmuiden, and the Zuidasdok redevelopment illustrate the urgent need to reconsider procurement and contract strategies.

The Van Brienenoord Bridge renovation highlights the challenges of traditional contracting models. In late 2022, Rijkswaterstaat (RWS) initiated a tender process for this major infrastructure project, but only one consortium submitted a bid. Due to excessive risk pricing and financial infeasibility, negotiations failed (Rijkswaterstaat, 2024). As a result, the project was delayed by four years, leading to considerable financial and logistical consequences. A subsequent evaluation by the Ministry of Infrastructure and Water Management (I&W) revealed that project costs had been severely underestimated and that the lack of competition had driven up prices significantly (Van der Brugge, 2024). This case underscores the need for alternative procurement strategies that can better distribute risks and attract market participation.

The renovation of the Zeesluis in IJmuiden is another example of the difficulties faced in large infrastructure projects. After nearly 100 years, the Noordersluis, measuring 400 meters in length, 50 meters in width, and 15 meters in depth, has reached the end of its lifespan and requires replacement (BAM Infra, n.d.). The project encountered multiple setbacks, including unforeseen technical issues and cost overruns. A design error increased project costs by €138 million (Niewold, 2018). Furthermore, structural redesigns led to additional costs of €61.5 million and a 27-month delay (Koenen, 2018). At one point, the government even considered terminating the contract and re-tendering the project, demonstrating the immense financial and contractual risks involved in such large-scale endeavors.

The Zuidasdok project is one of the most significant infrastructure undertakings in the Netherlands, aimed at improving accessibility to Amsterdam and the northern Randstad by both road and public transport. The project, a collaboration between Rijkswaterstaat, ProRail, and the Municipality of Amsterdam, is designed to maintain the functionality of the A10 Zuid, urban roads, and Amsterdam Zuid station during construction (Blaas, 2024). However, the complexity of the project led to significant challenges. Originally conceived as a single-package megaproject, Zuidasdok faced overwhelming risks and dependencies, ultimately leading to its failure in tendering in 2020 (Stil, 2024). The project was deemed too complex to manage effectively under a single contract. As a result, authorities decided to divide it into smaller, more manageable work packages, reducing interdependencies and improving control over project execution. However, this shift required a complete re-tendering process, the adoption of new collaboration models, and the development of alternative contract structures (Zwaga, 2020).

Beyond these individual cases, both public and private stakeholders struggle with managing highly complex infrastructure projects. There is a growing realization that neither public clients nor contractors currently have the capacity to effectively execute such projects within existing contractual frameworks. While initial efforts aimed to reduce government spending and improve efficiency, the unintended consequence has been a procurement system where risk is disproportionately allocated to contractors, creating an unsustainable market dynamic (Ebbers, 2019).

Recognizing the urgency of this issue, Rijkswaterstaat commissioned a study by McKinsey & Company in 2019 to assess the sustainability of infrastructure procurement in the Netherlands (Vitale Infrasector, n.d.). The findings were alarming: if procurement strategies remain unchanged, the market may eventually reach a point where no contractors submit bids for complex tenders (Rijkswaterstaat, n.d.-a). This scenario would threaten the continuity of Dutch infrastructure development.

In response, Rijkswaterstaat and market parties are now collaborating to establish a more financially sustainable and predictable infrastructure sector. The goal is to optimize knowledge utilization, improve risk allocation, and create an environment conducive to innovation and long-term stability.

These examples highlight the structural inefficiencies of the current procurement and contracting models. As infrastructure projects continue to grow in complexity, financial pressure, and risk exposure, it is of great importance to explore alternative contracting strategies that can offer a more balanced and sustainable approach to project delivery.

1.2 Problem definition

The increasing difficulties in the procurement and execution of complex infrastructure projects, as outlined in the previous section, demonstrate the urgent need for a reassessment of current contracting strategies. Clients face growing challenges in attracting competition, mitigating risks, and managing the rising complexity of large-scale projects (Ebbers, 2019). The examples of the Van Brienenoord Bridge, Schiphol Airport, Zeesluis IJmuiden, and Zuidasdok illustrate how traditional procurement and project delivery models struggle to accommodate these challenges, leading to failed tenders, financial overruns, and project delays.

In response to these setbacks, Rijkswaterstaat and other public authorities are reconsidering their contracting approaches, with segmented contracting emerging as a potential alternative (Rijkswaterstaat, 2019). By dividing large projects into smaller, more manageable work packages, this method aims to distribute risks more effectively, improve market accessibility, and enhance project control. However, despite its potential benefits, segmented contracting introduces new challenges related to contract structuring, coordination, and procurement strategies.

The evaluation by Van der Brugge (2024) on the procurement of the Van Brienenoord bridge suggests that Rijkswaterstaat should segment the large project to mitigate risks and attract a wider pool of bidders. By dividing the complex project of the renovation of the bridge into multiple smaller projects with their own contracts, risks could be better distributed, allowing for increased market interest and competition. However, industry experts remain divided on the effectiveness of this approach. Some argue that segmented contracting merely shifts risks rather than reducing them. Others, such as Remco Hoeboer (TBI Mobilis), emphasize that uncertainties in infrastructure projects are inevitable and must be managed, rather than eliminated, through budgeting and contractual agreements (du Saar, 2014). Additionally, concerns have been raised about whether breaking projects into smaller parts will lead to increased overall costs due to additional administrative burdens, interface risks, and coordination complexities.

A similar transition toward segmentation has already taken place in the Zuidasdok project. Initially procured as a single, large-scale contract, the project faced insurmountable complexity and risk concentration, ultimately leading to the termination of the original agreement with Heijmans, Hochtief, and Fluor (Zwaga, 2020). The project was subsequently restructured into multiple smaller tenders, each with its own scope and procurement process. This shift was intended to make the project more manageable, but it also introduced new challenges related to contract structuring, coordination, and risk allocation among different stakeholders. The case of Zuidasdok illustrates both the potential benefits and the inherent difficulties of segmented contracting.

The thesis by Dortmundt (2024) examines how complexities and risks shift when large infrastructure projects are segmented into smaller parts. Segmentation reduces technical complexity by allowing specialized contractors to manage specific project elements, improving focus and predictability. However, it increases organizational complexity, as multiple segments require strong coordination, clear communication, and integration efforts to prevent inefficiencies. While segmentation can enable parallel project execution, it also raises administrative burdens due to multiple procurement and contracting processes.

One major shift is the decentralization of risks. Instead of being concentrated in a single large contract, risks are spread across multiple smaller contracts, reducing the burden on individual contractors and encouraging market participation. However, interface risks increase, as different segments must align seamlessly. Coordination failures at these interfaces can cause delays, cost overruns, and operational inefficiencies.

Financial exposure also changes. Instead of one large financial commitment, clients and contractors handle multiple smaller contracts, which lowers entry barriers for smaller firms but increases transaction costs. While segmentation enables better resource allocation, it also demands careful planning, both organisation and financial.

The overall impact of segmentation depends on how well legal and organizational challenges are managed. While it fosters competition, improves risk allocation, and enhances project control, it requires strong contract structuring and coordination mechanisms. If not managed properly, segmentation can introduce inefficiencies rather than resolving them. Dortmundt's research underscores that a well-defined framework for contract design, tendering strategies, and project coordination is essential to fully realize the benefits of segmented contracting. Thus, legal frameworks and contractual agreements are critical to the success of segmented projects. An investigation into the legal challenges posed by segmented project delivery methods is necessary to identify best practices for drafting contracts that support segmentation. Research should examine how different legal frameworks can either facilitate or hinder the segmentation process and propose improvements to address these barriers.

Additionally, segmented contracting demands a rethinking of organizational setup. Managing multiple smaller projects simultaneously introduces complexities in project team coordination, communication, and resource allocation. Questions arise about where labor efficiency can be gained, what additional time may be required, and how interfaces between project segments should be managed. Moreover, maintaining alignment among segmented projects to ensure they collectively deliver a cohesive end product is a critical concern. Effective communication strategies and clear definitions of responsibilities are essential for the successful implementation of segmented contracting.

Although Dortmundt's research provides a solid theoretical foundation on the shift of technical, organisational and external complexities, it does not yet address how segmented contracting should be implemented in practice. The next step is to determine how this approach can be translated into effective procurement strategies and contractual frameworks. Understanding which contract types best align with segmented projects, how tendering procedures should be adjusted, and how project teams should be structured are key questions that remain unanswered. While previous research has extensively explored the impact of segmentation on risk distribution, this study does not seek to reevaluate those aspects. Instead, the focus is on understanding how segmented contracting can be effectively applied in infrastructure projects by investigating its legal, procedural, and organizational dimensions. By building upon Dortmundt's findings, this research aims to bridge the gap between theoretical insights and practical execution, offering a structured approach to the implementation of segmented contracting in Dutch infrastructure projects.

The following subchapters will outline the research objectives, defining the specific scope and relevance of this study. This includes an examination of which aspects of segmented contracting will be included, and which fall outside the scope. The research questions guiding this study will be introduced, followed by a detailed explanation of the research methodology. Through this approach, this thesis aims to contribute to a deeper understanding of how segmented contracting can be implemented effectively in infrastructure projects.

1.3 Rationale for research

1.3.1 Academical

As discussed in Chapter 1.2, Rijkswaterstaat and other public authorities are reconsidering their approach to contracting and risk allocation due to the increasing complexity of infrastructure projects. These projects face challenges on multiple levels, including technical execution, stakeholder coordination, and financial management. Given the limitations of traditional procurement methods, clients seek ways to regain control over project execution by assuming greater responsibility in the structuring and oversight of contracts. Various strategies have been explored to achieve this goal, with one of the most promising approaches being *segmented contracting*. This method involves dividing a project into smaller, more manageable contractual packages to improve flexibility, distribute risks more effectively, and enhance market participation.

Segmented contracting has gained attention as an alternative to conventional procurement methods due to its potential to mitigate risks, increase adaptability, and encourage broader competition. Previous research, such as the work of Dortmundt (2024), has demonstrated that breaking down projects can lead to a more balanced distribution of risks and a reduction in overall project complexity. However, despite these theoretical advantages, the practical implementation of segmented contracting remains largely unexplored. This research aims to bridge that gap by focusing on how segmented contracting can be structured in real-world applications.

While segmented contracting is one possible solution, alternative project delivery methods, such as two-phase contracting and the bouwteam, have also been considered. *Two-phase contracting*, as explored by Van Esch (2023), emphasizes early collaboration between the client and contractor to refine project scope and manage risks in a controlled manner. However, this model does not always align with the fragmented nature of complex infrastructure projects, where multiple disciplines, stakeholders, and independent work packages must be coordinated simultaneously. Additionally, two-phase contracting may not provide the same level of flexibility and competitive market access as segmented contracting. Therefore, this study focuses on segmented contracting as a more adaptable approach for complex projects.

Another project delivery method that has gained popularity is the *bouwteam* approach. In a bouwteam, the contractor is involved early in the design process to provide insights into constructability, risk mitigation, and cost estimation, fostering a cooperative environment between the client and contractor (Chao-Duivis, 2012; Werkgroep Handreiking Bouwteams, 2021). This model has proven particularly useful in achieving sustainability goals and optimizing project planning. However, despite its advantages, the bouwteam model has certain limitations when applied to highly complex infrastructure projects. Firstly, the effectiveness of a bouwteam heavily depends on the willingness of all parties to engage in open and transparent collaboration. In large-scale infrastructure projects with multiple contractors and subcontractors, aligning incentives and maintaining balanced partnerships can be challenging (Werkgroep Handreiking Bouwteams, 2021). Secondly, while a bouwteam enhances early-stage cooperation, it does not inherently provide a structured framework for segmenting responsibilities across different project phases. This means that once a project transitions from the collaborative design phase to execution, risks and responsibilities may not be as clearly allocated as they would be in segmented contracting. Thirdly, the bouwteam model typically focuses on a single contractor-client relationship, whereas segmented contracting allows for broader market participation by distributing work among multiple contractors (Chao-Duivis, 2012).

1.3.2 Societal

The findings of this research have significant societal relevance, particularly for public and private clients involved in infrastructure procurement. Infrastructure projects play a vital role in economic development, mobility, and sustainability, but inefficiencies in procurement and contract structuring can lead to cost overruns, project delays, and a lack of market competition (OECD, 2021). By exploring segmented contracting as an alternative procurement strategy, this research provides insights that can help clients make better informed decisions about contract selection and procurement strategies.

One of the primary societal benefits of segmented contracting is its potential impact on cost control and risk distribution. Traditional large-scale contracts often concentrate financial and operational risks on a single contractor, discouraging market participation from smaller firms and increasing overall project costs. By dividing projects into smaller contractual packages, segmented contracting allows for more distributed risk allocation, reducing the financial burden on individual contractors while increasing competition (Dortmundt, 2024). This, in turn, can lead to more competitive pricing, better cost efficiency, and a more resilient market of contractors in the infrastructure sector.

Another critical aspect is market stimulation and structuring competition. Properly designing segmented contracting requires a careful balance between ensuring healthy market competition and preventing excessive fragmentation. Too many small contracts could result in inefficiencies, whereas overly consolidated contracts might restrict participation to a limited number of large firms. This research examines how segmented contracting can be deployed in a way that encourages a diverse range of contractors to participate while maintaining project efficiency and coherence. By providing clear strategies for how projects can be optimally segmented and structured in the market, this study aims to inform procurement officials on how to maximize market incentives while preserving project quality and deliverability.

Ultimately, the results of this study will provide tangible guidance for public and private clients seeking more flexible, cost-effective, and competitive procurement approaches. In doing so, it contributes to a more sustainable and resilient infrastructure sector that can better respond to the increasing complexity of modern projects.

Therefore, there is a need for an other method. Given these constraints, this study centers on segmented contracting as a strategy that better addresses the challenges associated with complex infrastructure projects. By investigating its legal, procurement, and organizational implications, this research aims to provide insights into how segmented contracting can be effectively implemented in practice.

1.4 Research design

The research objectives aim to address the knowledge gap and uncertainties around the implementation of segmented contracting for complex infrastructure projects. This approach seeks to tackle the challenges posed by legal frameworks, the interplay between contract selection, and the organizational structures of project delivery methods.

Clients face significant challenges in managing both the aging infrastructure and new infrastructure projects in the Netherlands. Traditional procurement and contracting methods often fail to effectively distribute risks, encourage competition, or manage project complexity. Segmented contracting offers a potential solution by dividing projects into smaller, more manageable segments. However, its success depends on addressing legal, procedural, and organizational challenges.

1.4.1 Research question

This brings us to the main research question. The main research question is as follows:

MQ: How can clients adopt segmented contracting in complex infrastructure projects by making appropriate segmentation choices, and structuring contractual frameworks to support these choices?

1.4.2 Sub-questions

To answer this main question, several sub-questions have been formulated. Each sub-question addresses a specific element of the main question.

1. **What segmentation choices does a client have in segmented infrastructure projects, and which contract types best support these choices?**

   To enable a deliberate and effective use of segmented contracting, it is essential to understand the different segmentation options available to clients. These choices include horizontal or vertical segmentation, phased or parallel segmentation, and the different segmented project delivery methods within a single project. Additionally, clients must decide on the role and responsibilities of coordination; whether to assign it to one contractor, distribute it among segments, or retain it in-house. This question first maps out the various segmentation choices. It then explores how different types of standard contracts used in the Dutch infrastructure sector—such as the UAC, UAC-IC, and the TNR support or limit these segmentation approaches. Moreover, it investigates whether additional legal instruments such as coordination or collaboration agreements are needed to bridge the gaps left by standard contracts. By examining these contract-segmentation alignments, this question provides the foundation for understanding how segmentation choices influence the legal and organizational structuring of complex projects.

2. **How do phased and parallel segmentation, and horizontal and vertical segmentation, influence design and execution responsibilities in segmented contracting?**

   Segmented projects can be structured using horizontal or vertical segmentation, each affecting responsibilities within segmented contracting differently. Additionally, segments can be executed over time: either phased (sequentially) or parallel (simultaneously) segmentation. These approaches significantly impact responsibilities within segmented contracting. Moreover, the choice between these segmentation strategies and execution approaches influences each other. For instance, horizontal segmentation combined with parallel segmentation impacts responsibilities differently compared to vertical segmentation with parallel segmentation. To compare these choices effectively, the two segmentation strategies will be analyzed in combination with each other.

3. **What should clients consider when implementing multiple (different) segmented project delivery methods in a complex infrastructure project?**

   Building on the findings of the previous question, this question dives into how clients should manage multiple segmented project delivery methods within a single complex infrastructure project. The segmentation of projects, whether phased or parallel and horizontal or vertical, affects the allocation of design and execution responsibilities. This requires careful consideration of how different methods interact. This question explores how clients can align segmented project delivery methods with segmentation strategies while ensuring clear roles and responsibilities. Key considerations include coordination complexities between different methods, contractual consistency to prevent conflicts, and risk distribution across multiple contracts. Additionally, this study investigates which segmented project delivery methods work well together and which combinations introduce inefficiencies. The goal is to provide insights into how clients can structure segmented contracting strategies effectively, to ensure an integration of multiple project delivery methods within a single project.

4. **What specific contractual elements should be included when structuring contracts for the implementation of segmented contracting?**

The implications of phased and parallel execution, as well as horizontal and vertical segmentation in segmented contracting, introduce unique legal and organizational complexities that may require modifications to standard contract templates. This question examines which contractual elements need to be added or modified in current contract forms to better support the segmentation choices made by clients. The emphasis lies on how existing contracts can be adapted through specific clauses and provisions. Areas of interest include the assignment and scope of coordination roles, procedures for interface design and management, planning and scheduling integration, communication protocols, joint risk and opportunity management, and appropriate dispute resolution mechanisms. The findings will help structure contracts to ensure the successful implementation of segmented contracting into Dutch infrastructure projects.

By addressing these sub-questions, this research provides insights into the practical implementation of segmented contracting.

1.5 Scope

The scope of this research needs to be carefully narrowed down to ensure a focused and manageable study. By focusing on key aspects, this study aims to deliver a structured analysis that provides practical and strategic insights for public clients managing infrastructure projects in the Netherlands. Since public clients are responsible for initiating projects, defining procurement strategies, and structuring contractual agreements, this research primarily examines segmented contracting from their perspective. The following sections outline the focus areas and the reasoning behind their inclusion or exclusion.

Dutch market and procurement law

Segmented contracting operates within legal and regulatory frameworks that vary by country. This research specifically focuses on the Dutch market, where procurement law and public contract regulations shape how infrastructure projects are delivered. Since public clients must operate within these legal constraints, limiting the study to the Netherlands makes sure that the findings remain relevant and practically applicable to Dutch policymakers and contracting authorities.

Dutch infrastructure projects

The research is centered on infrastructure projects within the Netherlands, as public clients must use specific national frameworks and regulations when structuring procurement and contracting processes. While international examples may be referenced for comparison, the primary focus remains only on Dutch projects to provide practical insights that can directly benefit public clients managing similar developments. This study specifically focusses on the Dutch infrastructure projects: earth, road and waterworks (GWW in Dutch) (Rijkswaterstaat, n.d.-b). In this sector the role of client is in essence always fulfilled by a public party, mainly by municipalities and Rijkswaterstaat.

Public clients

This research is conducted from the perspective of public clients, as they are responsible for structuring the project, choosing whether to apply segmented contracting, defining the segmentation strategy, and establishing collaboration frameworks. These decisions significantly influence risk allocation, contractor responsibilities, and market engagement. While the contractor's role is important, analyzing both perspectives in equal depth would broaden the scope too much. However, in areas related to collaboration and organizational structures, the contractor's perspective will be considered where relevant to ensure a better understanding of project execution dynamics.

Subcontracting versus co-contracting

In construction projects, it is common for contractors to subcontract parts of their work to third parties. This practice, known as subcontracting, involves a contractual relationship between a main contractor and one or more subcontractors. A frequently used mechanism is back-to-back contracting, whereby the terms and conditions agreed between the client and the main contractor are mirrored in the subcontractor agreements (Bakkes, 2025; Petti, 2013; Van den Boogaart & Den Houting, 2023). Subcontracting differs from co-contracting in that subcontractors have no direct contractual relationship with the client, whereas co-contractors are each individually contracted by the client.

This thesis explicitly excludes subcontracting relationships from its scope. Whether in traditionally structured projects with a single main contractor, or in segmented projects involving multiple contractors, subcontracting may still occur. However, since the legal relationship lies solely between contractors, and not between the client and subcontractors, subcontracting falls outside the scope of this study.

Instead, this research focuses solely on contractors that are individually contracted by the public client. These are the co-contractors whose roles, responsibilities, and coordination mechanisms are central to the segmented contracting approach in this research. The functional collaboration between such co-contractors, including aspects of interface management, joint planning, and legal coordination, forms a core element of the study. Legal relationships internal to the contractor's organization or their subcontracting chain are not addressed.

Procurement and contracting phase

This research primarily focuses on the procurement and contracting phase, as this is the stage where public clients define the segmentation strategy, select project delivery methods, and structure contractual arrangements. These early decisions are critical, as they shape how responsibilities, risks, and coordination mechanisms are distributed across the project.

Although the construction and execution phases themselves fall outside the scope of this study, the research explicitly examines how procurement and contracting strategies affect the subsequent design and execution phases. This study analyses whether the chosen segmentation approach and contract structure provide sufficient legal and organizational support during project implementation. In this way, the research connects strategic decisions at the front of the project with their downstream implications.

Project delivery methods

Segmented contracting can be applied across different project delivery methods, as outlined in previous research by Dortmundt (2024). Instead of reassessing whether segmented contracting is applicable to different methods, this study assumes that it can be integrated into various approaches. The research will therefore focus on refining strategies and analyzing how legal and organizational structures support segmented contracting within different delivery methods.

UAC-IC 2005 and UAC-IC 2025

On January 14, 2025, the new edition of the UAC-IC 2025 was presented at the InfraTech event in Rotterdam (CROW, 2025).

The updated UAC-IC 2025 introduces several key improvements over its 2005 predecessor, focusing on contract transparency, risk distribution, and collaboration (CROW, 2024). Firstly, the new version places a stronger emphasis on proactive communication and cooperation between the client and contractor, ensuring that both parties actively engage in problem-solving throughout the project. Secondly, the responsibility for providing project information has been clarified, with a greater obligation on the client to supply accurate and complete data to prevent unforeseen risks and disputes. Lastly, liability regulations have been revised to distinguish responsibilities before and after project completion, ensuring a fairer balance of risks and limiting excessive financial exposure for contractors.

However, since the UAC-IC 2025 has only recently been introduced, there are currently no projects that have adopted this updated version. To align with ongoing projects, this study will therefore be based on the UAC-IC 2005.

2 Research approach

This chapter outlines the research approach employed to address the main research question and its corresponding subquestions. Given the nature of segmented contracting and its impact on legal, procedural, and organizational aspects, a qualitative research approach is adopted. The study relies on four primary research methods: a literature study, desk research, case studies, and interviews. These methods provide a better understanding of segmented contracting by combining theoretical insights with empirical data.

Qualitative research

This research adopts a qualitative approach as opposed to a quantitative methodology. Segmented contracting is a complex and relatively unexplored field that involves project structures, segmentation and legal frameworks which cannot be effectively analyzed using purely quantitative methods. Quantitative approaches, such as statistical modeling or large-scale surveys, would not be suitable for this research as segmented contracting lacks a large dataset of past implementations (Baarda et al., 2005). Instead, qualitative research allows for a deeper exploration of contextual factors, expert opinions, and case-specific challenges that impact the implementation of segmented contracting (Creswell, 2009). Therefore, these qualitative methods such as document analysis, case evaluations, and expert interviews provide the necessary depth and flexibility to understand the nuances of segmented contracting in infrastructure projects.

2.1 Research strategy

As mentioned before, this study relies on four research methods: a literature study, desk research, case studies, and interviews. These methods are used to address the four subquestions that underpin this research. Each method contributes uniquely to exploring the segmentation choices available to clients, the distribution of responsibilities in segmented contracting, and the necessary contractual support structures.

SQ1: What segmentation choices does a client have in segmented infrastructure projects, and which contract types best support these choices?

To answer this question, a literature study and a desk research were conducted to map out the segmentation options and coordination contracts available to clients. These include horizontal or vertical segmentation, phased or parallel execution, different segmented project delivery methods, and the potential role of coordination. The study then examined how standard Dutch infrastructure contracts of UAC, UAC-IC, and TNR support or constrain these segmentation strategies. Finally, additional legal instruments, such as coordination or collaboration agreements, were reviewed to assess how they can supplement existing contractual forms.

SQ2: How do phased and parallel segmentation, and horizontal and vertical segmentation, influence design and execution responsibilities in segmented contracting?

This question was answered using a multiple case study approach, focusing on four infrastructure projects with varying segmentation strategies. Each project was analysed to understand how segmentation affects the distribution of design and execution responsibilities between the client and contractors. Data was gathered from project documents and validated through interviews with key stakeholders such as contract managers, project managers, and technical advisors. This allowed for both in-depth project insights and a broader understanding of how responsibilities shift under different segmentation configurations.

SQ3: What should clients consider when implementing multiple (different) segmented project delivery methods in a complex infrastructure project?

This question explored the challenges and considerations that arise when multiple segmented project delivery methods are applied within one complex project. The analysis focused on how coordination, interface management, and contractual consistency were addressed in cases. The case studies reveals critical tensions and success factors. Interviews with project stakeholders provide additional insight into how clients approach integration and avoid inefficiencies across segmented packages.

SQ4: What specific contractual elements should be included when structuring contracts for the implementation of segmented contracting?

This final subquestion focused on how segmentation strategies are translated into contract terms and coordination agreements. Contractual documents from the case studies were analysed to identify relevant clauses on interface management, coordination roles, risk allocation, planning, and dispute resolution. These findings were enriched by interviews with legal professionals, who assessed whether existing contract models sufficiently support segmentation and proposed additional provisions to address identified gaps. Together, this method yielded a comprehensive overview of the contractual elements required to effectively embed segmented contracting practices in Dutch infrastructure projects.

This approach ensures that each research method supports the respective subquestion. By combining literature, case analysis, and expert interviews, this research provides a better understanding of segmented contracting.

Moreover, the subquestions were addressed in sequence, with findings from earlier questions informing the approach to subsequent ones. Specifically, insights from subquestion one shaped the case analysis in questions two, three and four. The results of those two questions, in turn, also informed the contractual focus of question four. Through this iterative research design, knowledge was continuously refined and integrated (Bosch & Boeije, 2010). This process is schematically represented in Figure 1.

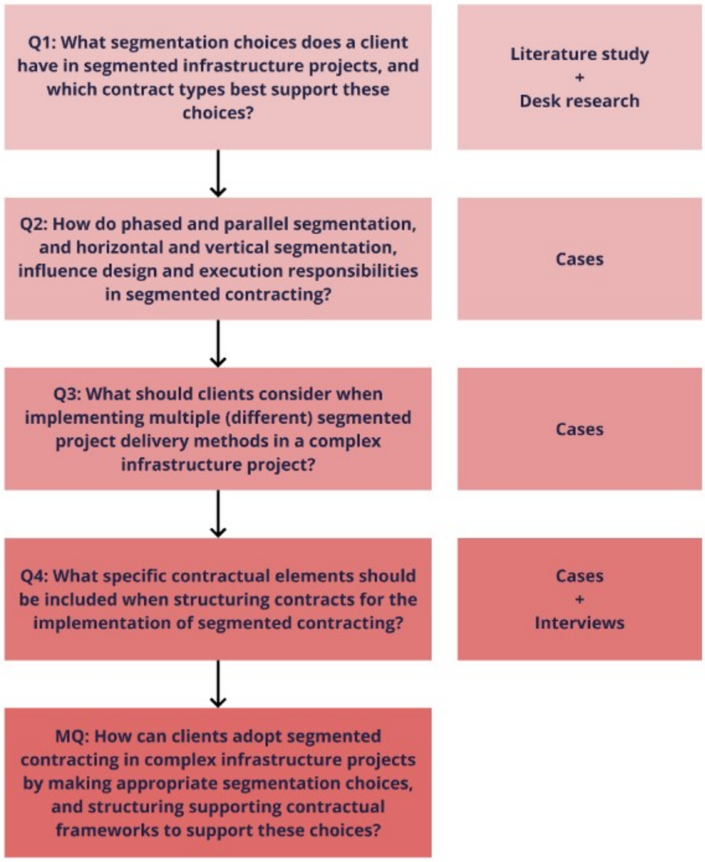

Figure 1: Overview of research strategy

2.2 Literature study

By conducting a systematic review of academic journals, industry reports, and relevant publications, multiple searches are used and will be used with different search terms. Databases searched included Google Scholar, TU Delft Repository, and Scopus. Key areas of focus include legal frameworks, contract structures and strategies, design and execution responsibilities, and organizational coordination in infrastructure projects. Literature searches are conducted using a systematic approach, applying relevant search terms and filtering by recency to ensure the study remains relevant to contemporary practices. As literature study will be performed on different topics, it helps to have an overview on the different research filters used for each topic. Table 2 presents an overview of examples of search quotations per research topic.

Table 2: Search quotations used for literature research

Segmentation	Segmented project delivery methods	Contracting
”infrastructure projects AND segmented contracting”	”segmented project delivery methods”	”contracting infrastructure AND legal framework”
”parallel infrastructure projects OR phased infrastructure projects”	”coordination AND infrastructure construction”	”collaboration AND contracting”
”horizontal segmentation OR vertical segmentation”	”interfaces AND infrastructure projects”	”coordination agreements AND infrastructure construction”

As this topic has mostly developed over the past decades, the filter *year = 1980 or later* is applied to filter less relevant literature.

2.3 Desk research

Desk research involves the collection and analysis of existing data. This method is particularly suitable for exploring formal documentation, public project records, and previously published studies or reports. Desk research helps as a structured investigation of contractual elements without the need for direct engagement with project stakeholders (Krul, 2014). In the context of this thesis, desk research will be used to analyse publicly available contract documents, coordination agreements and addenda from Dutch infrastructure projects.

This method is particularly relevant for answering *Subquestion 1: What segmentation choices does a client have in segmented infrastructure projects, and which contract types best support these choices?* The objective is to examine how existing contracts and agreements have been structured to support infrastructure projects. Moreover, it examines what additional legal instruments have been used to facilitate alignment across project segments. Examples of legal instruments are collaboration agreements, coordination agreements, or specific annexes.

The desk research will focus on case related contract documentation, including general terms and conditions, supplements to standard contracts, and annexes outlining segmentation strategies. The documents will be sourced from public platforms such as TenderNed, project archives, and through collaboration with AT Osborne and other project partners. Particular attention will be paid to how segmentation has been defined (e.g., horizontal vs. vertical, phased vs. parallel execution) and how responsibilities, interfaces, and coordination mechanisms are worked out in the legal framework. This analysis will allow for identification of recurring contractual patterns, gaps, and best practices as a starting point for subquestion 4.

2.4 Case studies

Case studies provide empirical evidence on how segmented contracting has been implemented in real-world infrastructure projects. In this way, the theory from the literature studies can be tested in practice on cases of real-world projects. The results of the literature review will be tested in the case study to check whether the components identified in the literature match with the components in the case. This validation process ensures that the findings from the literature review are robust and comprehensive. Moreover, the list of components from the literature review will be supplemented with new components identified from the case study. This approach not only validates the literature review findings but also enriches them with real-world data, providing a more detailed and practical understanding of the challenges and feasibility of segmented contracting.

Selection criteria for case studies include projects that have chosen for segmented contracting or similar procurement strategies actively on beforehand. Projects using portfolio methods can be used as comparison to segmented contracting. Potential case studies include projects managed by Rijkswaterstaat, Dutch municipalities, water boards, and other Dutch authorities. As described in subsection 1.5, this research focuses only on Dutch projects. Examples of possible case studies are the Uithoornlijn in North-Holland, the Zuidasdok in Amsterdam, the renovation of the A27, and projects of the Replacement&Renovation projects by Rijkswaterstaat. In collaboration with AT Osborne, the cases will be worked out.

Selection Criteria

To ensure that the selected case studies offer relevant and comparable insights into segmented contracting, a set of clear and consistent selection criteria has been applied. These criteria are set up to capture the essential characteristics of segmented contracting in the Dutch infrastructure sector and to support meaningful cross-case analysis. The following requirements were used to assess potential cases:

- **The project must be divided into multiple segments, each contracted separately.**
  Segmentation is central to the research and as such, each selected project must demonstrate a deliberate division of scope into two or more substantial contract segments. These segments must each be governed by a separate agreement between the client and the contractor. This allows for an in-depth analysis of how segmented responsibility and coordination mechanisms are implemented in practice. Segmentation is verified through tender documentation, project reports, or contract structure diagrams.

- **Only Dutch contract types are allowed, no international forms such as FIDIC or NEC.**
  Since the legal analysis focuses on Dutch general conditions (such as UAC, UAC-IC, and TNR 2011), only projects that rely on Dutch contracting frameworks are included. This ensures comparability and avoids methodological complications arising from international contract forms that differ substantially in terminology and legal basis. Public sources such as TenderNed or internal project documents are used to verify the contract form.

- **Segmentation may be planned or arise out of necessity.**
  The method of segmentation, whether strategically planned in the initial phase or introduced during the project due to unforeseen developments, is not restrictive. Both approaches are considered relevant, as they offer insights into proactive versus reactive segmentation strategies. The rationale behind segmentation is captured during interviews and document analysis.

- **At least two contractors must be directly contracted by the client.**
  A core feature of segmented contracting is that the client takes on the role of coordinating multiple direct contractual relationships. Therefore, each case must include at least two main contractors, each responsible for the delivery of a distinct segment. This is verified through contracting structures and organisational charts provided by the project owner.

- **Each segment must represent a substantial portion of the project scope.**
  To ensure balanced insights, selected projects must not rely on a single dominant segment supported by minor peripheral works. Instead, each segment must involve a significant share of the total project scope, in terms of budget, technical complexity, or schedule. This ensures that

segmentation meaningfully affects project dynamics rather than serving as a nominal division. Scope balance is assessed based on published budgets, work breakdown structures, and tender documents.

- **The project must have completed the tendering phase.**
  The tendering phase is an interesting part of the project, because that is when the client decides how the project will be organised and what type of contracts will be used. In this phase, choices are made about the segmentation and how responsibilities are divided. By focusing on projects that have already completed this phase, it is possible to see how these choices were made and how they played out in practice. This makes it easier to evaluate whether the selected setup was effective. Projects that are still in tendering may show potential, but it remains uncertain how the segmentation will actually work out. Therefore, only projects that have passed the tendering phase are considered suitable for this research.

- **Preferably, at least two different project delivery methods are used.**
  Projects are ideally structured such that different project delivery methods are applied across segments e.g., one segment using a traditional contract and another a construction team approach. This diversity allows for comparative analysis on how delivery methods interact within a single project context and what this means for responsibilities, risk distribution, and collaboration. This criterion is desirable but not mandatory, and is verified through project documentation and interviews.

Projects

Based on the selection criteria outlined above, four projects were selected that offer relevant insights into segmented contracting within the Dutch infrastructure sector. These projects differ in scope, client organisation, and segmentation approach, but all meet the minimum requirements regarding contract type, segmentation structure, and status. The four projects are the following:

1. Uithoornlijn
2. Schiphol baggage basement
3. Wastewater Treatment Plant (AWS) Zwanenburg
4. Amsterdam Central Station

2.5 Interviews

Two distinct types of interviews were conducted in this study: case-specific interviews and legal expert interviews. This distinction is important due to the different roles, knowledge scopes, and objectives associated with each group.

Case-specific interviews

The majority of the interviews were conducted with professionals directly involved in one of the four selected infrastructure projects. These interviewees included contract managers, project managers, and technical advisors, all working for the client in these projects. The primary aim of these interviews was to understand how segmentation and coordination were implemented and experienced in practice by clients within the context of a specific project. The interviews focused on the design and execution structure, the segmentation logic used (phased/parallel and horizontal/vertical), and how coordination, collaboration, and planning were organized among contractors and the client. The insights gained from these interviews directly contributed to the analysis of subquestions 2, 3, and 4.

Legal expert interviews

In addition to the case-specific interviews, three interviews were conducted with legal professionals specialized in infrastructure contracting. These experts were not tied to any of the four case projects and were asked to reflect on segmented contracting and agreements more generally. Their input served a different purpose: to provide a broader legal perspective on the limitations of current contracts, the use and design of coordination agreements, and the trends in contractual collaboration within the Dutch infrastructure sector. These interviews were primarily used to support the analysis of subquestion 4, by validating the gaps identified in existing contract templates and exploring whether legal additions would be sufficient and enforceable in segmented settings.

All interviews were semi-structured to allow for open discussion while maintaining consistency across sessions (Adeoye-Olatunde & Olenik, 2021). The interview guides were based on the findings from the literature study and desk research. By combining case-specific insights with broader legal reflections, the interviews offered both project-based and systemic perspectives on segmented contracting.

2.6 Ethical considerations

This research adhered to the ethical guidelines set by TU Delft's Human Research Ethics Committee (HREC) and the Netherlands Code of Conduct for Research Integrity (KNAW et al., 2018), and followed the university's protocols on data management and research integrity. Given the use of case studies and interviews, extra attention was paid to data privacy, confidentiality, and informed consent to ensure the protection of all participants involved.

Human Research Ethics Committee

Before conducting any interviews or case studies, an application was submitted to the HREC following the established TU Delft procedures (TU Delft, n.d.). The process included preparing and submitting an informed consent form, completing the HREC Checklist, and obtaining signatures from the thesis committee. The final HREC Checklist was approved by one of the thesis committee members before research activities commenced. All participants were provided with clear information about the study's purpose, their voluntary participation, and their right to withdraw at any time without consequences. Confidentiality and anonymity were strictly maintained, and personal data were not shared beyond what was necessary for verification by the thesis committee.

Informed Consent Forms

An informed consent form is an ethical document that ensured research participants fully understood the study's purpose, procedures, and their rights before agreeing to take part. In this study, the informed consent form provided participants with a detailed explanation of the research on segmented contracting, including the objectives, expected duration, and types of questions they would be asked.

Participants were explicitly informed that their participation was voluntary, and they could withdraw at any time without providing a reason. Confidentiality and anonymity were guaranteed through strict data management measures. Interviews were recorded via Microsoft Teams and automatically transcribed. Participants had the opportunity to review and correct the transcript before it was anonymized. Once the transcript was approved, all personally identifiable information, such as names and contact details, was permanently deleted. Anonymized transcriptions may be used in the final research report and stored in the TU Delft repository for academic purposes.

By signing the informed consent form, participants acknowledged that they understood the study's scope, potential risks, and data management procedures, and agreed to have their anonymized input included in research findings. A complete version of the informed consent form is provided in Use of AI, where further details can be reviewed.

Data Management Plan

A comprehensive Data Management Plan (DMP) was developed using the TU Delft DMPonline tool. This document outlined how research data would be collected, stored, and processed in compliance with university policies. The data collected during this study were only used for research purposes related to the thesis and were stored securely. The final report was published in the TU Delft repository, making the research process open for external readers while keeping participant information private and secure.

All interview data were anonymized before analysis and publication. Personal identifiers, including names of individuals and specific projects, were removed from public documents. Only the thesis committee members had access to the original data for verification purposes. Participants were asked to sign an informed consent form agreeing to the terms outlined in the DMP regarding data usage and confidentiality. A complete version of the informed consent form is provided in Informed Consent Form, where further details can be reviewed.

By implementing these ethical safeguards, this research ensured that data integrity, privacy protection, and respect for participants' rights were upheld throughout the study.

3 Literature study

To answer the first sub-question of this research, a literature study has been conducted on the most commonly used segmented project delivery methods in the Dutch construction sector. This review establishes the foundation for the rest of the thesis and provides the necessary background to explore segmented project delivery methods in more detail. The purpose of this chapter is to develop a better understanding of how responsibilities, tasks, and risks are allocated across various project configurations, and how these are formalised through contracts. By outlining the full range of delivery models and their legal frameworks, this study contributes directly to sub-question 1: *What segmentation choices does a client have in segmented infrastructure projects, and which contract types best support these choices?*

3.1 Introduction

This chapter starts by giving an overview of how segmented contracting works in Dutch infrastructure projects. It begins by explaining the main phases of a construction project as these phases help to understand when and how project responsibilities are divided.

Next, the chapter describes the main choices a client must make when organising a segmented project. These include whether to divide the work horizontally or vertically, whether to deliver it in phases or in parallel, which segmented project delivery method to use, and how to organise coordination between contractors. Each of these choices affects how the project is structured, how tasks and risks are divided, and how contractors must work together (Dortmundt, 2024; Jansen, 2009).

The chapter then further explains the four most commonly used segmented project delivery methods in the Netherlands: traditional, integrated, bouwteam, and two-phase. For each method, it describes how responsibilities are divided, what role the client and contractor have, and which contracts are usually used. It also discusses what changes when these methods are applied in a segmented way, such as the need for extra coordination between contractors.

Finally, the chapter looks at how coordination is organised in segmented contracting. It discusses how this is arranged in practice and what contracts say about it. Standard contract forms like UAC and UAC-IC are reviewed to see if they provide enough guidance for coordination. Where they fall short, additional agreements, like a coordination agreement, may be needed. This overview provides a basis for the rest of the thesis, where these ideas will be explored in real projects.

3.2 Phases of the construction process

First, it is important to understand the general structure of construction projects, as this provides the basis for analysing how responsibilities are distributed throughout the project. The specific phase in which a project delivery method becomes relevant determines which legal and organisational mechanisms are activated. It also influences how segmentation is applied and how contracts are structured.

In literature, construction projects are commonly divided into four general phases: concept, design, realisation, and operation (De Bosch Kemper et al., 2013; Kartam, 1996). While the operational phases are relevant for long-term performance, this phase falls outside the scope of this research.

This thesis focuses specifically on the concept phase, design phase and the realisation phase, as these are the phases in which project delivery methods are structured and executed in practice. This is visualised in Figure 2.

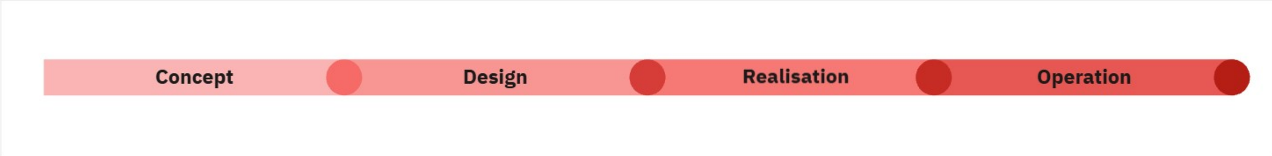

Figure 2: Phases of construction process (made by author)

The **concept** phase is the beginning of the construction process. In this phase, the client has a desire for a new functional situation. A project team is established to explore possible solutions and define the strategic direction of the project. Key activities include conducting a feasibility study, identifying and evaluating alternatives, and formulating a Program of Requirements. These efforts translate the client's needs and ambitions into concrete criteria and initial project objectives (De Bosch Kemper et al., 2013).

The **design phase** begins after the initial concept has been developed and the Program of Requirements has been defined. During this phase, the project is translated into a technical design. This includes not only the development of drawings and specifications, but also the structuring of procurement documents, the tendering process, and the selection of contract types and contractors (De Bosch Kemper et al., 2013). The way the design is structured and who is responsible for it, varies depending on the chosen project delivery method (Chao-Duivis et al., 2018).

The **realisation** phase, also referred to as the execution phase, covers all activities related to the actual construction of the project. It includes technical detailing, engineering, material procurement, on-site construction, and commissioning. This phase ends with the handover of the completed works to the client or operator (De Bosch Kemper et al., 2013).

Although financing and maintenance are sometimes defined as separate phases during the realisation and operation phase, this research considers financing to be a parallel process that runs across all phases. Maintenance and operation are only considered if they are contractually embedded in the project delivery method, for example in long-term integrated contracts.

Since this thesis focuses on the practical implementation of segmented project delivery methods, only the concept, design and realisation phases are analysed in detail. These are the stages where segmentation choices are made, responsibilities are allocated, and coordination between contractors becomes critical. Understanding how these three phases function and how project delivery methods interact with them, is therefore essential for evaluating the legal and organisational implications of segmented contracting.

3.3 General conditions

In the Dutch infrastructure sector, three standard sets of general conditions are commonly used to define the contractual relationships between clients, designers, and contractors. These are: *The New Rules* (TNR 2011), the *Uniform Administrative Conditions* (UAC 2012), and the *Uniform Administrative Conditions for Integrated Contracts* (UAC-IC 2005). Each of these contract frameworks is used in a specific type of project delivery method and plays an important role in guiding responsibilities, risk allocation, and collaboration throughout the project lifecycle.

This section outlines the legal characteristics of these three general conditions, which together form the contractual basis of Dutch infrastructure development.

The New Rules (TNR) 2011

The New Rules 2011, referred to in Dutch as De Nieuwe Regeling (DNR) 2011, define the standard legal relationship between a client and design professionals such as architects, engineers, and consultants (Jansen, 2009). This set of general conditions is commonly applied when clients engage designers to develop a building design, particularly in the early design phases of construction projects (Chao-Duivis et al., 2018). In traditional project delivery methods, design tasks are typically performed under agreements governed by the TNR 2011 framework (De Bosch Kemper et al., 2013).

The TNR 2011 provides a structured and uniform set of clauses that regulate the rights and responsibilities of both client and consultant throughout the design process. It comprises several key documents, including a standard basic contract, explanatory notes on the new rules and standard basic contract, and a standard job description that outlines the duties and scope of the consultant's work (Chao-Duivis et al., 2018). The TNR 2011 thus serves as the primary contractual framework for design-related services in Dutch construction projects.

Uniform Administrative Conditions (UAC) 2012

The Uniform Administrative Conditions 2012, known in Dutch as Uniforme Administratieve Voorwaarden (UAC 2012), form the most widely used general terms and conditions for construction contracts in the Netherlands (Chao-Duivis et al., 2018). The UAC 2012 do not constitute a standalone agreement but rather serve as general conditions that must be explicitly incorporated into the construction contract. The UAC consists of several documents, including the building contract, the specification, and the order of precedence between the contract and the specifications. The documents include information about the obligations of both client and contractors, the liability following the final completion, and contract-specific subjects such as the duty to warn (Chao-Duivis et al., 2018).

Under the UAC 2012, the client retains design responsibility, while the contractor is only liable for the correct execution of the design. This clear division of roles is a defining feature of the traditional delivery model. Therefore, the UAC 2012 are specifically drafted for the traditional project delivery model, in which the client enters into an agreement with a contractor for the execution of the design (Chao-Duivis, 2013).

Uniform Administrative Conditions - Integrated Contracts (UAC-IC) 2005

The Uniform Administrative Conditions for Integrated Contracts 2005, known in Dutch as Uniforme Administratieve Voorwaarden voor Geïntegreerde Contracten (UAC-IC 2005), were developed to support the legal framework for integrated project delivery models, such as Design & Build (D&B) contracts. The UAC-IC conditions are widely applied in Dutch infrastructure projects where design and execution responsibilities are contractually assigned to a single contractor (Chao-Duivis et al., 2018).

Unlike the traditional model, where the client separately contracts the design and construction work, the UAC-IC allows the client to transfer the responsibility for both the design and the execution to the contractor. In certain cases, long-term maintenance obligations may also be included. The contractor commits to delivering a fully completed and operational asset based on a client's initial requirements (Chao-Duivis & Wamelink, 2013).

The UAC-IC terminology follows a phased approach to the design process, including a Program of Requirements, Preliminary Design, and Final Design. The client typically launches the tender procedure once the project definition has reached one of these stages. The market party, upon award, becomes responsible for finalizing the design up to the level of an Execution-Ready Design and subsequently delivering the physical realization (Jansen, 2009).

The UAC-IC 2005 consists of several documents that together define the contractual framework. These include the model agreement, general administrative conditions, and standard annexes such as the verification and acceptance procedures, quality assurance protocols, and interfaces with third parties. These annexes clarify the procedural obligations of both the contractor and the client during the design and execution phases and form an integral part of the contract structure (Chao-Duivis et al., 2018). One of the most important documents is the client's requirements. On the basis of this document the contractor draws up and submits its design and afterwards its execution (Chao-Duivis & Koning, 2015).

One of the defining features of the UAC-IC is its shift in liability from the client to the contractor. The contractor is responsible for both design and construction defects, unless the client has provided incorrect information or has explicitly interfered with the design. This integrated liability model increases the contractor's risk exposure and requires a more internal quality assurance process. At the same time, it offers the client a single point of accountability throughout the development process (Chao-Duivis & Wamelink, 2013). Therefore, a key requirement under the UAC-IC is that the client must provide a clearly defined requirement specification prior to procurement. This specification may vary in detail depending on the phase of the design process, but must provide sufficient functional and performance-based requirements to guide the contractor through the integrated development process (Jansen, 2009).

On January 14, 2025, the new edition of the UAC-IC 2025 was presented at the InfraTech event in Rotterdam (CROW, 2025). However, since the UAC-IC 2025 has only recently been introduced, there are currently no projects that have adopted this updated version. To align with ongoing projects, this study will therefore be based on the UAC-IC 2005.

3.4 Segmentation

In segmented contracting, the concept phase plays a critical role in shaping the legal and organisational structure of the project. It is in this early stage that the client determines how the project will be organised, how interfaces will be managed, and how collaboration with multiple co-contractors will take place. These choices at the start of the project have a lasting impact on the division of responsibilities, the coordination burden, and the legal complexity in the design and realisation phases.

When preparing for the construction of a segmented project before procurement, a client must consider a number of strategic decisions that define how the project will be broken down and how cooperation will work out. This thesis identifies five key decisions that are made during the concept phase:

- Horizontal or vertical segmentation;
- Parallel or phased execution;
- Choice of segmented project delivery method;
- Coordination role;
- Coordination agreement.

This section elaborates on each of the five choices.

3.5 Horizontal and vertical segmentation

Horizontal segmentation divides the project based on geographic boundaries. Each contractor is responsible for a distinct physical area of the project (Dortmundt, 2024). This form of segmentation is commonly used in linear infrastructure projects, such as railways or highways. An example can be found in the A27 project, where there is a distinction between the northern and the southern part of the highway renovation, where both parts are assigned to different contractors responsible for separate geographical sections of the project.

Vertical segmentation, on the other hand, divides the project based on technical discipline (Dortmundt, 2024). In this approach, multiple contractors work within the same physical area but each contractor holds responsibility for a different functional or technical scope. For instance, one contractor may be responsible for structural engineering, another for mechanical installations, and a third for IT systems.

These two approaches result in different types of interface challenges. Horizontal segmentation tends to produce fewer physical overlaps between contractors but requires geographic coordination. Vertical segmentation leads to high interdependence within the same space, demanding strict interface management and collaboration protocols (Dortmundt, 2024).

3.6 Parallel and phased segmentation

Parallel segmentation refers to the simultaneous execution of multiple segments. Each segment is developed and delivered in parallel with the others (Rademaker & Hoornstra, 2024). This means that the co-contractors all work on the project at the same time, which could require significant upfront coordination and interface alignment but can reduce the overall project duration.

Phased segmentation implies that segments are delivered sequentially over time. In this way every contractor works further on the work of the contractor before (Dortmundt, 2024). It can help in managing uncertainty, for instance by starting construction in areas where designs are already fixed while continuing design development elsewhere.

Both choices, horizontal or vertical and parallel or phased, are foundational for the legal and organisational structure of the project. They directly influence the scope of contracts, the type of coordination required, and the risk distribution between parties.

3.7 Project delivery methods

In the Dutch construction sector, a range of project delivery methods is used to define how responsibilities for design, execution, and sometimes maintenance and financing are distributed between clients and contractors. These methods, referred to in Dutch as bouworganisatievormen, play a crucial role in forming collaboration structures, procurement strategies, and contract allocation in infrastructure projects (Dortmundt, 2024; Jansen, 2009).

This section provides an overview of the most commonly applied segmented project delivery methods in the Netherlands. Each method will be introduced in terms of its fundamental principles, distribution of responsibilities, advantages and disadvantages, and its contractual implications. By doing so, this chapter lays the foundation for understanding how these delivery models are applied in segmented contracting settings. The analysis includes the traditional method, the integrated method, the bouwteam method, two-phase contracting, and co-contracting.

3.7.1 Segmented traditional project delivery method

The segmented traditional project delivery method builds on the classic Design–Bid–Build (DBB) structure, where the design and construction phases are clearly separated. In the traditional model, the client retains full control over the design, which is developed independently and fully completed before tendering (De Bosch Kemper et al., 2013). Contractors are then procured solely for the execution phase, based on the finalised design documents (Davies et al., 2019; Miller et al., 2000). The contractor builds the project, and upon completion, the owner assumes the responsibility for the operation and maintenance of the project (Miller et al., 2000). This separation ensures maximum client control but also places full design responsibility and liability on the client (Touran et al., 2009).

In the segmented version of this model, the realisation scope is divided into multiple segments, each contracted separately. This results in several agreements between the client and various contractors, also known as co-contractors. Each co-contractor is responsible for delivering a specific segment of the overall works. A co-contractor can also outsource his own work or parts of his own work to subcontractors. The segmentation can follow a horizontal (geographical) or vertical (functional) logic, depending on the nature of the project.

This is schematically worked out in Figure 3, which shows the traditional segmented project delivery method as presented by Dortmundt (2024).

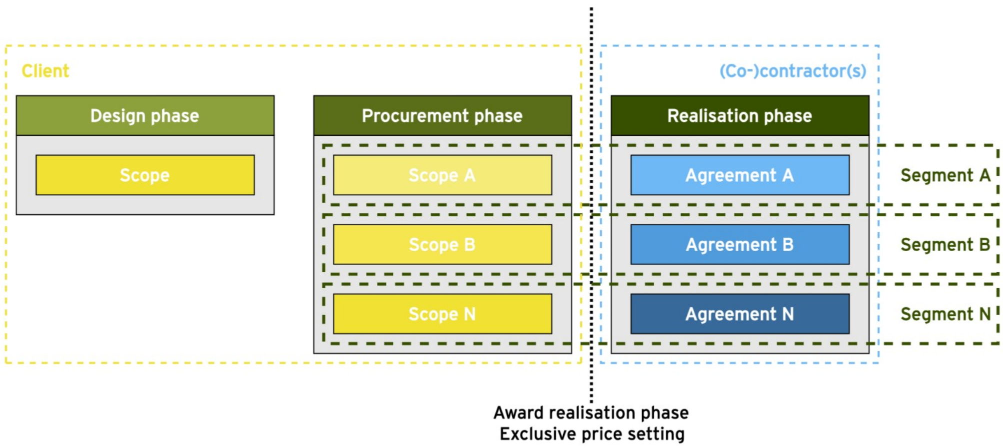

Figure 3: Schematic representation of the segmented traditional project delivery method

One of the key advantages lies in the ability to attract specialised co-contractors for specific segments, each bringing domain-specific expertise to address the technical or logistical complexities of their assigned portion. Compared to a single contractor who subcontracts various tasks, this approach may reduce overhead and provide the client with more direct control over the selection and performance of each segment. Moreover, the segmentation of the scope offers clients improved oversight and flexibility in managing progress, adjustments, or interventions when necessary.

However, these advantages come with considerable demands on coordination. As each contractor operates independently within their own contract, the responsibility for aligning timelines, interfaces, and deliverables rests primarily with the client. Effective coordination is therefore critical to avoid fragmentation in execution. As Dortmundt (2024) notes: “Coordination of activities among co-contractors is essential to ensure that each contractor can effectively accomplish their duties.” A central, overarching schedule must be established to align the individual planning efforts and ensure that interdependencies are recognised and managed. Clear agreements must be in place to address schedule changes, delays, and communication protocols across segments.

Any failure in coordination may result in delays, interface conflicts, or quality discrepancies. While one co-contractor may deliver according to plan, misalignment with the other segments can compromise overall project performance. Therefore, the segmented method asks for more control and coordination by the client. This responsibility lies primarily with the client, who may choose to manage coordination internally or delegate this task to an external party, such as a lead contractor, advisor, or construction manager. As such, the client retains significant accountability for the quality of coordination and the success of the segmented delivery. To mitigate these risks, Dortmundt (2024) recommends the implementation of a formal coordination agreement signed by all co-contractors. Such an agreement can help clarify responsibilities, interface management, and dispute resolution mechanisms throughout the project.

Contracts

The TNR 2011 is commonly applied as the general set of contractual conditions for the design phase. In addition, the UAC 2012 are used as the contractual framework for execution in segmented traditional project delivery methods (De Bosch Kemper et al., 2013). As explained in 3.9, the UAC 2012 makes a clear distinction between design and execution responsibilities, making it particularly suitable for use in the traditional project delivery method.

3.7.2 Segmented integrated project delivery method

The segmented integrated project delivery method builds upon the principles of integration, in which both design and construction responsibilities are assigned to the same contractor. This structure is typically implemented through Design & Build (D&B) contracts, where a single party develops the design based on a Program of Requirements and subsequently executes the works (Chao-Duivis & Wamelink, 2013). This development emerged as a response to the limitations of the traditional delivery model, and has some advantages (Jansen, 2009).

The integration of design and execution can offer several advantages for the client. First, it allows for greater benefit of the innovative capacity of the market. Additionally, it can lead to a shorter production period, which accelerates project delivery. Another advantage lies in the reduced complexity of coordination. In contrast to traditional project delivery methods, where responsibilities are divided across multiple parties, integration places both the design and construction responsibilities within a single contractor's scope (De Bosch Kemper et al., 2013). As a result, issues related to coordination are less prominent, since the associated responsibilities rest entirely with the design and build contractor (Jansen, 2009).

However, since the owner no longer holds responsibility for the design details, successful collaboration requires a high level of mutual trust between the client and the design-builder (Beard et al., 2001).

The role of the client may vary depending on the extent to which design responsibilities are delegated. The more responsibilities are transferred to the contractor, the more limited the client's role becomes (Chao-Duivis & Wamelink, 2013).

In the segmented variant of this model, the overall project is divided into multiple distinct segments. Each segment is assigned to a separate co-contractor, who holds full responsibility for both the design and execution of their scope. This is illustrated in Figure 4, as presented by Dortmundt (2024).

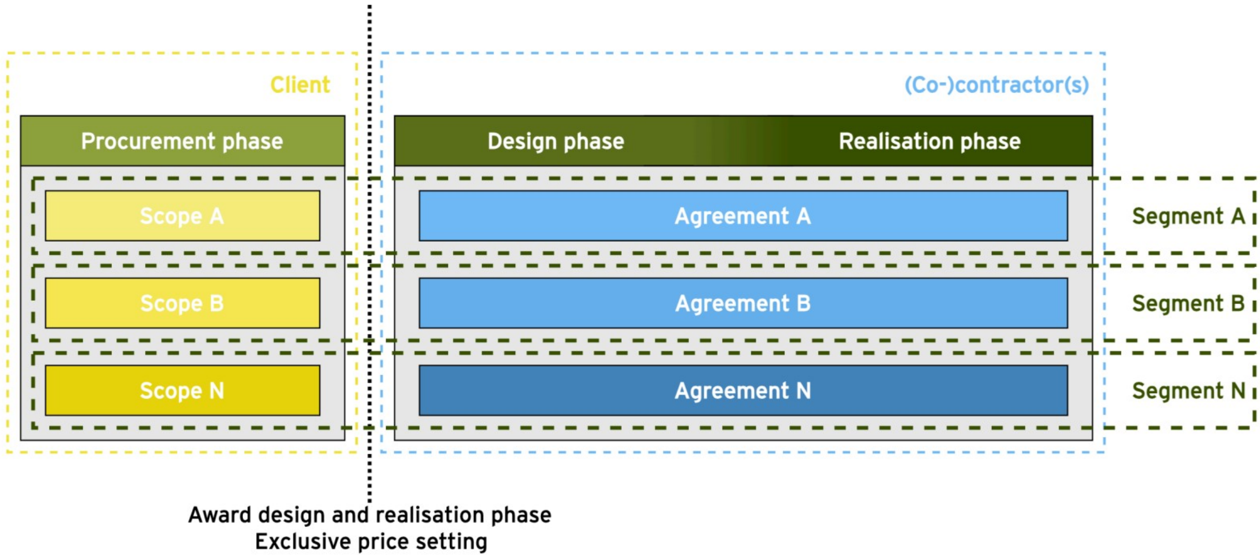

Figure 4: Schematic representation of the segmented integrated project delivery method

One of the key advantages of this model lies in the ability to engage specialised contractors for specific segments. Rather than relying on a single party to deliver the entire scope, the client can attract contractors with specific expertise on the unique demands of each segment. This can result in reduced costs by limiting subcontracting, improved quality due to the involvement of domain specific contractors, and better control over the progress of individual work packages.

At the same time, integrated segmented contracting places considerable demands on coordination. Because each co-contractor is responsible for both the design and construction within their own segment, the client must ensure that the various contributions are effectively integrated. This requires the development of a coordination plan, including an overall schedule detailing when each segment begins, progresses, and concludes. Interface management becomes a critical success factor. The client needs to add focus on alignment in time, scope, and quality between segments, which are necessary to prevent disruptions and ensure that the project performs as a unified whole.

The involvement of multiple co-contractors introduces additional risks, particularly with respect to delays, inconsistencies at the interfaces, and overall quality assurance. While each segment may be executed competently in isolation, the added complexity lies in ensuring that the collective result meets the integrated design and performance requirements. Without effective coordination and clear contractual arrangements, the segmented integrated model can become fragmented in practice.

Contracts

The integrated model is commonly used in the Netherlands and is contractually supported by the Uniform Administrative Conditions for Integrated Contracts (UAC-IC 2005), also known as UAC-IC 2005 (Chao-Duivis et al., 2018; Jansen, 2009). While this set of conditions provides the legal framework for integrated contracting, it does not guarantee that such integration will occur in practice.

Whether a project is truly delivered in an integrated manner depends on how both client and contractor apply the framework in their working relationship.

Within this model, the contractor is both responsible and liable for the design they develop and for the execution of that design. Should defects arise during or after construction that can be traced back to the contractor's own design, the responsibility lies entirely with them. At the same time, the client bears responsibility for the completeness and accuracy of the initial brief. This typically includes the Program of Requirements and in some cases, a preliminary or definitive design. If errors are embedded in the client's input, the contractor cannot be held liable for their consequences. However, the UAC-IC places a duty to warn on the contractor, meaning that responsibility may (partially) shift if they fail to identify and report clear deficiencies in the client's brief (Chao-Duivis & Koning, 2015; Chao-Duivis & Wamelink, 2013).

The integrated contract is specifically designed to create a degree of design space within which the contractor can determine how to meet the functional and performance requirements set out by the client. The contractual structure intentionally avoids prescribing detailed technical solutions, instead leaving the contractor room to engineer their own. This concept aligned with the original promise of UAC-IC, namely a "hands-off" approach from the client, where risk transfer would lead to reduced involvement and a more autonomous contractor (Brouwer et al., 2020).

In practice, however, this intended autonomy often leads to misinterpretations on both sides. A first recurring issue arises when clients, despite having transferred design responsibility, still interfere with design decisions. While the contract grants freedom to the contractor, clients may still hold strong opinions on the outcome. This undermines the principle of design autonomy and can lead to misalignment between what the contractor believes they are entitled to decide and what the client expects to control. It is therefore critical that the contract clearly defines the limits of design freedom, to avoid false assumptions or disputes later in the process.

A second issue stems from insufficient clarity in the client's initial brief. The freedom to design and engineer solutions is only functional when the Program of Requirements is well-defined. Without clear objectives, constraints, and specifications, the contractor lacks the guidance necessary to make informed design decisions. As such, even under a "hands-off" model, the client retains a key responsibility. He should provide timely, reliable, and complete information. Any ambiguity or omission in the brief can compromise the quality and feasibility of the project (Brouwer et al., 2020).

Ultimately, the effectiveness of the UAC-IC depends not just on its legal provisions, but on how well both parties understand and adhere to their roles. For the contractor, this means taking full ownership of design and execution. For the client, it means letting go where appropriate, while still setting clear boundaries in the Program of Requirements for the aspects of the project that are non-negotiable.

3.7.3 Segmented bouwteam project delivery method

The bouwteam project delivery method, known in Dutch as "bouwteam", or Early Contractor Involvement (ECI) is a collaborative approach in which the architect and consulting engineers lead the design process, while the contractor is involved from an early stage to provide input on constructability, cost, and feasibility (Chao-Duivis et al., 2018). The aim is to jointly develop an integrated, feasible, and widely supported design. As defined by Van den Berg and Van Gulijk (2022), a bouwteam is "a temporary partnership on an equal footing between representatives of the roles in the building process of initiation, design, and execution, where participants coordinate their tasks and assist each other where possible." This differs from traditional project delivery methods, where contractors are only engaged after the design is finalised. The goal of the bouwteam approach is to jointly develop a feasible and widely supported integrated design. Once the design is finished, the contractor and the client enter in a separate agreement for the execution of the work (Werkgroep Handreiking Bouwteams, 2021). While the contractor takes part in advising and supporting the process, the client continues to play a central role with considerable influence over the design direction and project scope (Chao-Duivis et al., 2018).

A segmented bouwteam project delivery method applies this collaborative model to a segmented project structure. Rather than working with a single contractor, the client engages multiple co-contractors, each responsible for a specific segment of the project. These co-contractors participate in the design phase from the start, contributing knowledge specific to their assigned segment. This segmented collaboration allows for early contractor involvement across all segments, aiming to combine practical expertise with the integrated development of the overall design (Dortmundt, 2024).

In practice, this segmented model can take two forms: a traditional bouwteam variant, where the design is finalised before construction starts, and a bouwteam 2.0 variant, where design responsibility is further extended into the execution phase.

In the traditional variant, co-contractors participate in the early design process, but the final design is developed collectively and completed before construction begins. The client retains ownership over the design and enters into separate execution contracts with each co-contractor. A schematic overview of this delivery method is shown in Figure 5, based on Dortmundt (2024).

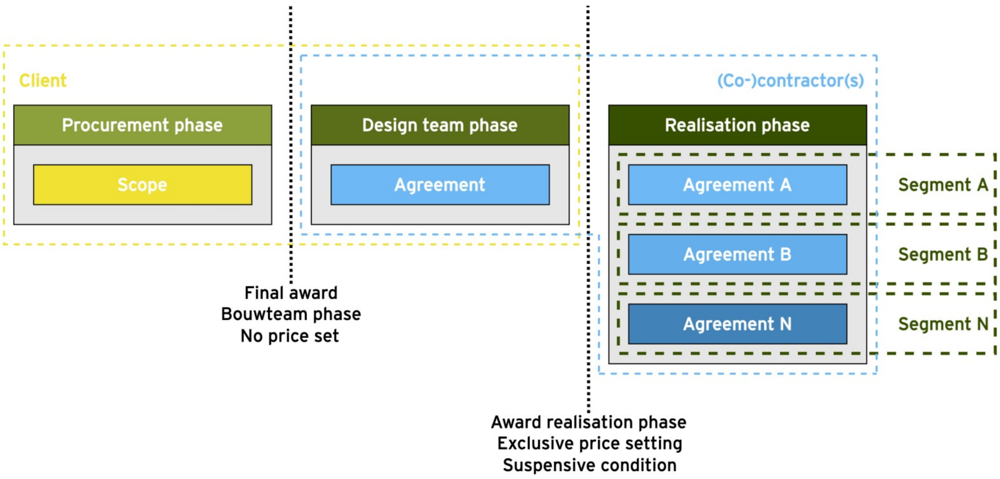

Figure 5: Schematic representation of the segmented bouwteam project delivery method

The second option shifts more design responsibility to the individual co-contractors. In contrast, the bouwteam 2.0 model applies when the contractor continues under UAC-IC (Bruggeman & Jansen, n.d.). In this case, the contractor assumes more responsibility for completing the design during the execution phase. The main difference lies in the level of design ownership and liability. This approach mirrors the principles of the Design & Build (D&B) method and is often supported contractually by UAC-IC. As noted by Dortmundt (2024), "By leveraging the principles of the integrated project delivery method within the segmented bouwteam framework, this approach aims to further streamline processes, improve risk management, and enhance overall project outcomes." A visualisation of this model is shown in Figure 6, based on Dortmundt (2024).

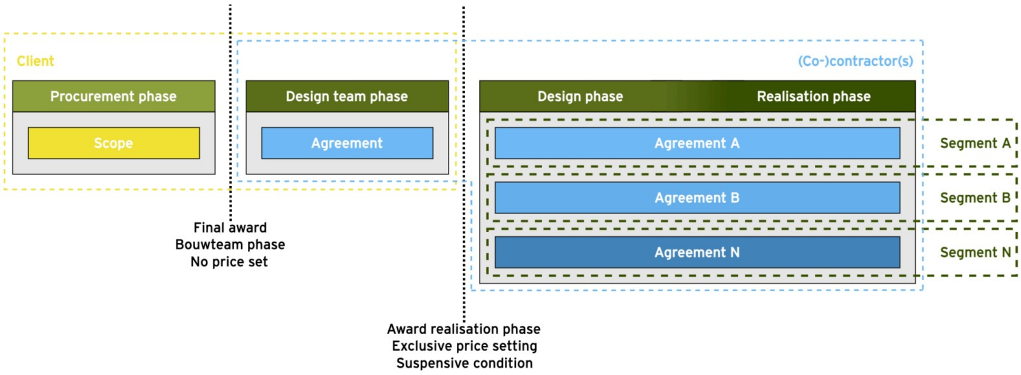

Figure 6: Schematic representation of the segmented bouwteam 2.0 project delivery method

One of the main advantages of the segmented bouwteam model lies in its ability to combine early contractor involvement with specialised expertise across different segments. By engaging co-contractors early in the process, clients benefit from practical input during the design phase, which can lead to more feasible, cost-efficient, and technically sound solutions. This collaborative environment allows for optimisation of the design, improved constructability, and better alignment with project objectives from the outset.

From a commercial standpoint, this setup also reduces reliance on subcontracting. Co-contractors are engaged directly by the client, which allows the client to avoid additional costs and to maintain more direct control over both progress and quality. Especially in complex projects with varying scopes, this can result in a more efficient use of expertise and resources, as well as a faster overall timeline due to the potential for parallel progress across segments.

However, these benefits come with certain challenges. Coordinating multiple co-contractors with responsibility for both design and execution within their own segment, adds complexity to the management of the project. Interface risks increase, particularly where one segment must align seamlessly with another. Any misalignment can lead to quality inconsistencies, delays, or even disputes between parties.

To manage this, the client may either assume the coordination role directly or appoint a coordinating party, such as a lead contractor or construction manager. When coordination responsibilities are assigned to one of the co-contractors, that party must facilitate communication, integrate schedules, and ensure consistency across all segments. Yet, such delegation does not absolve the client of their overarching responsibility for the integration of the project. As with the segmented traditional approach, poor coordination can compromise project outcomes.

A final challenge relates to the increased administrative burden. Segmenting a project into multiple contracts requires greater effort in contract management, oversight, and communication. Each agreement must clearly define responsibilities, timelines, and quality standards. This is particularly important in the distinction between the traditional and bouwteam 2.0 variants of the segmented project delivery method. In the bouwteam 2.0 model, where co-contractors have greater freedom in developing the design, clear boundaries and expectations must be set upfront. Without this, design overlaps or omissions may occur, what will result in undermining the coherence of the final product.

Dortmundt (2024) therefore recommends the implementation of a coordination agreement signed by all parties involved. Such agreements help to clarify the responsibilities of each co-contractor, to define procedures for interface management, and to establish dispute resolution mechanisms, and thereby supporting the integrated execution of segmented projects.

Contracts

In the segmented bouwteam project delivery method, the client typically enters into separate agreements in the design phase and the construction phase. The design is usually governed by a design contract designated as the bouwteam agreement. During this phase, parties collaborate under the legal framework of the TNR 2011, whereby the client holds primary liability. Within this framework, the contract, requirements, conditions, design, risk allocation, pricing, and scheduling are jointly developed (Werkgroep Handreiking Bouwteams, 2021).

The construction phase is governed by a separate building contract (Jansen, 2009), as designated in Agreement 2. To support collaboration, a three-party construction team agreement is often signed between the client, architect, and contractor. This is commonly based on the VGBouw Model Bouwteam Contract 1992 or the newest version, the DG Model bouwteam Contract 2020, which outline the general conditions for working within a construction team context (Chao-Duivis et al., 2018; PIANOO, n.d.).

The contractual framework used in the construction phase depends on the completeness of the design produced during the bouwteam phase. If the design is sufficiently detailed, the follow-up agreement with the contractor is typically governed by UAC. This is referred to as a traditional bouwteam. Conversely, if the design is not yet fully completed, UAC-IC is usually applied. This is often called a bouwteam 2.0 arrangement (Bruggeman & Jansen, n.d.; Lindeboom et al., 2021). The choice between UAC and UAC-IC significantly affects the legal and risk management framework of the project. In practice, UAC-IC is more commonly used for large infrastructure projects due to the greater design responsibility placed on the contractor during the bouwteam phase (Bleeker, 2022). UAC-IC aims for a more integrated and collaborative approach (Strang, 2018).

In all cases, the Model Bouwteam Contract is concluded between the client and the contractor. Other team members, such as the architect and advisors, are named in the agreement but are not direct contractual parties. They act as auxiliaries to the contracting parties. Therefore, the client and contractor are mutually responsible for the performance of each other's auxiliaries.

Each party retains responsibility for their respective role: the architect for the design, and the contractor for the execution. The client holds legal responsibility for the performance of the design towards the contractor. However, the contractor may also bear shared responsibility for the design, particularly if they fail to identify and report clear design flaws during the advisory phase (Chao-Duivis, 2012).

These arrangements align with the principles of the bouwteam project delivery method. Even when the division of responsibilities is adjusted by limiting or extending the contractor's design involvement, the delivery strategy remains unchanged, provided the roles of architect and contractor remain clearly defined. Only when the contractor formally assumes part of the design responsibility does the delivery method begin to resemble a more integrated approach (Jansen, 2009).

The contractor's advisory role within the team does not mean they share the design task with the architect or engineering consultant. However, their deeper involvement does entail a bigger duty to identify potential design issues during the project's development.

Moreover, articles 9 and 10 of the DG Model Bouwteam Contract 2020 state that responsibility for advice and designs lies with the person whose expertise it concerns, provided that that person has adopted the advice as their own. This ensures that responsibility lies not with the originator of an idea, but with the party that accepts and integrates it into the project (Chao-Duivis, 2012; Strang, 2018). This shift in liability is designed to foster open idea-sharing among participants, without fear of automatic liability.

It is important to note, as highlighted in footnote 12 of the new DG Model, that parties should address in the subsequent construction agreement how they intend to deal with potential liabilities for contractor shortcomings during the bouwteam phase, particularly those that go unnoticed at the time but later affect execution costs (Hertstein, 2020; Lindeboom et al., 2021).

3.7.4 Segmented two-phase project delivery method

In response to increasing project risks, declining bid participation, and rising complexity in infrastructure delivery, Dutch public authorities have explored more collaborative approaches to procurement. One such approach is the two-phase project delivery method. This method introduces a joint design or exploratory phase (Phase I) prior to the final award and execution phase (Phase II). The objective is to collaboratively develop the project scope and gain insight into project risks and opportunities before committing to a definitive price and schedule for execution (Heij & Bockhoudt, 2023; Rijkswaterstaat, 2019).

In a two-phase approach, the client and the contractor first enter into an agreement for Phase I. During this initial phase, they work closely to develop the design, conduct necessary studies, and explore optimisations. This collaboration enhances the information base, mitigates risks, and fosters a shared understanding of the project's complexity. Only upon successful completion of Phase I—and following a formal go/no-go decision—does Phase II commence. If agreement cannot be reached on the price, planning, or design, the client may terminate the process without entering Phase II (Heij & Bockhoudt, 2023; Van Esch, 2023).

In a segmented two-phase project delivery method, the same principles are applied, but the project is divided into multiple segments, each managed by a separate co-contractor. The client enters into individual two-phase agreements with each co-contractor, who is responsible for both the design and execution of their own segment. During Phase I, the co-contractors are engaged to collaboratively develop their portion of the design, identify segment-specific risks, and contribute to the overall planning of the project. This segmented model allows clients to engage specialised contractors for different parts of the project while still leveraging the benefits of the two-phase structure.

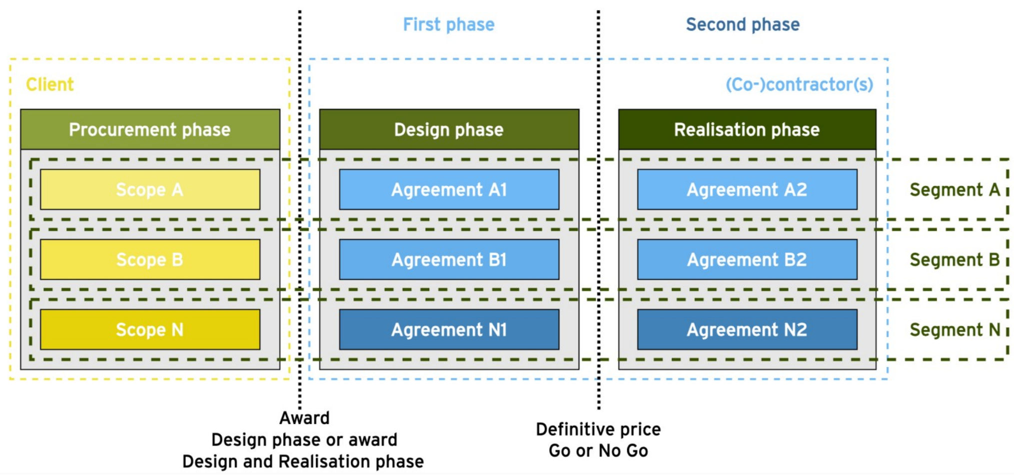

Figure 7: Schematic representation of the segmented two-phase project delivery method

During Phase I, coordination plays a critical role. Although co-contractors work independently on their respective segments, the outputs must be compatible and aligned with the project's integrated design and delivery goals. To achieve this, the client may appoint a coordination party or take on the coordination role themselves. In some cases, one of the co-contractors may be assigned a lead role, responsible for managing interfaces, integrating planning schedules, and facilitating cooperation between segments. It is essential that Phase I not only generates detailed segment-level plans but also ensures consistency and integration across the full scope of the project.

In Phase II, each co-contractor proceeds with execution based on the jointly developed and validated designs. By dividing responsibilities in this way, the segmented two-phase approach enables parallel progress across segments, allowing for shorter project timelines, reduced subcontracting layers, and better utilisation of specialist knowledge (Van Esch, 2023). In large-scale or technically diverse projects, this segmentation offers both flexibility and the ability to attract a broader range of market parties.

Despite these advantages, the segmented two-phase model introduces several challenges. Most notably, the administrative burden increases significantly. The client must manage multiple two-phase agreements, align deliverables and timelines, and mitigate interface risks across contracts. The quality of coordination, especially during Phase I, determines the coherence of the final outcome. If alignment is poor or interface definitions are vague, the project may face inconsistencies, delays, or disputes in Phase II. Additionally, if agreement on price or design cannot be reached with one or more co-contractors at the end of Phase I, the go/no-go decision becomes more complicated and may affect the project's integrity (Van Esch, 2023).

Nevertheless, the model offers considerable benefits: early risk recognition, improved design quality, and more accurate pricing. It fosters a collaborative mindset among all involved parties and can lead to smoother execution with fewer surprises.

Contracts

The two-phase method is typically formalised through a phasing agreement (fasenovereenkomst) that covers both Phase I and Phase II. This agreement provides an overarching legal framework in which separate subcontracts can be embedded for each phase. Commonly, Phase I is governed by a collaborative design agreement (bouwteamovereenkomst), while Phase II often follows the commonly used models for execution, namely UAC or UAC-IC (Bleeker, 2022; Heij & Bockhoudt, 2023).

Because this model relies on different contract forms for Phase I and Phase II, it is essential to clearly link these agreements through a single phasing agreement. Since a single contract is awarded to the contractor for both phases, the legal relationship between the contracts must be unambiguous. The phasing agreement therefore serves as the overarching contractual document, and clarifies how both underlying contracts of the two phases relate to one another. The contracts for Phase I and Phase II can be considered as subcontracts to the phasing agreement. This is visualised in Figure 8 by Heij and Bockhoudt (2023).

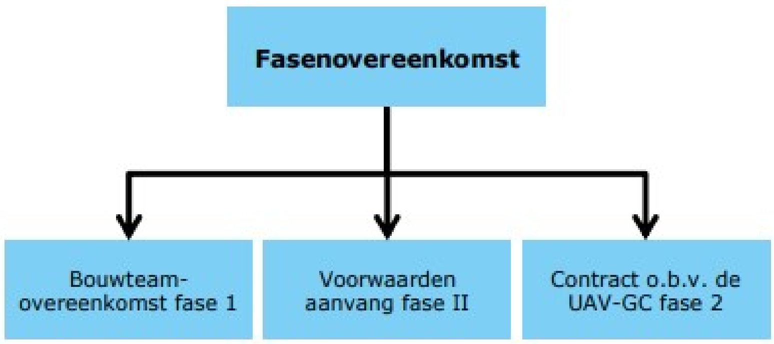

Figure 8: Contracts phasing agreement two-phase

In addition, the phasing agreement typically sets out the overall scope, structure, and timeline for both phases, as well as the procedural conditions for the go/no-go decision that separates Phase I from Phase II. It defines the collaborative process during Phase I, including how parties will manage risks, often by maintaining a shared risk register. Moreover, it outlines the transition from the design to the execution phase and sets the contractual document hierarchy to avoid disputes during implementation. Importantly, the agreement also defines the conditions under which the project may continue, be postponed, or be terminated following Phase I.

In some cases, additional project-specific clauses are added to address responsibilities such as area maintenance during both phases, innovation targets, or specific design validation procedures. The strength of the two-phase contract model lies in its flexibility: while the legal framework is robust and detailed, it offers room to adapt the contractual structure to the unique needs and risks of each infrastructure project.

3.8 Coordination role

In construction projects involving multiple contractors or segments, coordination is essential to ensure timely delivery, safety, and quality. Particularly in segmented projects or in situations with parallel contracts and co-contractors, coordination becomes a critical function that directly impacts project success.

Coordination involves aligning design and execution activities in terms of time, location, and technical content. As Van Gulijk and Muller (2011) point out, inadequate coordination between parallel contractors can result in delays, quality defects, and even liability issues. An illustrative example is provided where a contractor fails to provide openings in time for another contractor, leading to delay and financial claims. Thus, coordination is not only a logistical challenge but also a legal and financial concern.

The coordination function may be assigned to either the client or one of the contractors. Each option has specific implications:

Coordination by the client The client is often considered responsible for the overall integration of the project, especially in segmented contracts where no general contractor exists. As Van Gulijk and Muller (2011) observe, clients may prefer co-contracting to maintain direct control and reduce costs, but this inherently increases their coordination burden. A major advantage is that the client retains full control over the interface management and can directly steer planning and collaboration. However, in practice, clients often lack the operational expertise and capacity to effectively manage this task, leading to the outsourcing of the coordination role.

Coordination by a contractor Alternatively, the coordination can be contractually assigned to one of the (co-)contractors. This party, then, assumes responsibility for aligning activities among the other contractors. This option can leverage the contractor's technical knowledge and execution experience. However, Strang (2018) warns that this role requires that the coordinating contractor be given adequate authority, and that their neutrality in managing the interface between other contractors is not always guaranteed. There is a risk that they prioritize their own interests.

Regardless of which party coordinates, Strang (2018) emphasize that clear allocation of responsibilities, sufficient authority, and contractual arrangements are essential for effective coordination. Contracts should facilitate early identification and management of interface risks, stimulate cooperative behavior, and include procedures for communication and information exchange.

However, it is important to note that even when the coordination responsibility is delegated, the client always retains a residual role. According to Van Gulijk and Muller (2011) and Strang (2018), the client remains ultimately responsible for the cohesion of the project. This includes setting up a proper meeting and information structure, ensuring that responsibilities are clearly distributed, and that safety, planning, and interface management are adequately controlled.

Points of attention when assigning coordination

When allocating coordination responsibilities, Terwel (2014) and Strang (2018) mention several factors that require attention:

- **Clarity of tasks and responsibilities:** Every actor must have a clear understanding of their own duties and those of others. Terwel (2014) emphasizes the importance of an exhaustive task list.
- **Authority and mandate:** The coordinator must be empowered to enforce alignment and resolve conflicts.
- **Interface management:** Particular attention must be paid to timing, location, and technical dependencies between activities.
- **Communication structures:** Frequent and structured meetings should be in place to share plans and solve issues.
- **Liability and incentives:** Contracts should create the right incentives and clearly allocate liability in case of coordination failure.
- **Safety and risk awareness:** Coordination is crucial for ensuring constructional safety, especially where responsibility interfaces exist.

Ultimately, coordination is not a static role, but a dynamic process requiring active management, clarity, and collaboration. Properly embedding coordination in both contracts and practice is crucial to ensure successful and safe delivery of complex construction projects.

3.9 Contractual frameworks

Now that the coordination role has been discussed from an organizational perspective, this section examines how coordination should be contractually embedded alongside other critical topics identified in the literature, such as interface management, communication, and collaboration. As previously established, coordination is not a static role, but a dynamic process requiring active management, clarity, and cooperation. Therefore, embedding this coordination structurally in legal agreements is important for segmented contracting.

Dutch contracting typically involves the use of bilateral contracts between a client and a contractor. While this arrangement clearly defines the relationship between the client and each contractor individually, it creates a fragmented structure in which contractors do not share contractual ties with each other. This absence of contractual relationships between contractors is a fundamental challenge for coordination.

To address this issue, a multilateral agreement may be used, signed by the client and multiple contractors all in one contract. Such agreements are not intended to replace bilateral contracts but to supplement them by clarifying coordination tasks, promoting collaboration, and reducing interface risks all in one functional and legal framework (Van Gulijk & Muller, 2011). Examples include the coordination agreement and the cooperation agreement, which aim to bridge the coordination and collaboration gaps that arise in segmented setups (Van Gulijk & Muller, 2016).

Coordination agreement

The most relevant multilateral instrument in this context is the coordination agreement, as also emphasized by Dortmundt (2024). This agreement is signed by the client and all main contractors to manage the physical, technical, and logistical interfaces between them (Van Gulijk & Muller, 2011). Coordination agreements often include the designation of one contractor as the coordinator, who is responsible for overarching interface management, schedule alignment, and facilitating meetings. Although contractors remain contractually accountable to the client, the coordinator holds a central role in aligning the segments.

One of the main references for this structure is the *VGBouw model coordination agreement*, which highlights several legal challenges (Bouwend Nederland, 1999). A key issue is the mutual liability of co-contractors. The model aims to exclude such liability, yet the effectiveness of this provision is debated (Strang, 2018). Rather than solving conflicts through indirect client-mediated claims, early signaling of conflicts and cooperative dispute resolution should be prioritized.

Furthermore, under the VGBouw model, the coordinator is only liable to the client, not to other contractors. This limitation, along with a liability cap tied to direct damages and the coordinator's fee, could expose the client to residual risks. Improvements to the model are also possible in areas such as dispute resolution and partial termination.

Typically, a coordination agreement includes the following elements:

- Responsibilities and tasks of parties
- Liability during execution
- Liability after completion
- Communication and information
- Planning
- Interfaces and works by other contractors
- Coordination and cooperation
- Penalties and bonuses
- Duty to warn
- Changes
- Delays and disruptions
- Non-compliance and default
- Dispute resolution

While the listed elements provide a overview of the topics typically addressed in coordination agreements, they do not exist solely. As described earlier, segmented contracting in the Netherlands is usually based on bilateral contracts between the client and individual contractors ,and most commonly following standard forms UAC or UAC-IC. These contracts define the responsibilities and obligations between two parties, but do not establish direct relationships between co-contractors, which poses limitations for coordination, especially in segmented projects.

To determine which contractual gaps remain unaddressed, it is necessary to first assess whether the standard provisions of UAC and UAC-IC sufficiently cover the critical topics listed above. Topics such as interface management, coordination responsibilities, escalation mechanisms, and collaborative processes, are essential for ensuring alignment across different contractors and segments. If such topics are already well-defined in the bilateral contract forms, they may not need to be duplicated in additional agreements. However, if they are absent, vague, or insufficiently specified, additional legal instruments, such as a coordination agreement or tailored annexes, are required to fill these gaps.

Therefore, the next step is to analyse the extent to which these topics are already addressed in the existing standard contracts. The comparison table below outlines the relevant clauses in UAC and UAC-IC, helping to identify where the contractual foundation is strong, and where further elaboration or supplementation is needed.

This is worked out in Table 3 based on information from Van der Beek and Chao-Duivis (2018), Chao-Duivis and Koning (2015), and Chao-Duivis et al. (2018).

Table 3: Comparison of attributes in UAC and UAC-IC

Attribute	UAC	UAC-IC
Responsibilities and tasks of parties	§5 Client: permissions, site and waters, drawings and provisions, prescribed constructions and methods, enabling the work. §6 Contractor: execution of the work according to the agreement.	§3 Client: responsible for the entire contents of the specification, information, and goods provided to the contractor. §4 Contractor's obligations. §4(9): Contractor is responsible for any defect in the work unless attributable to the client, the agreement, or general legal principles.
Liability during execution	§5(4): Client liable for functionally unsuitable materials. §6(24): If two or more persons jointly undertake a project, they are jointly liable for its full execution. One must be designated as the representative.	§4(1): General obligation. Contractor must ensure design and execution such that the work complies at delivery. §4(8): Liability for failure to warn. §4(10): Contractor liable for damages caused to related works or client's property if attributable to their work.
Liability after completion	§12: After the project is considered completed according to §10, the contractor is no longer liable for deficiencies unless the issue is attributable, reported, and could not have been reasonably detected by the client.	§28 and §29: Responsibility for defects after completion and during the multi-year maintenance period.

Continued on next page

Attribute	UAC	UAC-IC
Communication and information	§27: Includes procedures for daily records, weekly summaries, reports, and site meeting notes.	§9: The client determines who coordinates; possibility of a coordination agreement included in the annex.
Planning	§26: General time schedule and contractor's work plan. §26(5): The schedule is a guideline only and does not increase obligations.	§7: Contractor must adhere to planning and milestone dates; must submit a detailed schedule for client approval.
Interfaces and works by other contractors	§31: Connections with other works.	§8: Interfaces with other works. If subcontracted work affects the project, the client must specify the nature, timing, and coordination in an annex. Article 9 MBO: The client must describe the nature and schedule of other contractors' work in an annex.
Coordination and cooperation	§31: Cooperation with subcontractors required; the contractor must coordinate with other parties on site.	§9: The client determines who coordinates; possibility of a coordination agreement included in the annex. Annex 5 specifies which subcontractors will carry out work, where, and when. The contractor must take this into account.
Integration	No clauses found.	No clauses found.
Penalties and bonuses	§42: Penalties for late completion. If unspecified, the default is €60 per day.	§36: Penalties for missing deadlines unless not attributable to the contractor. Bonuses for early completion. Also allows performance-based bonuses/penalties. §36 outlines: • Penalties linked to milestones and completion dates • Implementation: fatal terms, no cumulative penalties, deduction in next payment • Bonuses
Duty to warn	§2(5): Contractor must warn the client about apparent inconsistencies. §6(14): General warning obligation.	§4(7): Contractor must immediately and in writing warn in specific situations involving clear errors or risks.
Changes	§36: Specification changes by the client. Contractors may demand price changes only if they warned the client in time. Must follow all changes.	§14: Client can demand changes to scope, requirements, annexes, and specifications. Must be executed by the contractor. §15: Contractor can propose changes only if not yet reviewed/approved by the client. Otherwise, permission is required.

Continued on next page

Attribute	UAC	UAC-IC
Delays and disruptions	§6(6): Contractor generally bears risk for careless execution.	§4(6): Contractor must execute work so as to avoid unnecessary hindrance to the client or third parties, and to minimize environmental or material damage.
Non-compliance and default	§45-§46: Default, incapacity, or death of either party.	§28: Contractor not liable for post-completion defects unless: • The defect is due to their fault • The client could not have noticed the defect before delivery • The defect was not reasonably discoverable at the time of delivery
Dispute resolution	§49: Dispute resolution; jurisdiction of the Arbitration Board.	§47: Dispute resolution; jurisdiction of the Arbitration Board.

First, it is important to distinguish between two levels of contractual coverage. Standard contracts like UAC and UAC-IC primarily regulate bilateral relationships between the client and individual contractors. While some provisions may suffice in managing responsibilities between these two parties, they do not necessarily guarantee clarity or coordination between contractors themselves. In segmented contracting, however, inter-contractor coordination is essential. Therefore, unless standard contracts explicitly prescribe mechanisms for communication, collaboration, and shared responsibilities between contractors, these issues must be addressed through additional legal instruments such as coordination agreements or tailored annexes.

This comparison with a closer review of the UAC and UAC-IC reveals that the topics duty to warn, non-compliance and default, and dispute resolution are adequately addressed on the bilateral level and do not require further elaboration in a multilateral agreement. However, several provisions only partially cover multilateral implications. This applies for liability, communication and information exchange, planning, interfaces, penalties and bonuses, changes, and delay management, which are typically framed in bilateral terms without sufficient guidance on how coordination should be handled across segments or contractors.

Moreover, one crucial aspect of integration is not addressed at all in either UAC or UAC-IC, despite being vital in segmented and interface-heavy project environments.

As a result, further elaboration is needed for the following critical elements, particularly from a multilateral perspective. Where appropriate, related terms have been consolidated to streamline the analysis. In addition, attention is given to the coordination agreement itself in relation to the other contractual documents, as well as to the overall effectiveness of the agreement. These aspects are reflected in the following list:

- Function and relation to other documents
- Effectiveness of the agreement
- Coordination and role division

- Collaboration and conflict management
- Communication and information sharing
- Phasing of design and execution
- Design and interfaces
- Planning and delays
- Escalation
- Incentives

While the previous overview identified a set of contractual elements that are critical to enable coordination in segmented contracting, it raises another question: to what extent has guidance already been provided on how to structure these elements? Rather than treating each topic in isolation, it is essential to explore whether existing literature offers concrete recommendations for their contractual embedding from a multilateral perspective involving multiple co-contractors.

For several of these elements, literature already provides meaningful suggestions. Researchers such as Strang (2018), Terwel (2014), and Ren et al. (2024) have analyzed the legal, organizational, and collaborative dimensions of coordination in multi-contractor environments. Their insights help to clarify what additional provisions may be necessary beyond standard bilateral contracts like UAC and UAC-IC.

The remainder of this section discusses each contractual attribute from the list above, using literature to illustrate how these topics can be addressed in coordination agreements or other multilateral instruments.

Function and relation to other documents Coordination agreements must have a clearly defined legal status in relation to the bilateral agreements. Strang (2018) recommends assigning coordination responsibilities through a binding annex, to prevent ambiguity and overlap.

Effectiveness of the agreement Ren et al. (2024) emphasizes that legal structures must be designed not only for blame assignment but to detect and manage errors early. In that sense, the coordination agreement should enhance system-level resilience, support early warning systems, and promote a non-punitive culture of coordination. Melchers et al. (1983) also stresses that contract structures influence quality assurance and risk outcomes.

Coordination and role division Terwel (2014) points out that the most suitable coordinator must be assigned and empowered with sufficient authority. The coordinator's role should cover interface management, planning, and conflict facilitation. Article 9 of the UAC-IC provides different options but lacks enforceability and clarity. Strang (2018) advocates for these roles to be clarified in a coordination agreement that is signed by all contractors.

Collaboration and conflict management The VGBouw model provides general obligations to cooperate but lacks mechanisms for joint risk registers or collaborative dispute resolution. Strang (2018) calls for formalized structures such as joint conflict boards and early warning clauses. Terwel (2014) stresses the role of repeated collaboration, risk awareness, and clear role allocation in fostering project safety and cooperation.

Communication and information sharing Information exchange is key to coordination. Terwel (2014) recommends explicitly formalizing communication obligations and determining which types of data must be shared. Strang (2018) adds a formalisation of coordination meetings and decisions.

Phasing of design and execution Strang (2018) advises embedding planning and design transitions into contract schedules, including freeze dates, handovers, and planning dependencies. Phased execution should be supported by phased responsibilities and progressive interface integration.

Design and interfaces As coordination revolves around managing interfaces, the agreements must contain detailed interface documentation. Strang (2018) calls for the inclusion of interface responsibilities and procedures. The VGBouw model includes a separate annex for this purpose, but its content is often underdeveloped.

Planning and delays A coordinated planning approach is essential. Strang (2018) recommends deviation from Article 26(5) UAC, advocating for a binding and milestone-based schedule. Coordination agreements should clarify how contractors adapt their plans based on others' progress and who decides in case of conflicts. Planning misalignments are a known source of interface delay.

Escalation Conflicts in segmented contracting often arise at interfaces. Strang (2018) suggests including structured escalation procedures in coordination agreements: who can escalate, to whom, under what timelines, and with what documentation. The VGBouw model includes a basic escalation clause, but it can be expanded into a conflict resolution pathway.

Incentives Contractual incentives can stimulate collaboration. Strang (2018) proposes the use of shared bonus/malus arrangements and performance indicators. Current models like UAC or UAC-IC do not support shared incentives between contractors. Integrating them into the coordination agreement, possibly linked to joint milestones, can promote alignment.

3.10 Conclusion

In this chapter, the four choices of the client are worked out, namely horizontal or vertical segmentation, parallel or phased segmentation, the segmented project delivery method, and the role of coordination and agreements.

There are four main segmented project delivery methods of traditional, integrated, bouwteam, and two-phase method used in Dutch infrastructure projects have been described. Each method offers a different way to organise responsibilities, distribute risks, and structure cooperation between clients and contractors. When segmentation is applied, these methods are divided into smaller parts, each managed by different contractors. This offers benefits such as more flexibility and the ability to involve specialised contractors, but also brings new challenges, especially organisational in terms of coordination and communication.

The chapter also explored the role of coordination and the contractual arrangements that support it. Coordination is critical in segmented projects, particularly when multiple contractors work in parallel. It can be assigned to the client or to one of the contractors, but in all cases, clear responsibilities, sufficient authority, and structured communication are essential. To support coordination legally, a separate coordination agreement is often used alongside the standard bilateral contracts UAC and

UAC-IC. This multilateral agreement helps to manage interfaces, align planning, and promote collaboration. Literature shows that while UAC and UAC-IC cover some elements, additional provisions are needed to address coordination, interface risks, and cooperative behavior in a multi-party context.

This makes the conclusion of this chapter. It provides a foundation for the rest of the research, where these methods will be further examined in practice by looking specifically at responsibilities, coordination, and how contracts can be adapted to support segmented contracting in complex projects.

4 Cases

This chapter presents the results of the multiple case study conducted to answer subquestions 2, 3, and 4 of this research. These subquestions address how segmentation choices influence responsibilities, how multiple segmented project delivery methods are managed within a single project, and which contractual elements are needed to support these strategies.

The findings are based on the analysis of various infrastructure projects in the Netherlands that applied segmented contracting in practice. Each case was examined using project documentation, interviews with key project stakeholders, and supplementary desk research. The interviews were conducted with the following respondents as mentioned in Table 4.

Table 4: Interview respondents project experts

Interview number	Project	Position
E1	Uithoornlijn	Projectmanager contractors
E2	Uithoornlijn	Projectmanager contractors
E3	Uithoornlijn	Projectmanager
E4	Uithoornlijn	Contractmanager
E5	Schiphol baggage basement	Projectmanager
E6	Schiphol baggage basement	Contractmanager
E7	AWS Zwanenburg	Projectmanager
E8	AWS Zwanenburg	Contractmanager
E9	Amsterdam CS	Executionmanager
	Amsterdam CS	Executionmanager
E10	Amsterdam CS	Manager Projectcontrol
	Amsterdam CS	Technical projectmanager

While the projects vary in scale, scope, and segmentation strategy, together they offer valuable insights into how segmentation affects coordination, interface management, contract design, and execution processes.

The analysis is structured around the main segmentation dimensions (horizontal vs. vertical, phased vs. parallel), the project delivery methods applied (traditional, integrated, two-phase, and bouwteam), and the supporting contractual arrangements (e.g., coordination agreements) as described in section 3. By identifying recurring challenges, best practices, and project-specific solutions, this chapter builds the empirical foundation for the conclusions and recommendations in the final part of the thesis.

4.1 Uithoornlijn

The Uithoornlijn is a new high-quality tram extension developed by the regional public transport authoritie of Amsterdam to improve accessibility in the Amsterdam metropolitan area (Uithoornlijn, 2024). The project extends the previously upgraded Amstelveenlijn from its former stop in Westwijk to the town centre of Uithoorn. This five-kilometre tram line replaces part of the existing bus network and aims to reduce road congestion while increasing the reliability of public transport in the region. The alignment includes three new stops: Aan de Zoom, Uithoorn Station, and Uithoorn Centrum. It follows a former railway embankment, incorporating a viaduct over the N201 highway and an underpass beneath the Zijdelweg. The main client for the project is the Amsterdam regional transport authority.

Vertical segmentation

The Uithoornlijn project was segmented vertically based on technical content. A distinction was made between general infrastructure, managed by the main contractor, and specialized systems like switch control, detection elements, and passenger information systems. These systems required domain-specific expertise and integration with existing urban systems, such as camera networks managed by suppliers.

Part of the contractor selection was predetermined by existing long-term contracts between the owner of the project and specific suppliers. Furthermore, many of the systems had to align with existing installations in the surrounding urban network, which made it logical, and even sometimes necessary to re-engage the same parties. Due to the nature of rail infrastructure, the project included numerous technical installations such as signal control, crossing detection, and security systems. For each of these, a specialized contractor was selected. Many of these installations were interdependent and tightly integrated, leading to a high number of interfaces that had to be carefully managed. This interface density increased the design coordination burden significantly and required early and structured alignment between all involved parties.

Because of their complexity and interdependence, these systems were separated into individual subcontracts. The segmentation ensured quality and continuity but demanded high levels of interface coordination, especially in the design phase. The decision worked well technically, but required strong oversight by the client to safeguard integration.

Scope	Description	Type of segmentation	Parallel or phased	Agreement	Type of contract	Contractor
Scope A	Realisatie UHL	Vertical	Parallel	Agreement A	D&C	Contractor A
Scope B	NMA	Vertical	Parallel	Agreement B	Frameworkcontract	Contractor B
Scope C	Stationssystemen	Vertical	Parallel	Agreement C	Frameworkcontract	Contractor C
Scope D	DRIS tram	Vertical	Parallel	Agreement D	Frameworkcontract	Contractor D
Scope E	Verlichting	Vertical	Parallel	Agreement E	Frameworkcontract	Contractor E
Scope F	Beveiliging opstelterrein	Vertical	Parallel	Agreement F	Frameworkcontract	Contractor F
Scope G	CBI tram	Vertical	Parallel	Agreement G	Frameworkcontract	Contractor G
Scope H	ABRI's tram	Vertical	Parallel	Agreement H	Frameworkcontract	Contractor H
Scope I	ABRI's bus (Uithoorn)	Vertical	Parallel	Agreement H	Frameworkcontract	Contractor H
Scope J	ABRI's bus (Noord-Holland)	Vertical	Parallel	Agreement I	Frameworkcontract	Contractor I
Scope K	DRIS bus	Vertical	Parallel	Agreement J	Frameworkcontract	Contractor J
Scope L	TMS	Vertical	Parallel	Agreement K	Frameworkcontract	Contractor K
Scope M	Wisselbesturing	Vertical	Parallel	Agreement L	D&C	Contractor L
Scope N	VOS	Vertical	Parallel	Agreement M	D&C	Contractor M
Scope O	VRI besturing	Vertical	Parallel	Agreement N	Frameworkcontract	Contractor N
Scope P	DMS	Vertical	Parallel	Agreement O	Frameworkcontract	Contractor O
Scope Q	Energievoorziening	Vertical	Parallel	Agreement P	Frameworkcontract	Contractor P
Scope R	Hal	Vertical	Phased	Agreement Q	D&C	Contractor Q
Scope S	Zandvulinstallatie	Vertical	Phased	Agreement R	D&C	Contractor R
Scope T	Wasinstallatie	Vertical	Phased	Agreement S	D&C	Contractor S

Figure 9: Uithoornlijn scope (made by author)

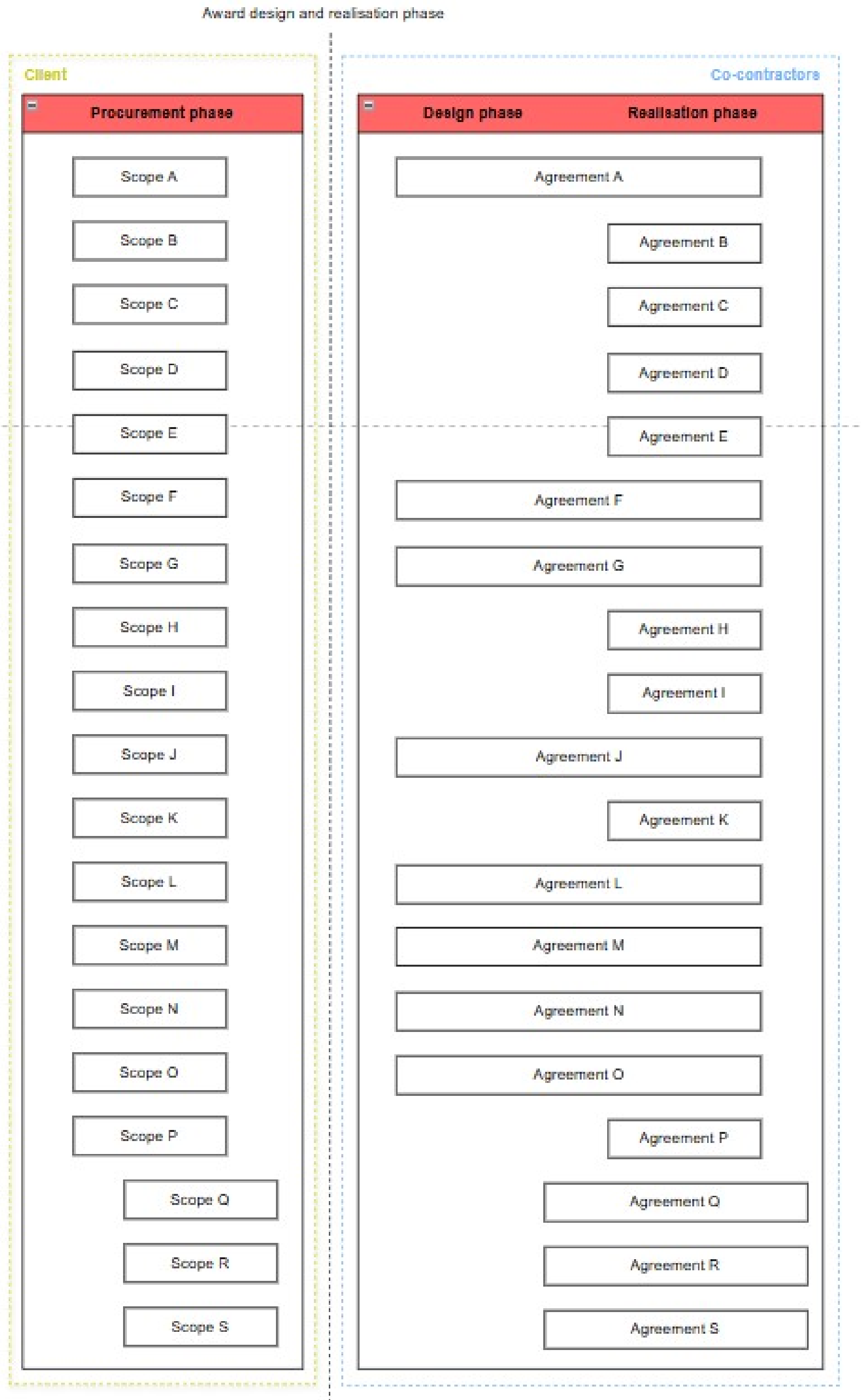

Figure 10: Uithoornlijn contracts (made by author)

Parallel segmentation

The Uithoornlijn project applied a consciously chosen parallel segmentation strategy, meaning that all contractors worked simultaneously on both the design and execution of their respective parts of the project. This setup was implemented to enable early detection and resolution of potential conflicts, which substantially reduced rework and cost overruns.

According to Interviewee E2, the largest contractor was contracted first, at a time when several long-term framework agreements were already in place and the procurement processes for remaining packages were ongoing. “We deliberately contracted all contractors during that same phase so they could begin their design phases simultaneously.” This ensured that all parties were involved early and had the opportunity to align and discuss their designs from the start.

Interviewee E3 supported this by highlighting lessons learned from the earlier Amstelveenlijn project, which influenced the strategy for Uithoornlijn: “We discovered that parallel design and execution has many benefits, especially if you coordinate interfaces early on.” The interviewee noted that when the main contractor was selected, the project team also initiated the procurement of key co-contractors. While some of these were formally contracted at a later stage, the most critical interfaces had already been worked out in documentation. “The main contractor already knew which parties would be involved and what had to be coordinated with them. We actually aimed to contract all co-contractors simultaneously with the main contractor, so they could make agreements directly with each other.”

The advantages of this approach became clear throughout the design process. As Interviewee E4 put it: “One major benefit was that, because of this parallel approach, we saw many of the conflicts coming much earlier and were able to steer accordingly. Rather than discovering too late in the project that something didn’t fit or wasn’t working, we caught many of those issues already during the design phase.” Interviewee E1 even mentioned: “The earlier you know who is involved, the better you can coordinate the overall design.”

This strategy relied heavily on structured interface documentation, clear scoping, and proactive coordination between parties during the design phase. The outcome was a more integrated and predictable design and construction process, despite the complex technical interdependencies between the various systems and contractors.

While the design phase was largely executed in parallel, certain elements of the execution had to be phased for practical reasons. For example, on the depot site, the floor and track system were installed first by one contractor, after which a second contractor constructed the depot building. In such cases, the sequence of execution was deliberately staggered to manage dependencies. Contractors were initially provided with a general time window for their work, with precise locations and schedules communicated later. Overall, although the project followed a parallel segmentation approach in principle, the execution was adapted where necessary to reflect on-site constraints and interface sensitivities.

Project delivery method

The project was organised through multiple types of contracts. The three main workpackages were delivered under Design and Construct (D&C) contracts based on the UAC-IC conditions. These contracts included the civil infrastructure and core systems of the transport line. In addition, several smaller contracts were executed under existing framework agreements and some through direct orders, often without any design responsibilities.

This contracting strategy was chosen primarily due to the specialist knowledge required for many of the system components. The client deliberately chose to delegate design responsibility to the contractors, especially for components where in-house expertise was lacking. As such, the parties most familiar with the technical systems were made responsible for developing their own designs, which improved integration and quality assurance. This approach proved effective but also introduced challenges. Notably, differences arose in the interpretation of UAC-IC requirements. Some contractors, particularly international suppliers, were unfamiliar with the Dutch UAC-IC contract form, resulting in misunderstandings regarding documentation and deliverables.

Design handover varied across contracts. For the three D&C packages, the client delivered a structured programme of requirements and preliminary designs. From this point, the contractor developed the detailed and final designs. For other smaller packages, where existing suppliers were involved, little to no design input came from the client. In such cases, contractors relied on their own technical knowledge and past experiences.

A key feature of the project was the interface management. To manage the many interrelated subsystems, the client developed detailed system notes for the most important subsystems, including their scope, owner, design and execution responsibilities, and interface descriptions with other works. These notes covered both the functional integration of each subsystem and its relation to the main operating system. This approach provided clarity and transparency in managing interfaces between contractors. And during the design phase, the design development involved numerous iterative steps, where contractors continuously coordinated their designs based on each other's requirements and technical constraints.

Although multiple contract types were used, this segmentation was intentional. It allowed the client to allocate responsibilities according to expertise and contractual familiarity. For the main civil works and track systems, the choice to apply D&C contracting proved logical and aligned with the contractor's capability. For technical systems, interface clarity and early coordination helped mitigate integration risks, despite the complexity introduced by having different parties responsible for design and implementation.

Design and execution responsibilities

The combination of vertical and parallel segmentation on the Uithoornlijn project had a strong influence on how design and execution responsibilities were distributed and managed. The big contractors were made responsible for a specific subsystem, with their scope clearly defined in interface documents and separate system notes. These documents not only described the subsystem's technical function, but also its relation to the main transport system and its interfaces with other subsystems, and who is responsible for which interface. These detailed documents provided a strong set of information for managing responsibilities during both design and execution.

During the design phase, the parallel segmentation together with the choice for integrated contracting allowed contractors to begin work simultaneously. However, because many subsystems were tightly connected such as signalling, overpasses, and civil infrastructure, the early coordination was essential. Interviewees E2 and E3 emphasized the importance of starting co-contractor procurement early to enable timely and integrated design development. As Interviewee E2 noted, "The earlier you know who is involved, the better you can coordinate the overall design and let the contractors collaborate. Early integrated coordination is essential". Shared tools like BIM were used to ensure visibility of the latest designs. For example, detection elements designed by one contractor could be integrated into the civil rail model of another. This setup enabled early detection of conflicts and ensured that spatial and technical dependencies were resolved before construction began.

Still, the distributed responsibility brought challenges. When additional scope was added late in the design, this led to misalignment. Earlier contractors had not designed with these future connections in mind, resulting in rework and increased costs. In one case, structural elements were overengineered due to uncertainty about what would later be added. This highlighted that delayed scope definition is particularly problematic when subsystems are highly interdependent. In these cases, parallel design becomes inefficient, as earlier packages cannot anticipate later requirements.

During execution, however, segmentation helped avoid overlap between contractors. Contractors were not working in the same space at the same time. Work zones were clearly defined, and each contractor was called to the site by a central coordinator. This phased execution, combined with parallel design, allowed for orderly progress on site. And contractors were initially informed of their time slots in general terms, with specific work zones clarified later. This staged approach was formalized in coordination agreements.

In the execution phase, the benefits of prior coordination were more evident. Many potential conflicts had already been resolved in the design stage, leading to fewer disruptions during construction. Work zones were clearly defined, and each contractor was called to the site by a central coordinator. This phased execution, combined with parallel design, allowed for orderly progress on site. And contractors were initially informed of their time slots in general terms, with specific work zones clarified later. This staged approach was formalized in coordination agreements.

Ultimately, the segmented setup placed a large part of the integration responsibility with the client. Contractors were responsible for their specific design and execution scopes, but aligning all components into a functioning transport system required strong oversight. The use of system notes and interface documentation helped mitigate these challenges. Interviewees emphasized that early involvement of all contractors is key to successful parallel development.

Role of coordination and contracts

Coordination in the Uithoornlijn was assigned to a single main contractor, who formally assumed the role of coordinator through a coordination agreement included as an annex to the overarching contract. This contractor was responsible for aligning the efforts of all co-contractors.

This choice was made to prevent fragmentation and finger-pointing, ensuring a single party could be held accountable for overall coherence. However, the success of this setup depended heavily on how the role was actually implemented. As interviewee E2 noted, "It really helps if one party has the lead, but you also need to make sure that person has the authority, time, and mandate to actually coordinate effectively." In practice, this meant that the client remained actively involved in the early stages of the project, organizing kick-off meetings, monitoring collaboration, and facilitating communication training for the teams. This early investment helped to establish trust and set expectations, which allowed the client to adopt a more hands-off role once coordination functioned properly.

Despite being under a single contractor, the coordinator operated through three different divisions: civil, rail, and electrical. Each division with its own culture and working method. This internal complexity asked for additional coordination, which was managed through project-level steering within the contractor's own organization.

Coordination in the field was supported by interface notes that documented each technical and functional interface between contractors. These notes assigned responsibilities per party and per system. For instance, physical construction of an element could be assigned to Contractor A, while the functional operation of the system would be under the responsibility of Contractor B. These notes were signed by the involved parties, ensuring clear accountability.

Technical coordination was further institutionalized via biweekly meetings, alternating between detailed technical sessions and short operational check-ins. Key design milestones, such as the traffic control system, were reviewed and formally approved by the asset manager to secure critical requirements and reduce the risk of last-minute changes.

Furthermore, the list below states the provisions included in the coordination agreement in the Uithoornlijn project, with a specific explanation of the content added for each provision.

- **Function and relation to other documents**
  The coordination agreement is included as an appendix to Annex VI: Overview of Works of Co-contractors and Environmental Parties.
- **Effectiveness of the agreement**

No explicit evaluation or clause was found concerning the effectiveness of the agreement in the contractual annex.

- **Coordination and role division**
  The contract clearly identifies which party is the coordinator and defines their duties. Obligations for all parties include full collaboration, timely provision of information, and support for coordination activities. Each party's coordination tasks are explicitly listed and include:
  - Identifying interfaces, constraints, and boundary conditions arising from separate contracts.
  - Verifying the completeness and accuracy of these interfaces and constraints.
  - Executing and testing their own works in alignment with the coordination schedule.
  - Contributing to and updating the coordination schedule.
  - Agreeing to and adhering to the coordination schedule.
  - Seeking optimizations in time, cost, quality, or disruption.
  - Collaborating on spatial, logistics, design, safety (V&G), and test coordination.
  - Timely exchange of relevant planning, design, execution, and testing data.
  - Participating in coordination meetings with sufficient expertise and authority.

  The responsibilities of the coordinator are also specified in detail:
  - Managing all types of coordination (design, spatial, logistics, safety, and testing).
  - Ensuring that all parties follow the coordination schedule.
  - Supervising compliance with the coordination schedule.
  - Updating the schedule based on optimizations.
  - Allocating workspace to co-contractors based on predefined windows.
  - Producing a spatial design solution for systems coordination, subject to client approval.
  - Drafting and distributing the coordination schedule and meeting minutes.
  - Chairing the coordination meetings.
  - Integrating safety systems across co-contractors.
  - Ensuring system integration between Uithoornlijn and other subsystems.
- **Changes and escalation**
  A structured change procedure was in place, requiring parties to submit change requests for all proposed alterations. This procedure was rigorously followed. The escalation process required the coordinator to organize a coordination meeting within one week when issues arose. If no solution was found, a proposal was submitted to the client. Persistent non-cooperation allowed the client to issue a formal warning. If the warning was ignored, it constituted a breach of contract, entitling the client to enforce sanctions.
- **Collaboration**
  Conflicts followed the procedures set out in the standard agreement with no further customization.

- **Phasing of design and execution**
  No specific provisions were found regarding the phasing between design and execution within the coordination agreement.

- **Design and interfaces**
  An annex outlined the co-contractors' scopes, but no detailed interface matrix or assignment per interface was included in the coordination agreement. There is no information given on the use of BIM.

- **Planning and delays**
  A central coordination schedule was developed and maintained by the coordinator. Co-contractors were required to provide timely input, and commit to the schedule by signature. The schedule included work sequences, equipment needs, and necessary coordination data. Each co-contractor received advance notice of work window start dates with a margin of +3 to -1.5 months one year in advance and +2 to -1 months six months in advance. If delays occurred, they were escalated per the formal procedure.

- **Communication and information sharing**
  Coordination meetings were held every two months with mandatory attendance. Meeting protocols detailed the objectives, participants, and outputs. Additionally, a communication protocol outlined how and through which channels decisions were to be communicated. All parties were obligated to cooperate in sharing information regarding planning, availability, and execution.

- **Incentives**
  For one major contractor, a bonus was included for on-time system delivery. However, setting such incentives early in the tender was considered risky, given uncertainty about contractor selection and milestone dates. Incentives were only recommended once most contractors had been engaged and detailed scheduling was available.

From a contractual standpoint, the coordinator's role was formalized, but operationally it still required continuous monitoring by the client. As emphasized by interviewee E3, the role of coordinator must be clearly defined from the outset, with clarity on authority, time availability, and mandate. A detailed coordination plan should be required as part of the contract, including a governance structure, responsibilities, and decision-making procedures. This plan should not only be approved at the start but also reviewed during execution to verify continued compliance.

Finally, involving the asset manager early in the design phase proved valuable. Especially for line infrastructure, their knowledge of operational processes ensured that designs were practical and maintainable for the end-user. While formal standards existed, early participation helped align expectations, reduce late changes, and improve constructability.

This is worked out in the following Figure 11 on the best effort versus result obligations, which has been constructed by the author based on an interpretation of the interview findings. This is based on an analysis of the case studies and contractual documentation.

Interviewee E3 mentions that one important lesson from the project was the need to define and actively shape the coordinator role from the outset. The client should explicitly determine who will fulfill this role, how much time the person can dedicate to it, and whether they have sufficient authority to make binding decisions. These preconditions must be properly arranged in the agreement. Additionally, the client should reflect on its own role in the coordination process and whether to stay involved or delegate responsibilities. It is strongly recommended to require a detailed coordination

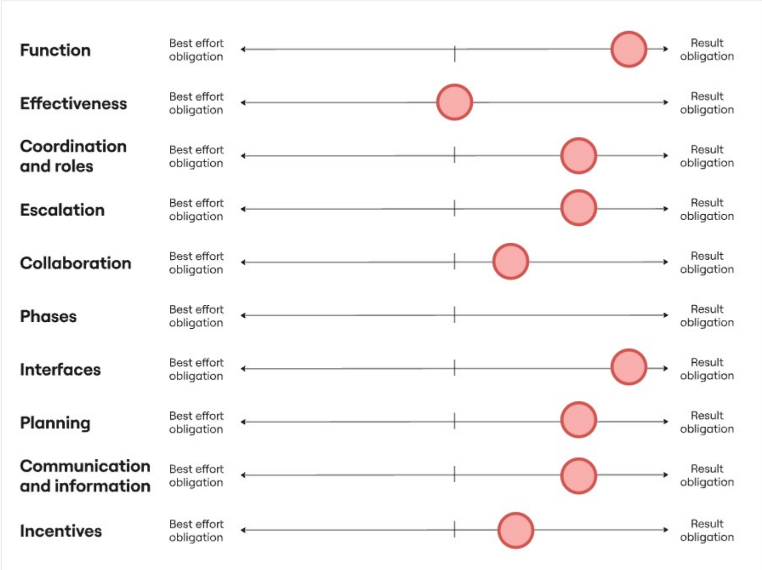

Figure 11: Obligations contract Uithoornlijn (made by author)

plan as part of the contract, outlining responsibilities, governance structure, and decision-making powers, and to thoroughly review and test this plan before implementation. Also during execution this plan should be tested to check whether the coordinator still complies with the plans.

4.2 Schiphol baggage basement

Schiphol Airport initiated the construction of a new baggage basement to create the necessary capacity for replacing and upgrading its existing baggage handling system (Schiphol, 2023). The current system had become increasingly prone to malfunctions and had reached the end of its technical lifespan. The new basement is therefore designed to accommodate a state-of-the-art baggage handling system that ensures future reliability and operational capacity (Schiphol, 2024). In the long term, a new terminal building is planned on top of the basement. However, due to the urgent need to replace the existing baggage facilities in the surrounding terminal, responsible for 20–25% of Schiphol's total baggage capacity, the basement is developed as a stand-alone structure that can operate independently until the terminal is realized.

Horizontal and vertical segmentation

The Schiphol baggage basement project was segmented, both horizontally and vertically. The horizontal segmentation was applied between the substructure (the baggage basement) and the superstructure (the future terminal building). This separation was made for three main reasons. Firstly, interviewee F5 explained that from a technical perspective, the basement needed to be constructed first, as it forms the structural foundation for the terminal above. The construction sequence therefore required that the basement be completed before terminal works could begin. Secondly, F5 noted that the terminal project faced delays in decision-making due to political sensitivities and the COVID-19 crisis, which prevented the design from progressing beyond the preliminary design (VO) phase. Thirdly, the existing baggage infrastructure was reaching the end of its technical lifespan. One of the existing baggage halls handled around 20–25% of the airport's total baggage capacity, but was highly outdated. Without timely replacement, this would have led to serious operational issues. As a result, the baggage basement was deliberately brought forward in execution, while the terminal remained on hold at VO level.

Vertical segmentation occurred within the basement project itself. The design and realisation of the structural works were handled separately from the technical installations of the baggage handling system. According to F5, this separation was based on functional logic. The civil contractor was responsible for constructing the basement shell, while a specialist supplier was contracted under a separate agreement to design and deliver the baggage system. This setup allowed Schiphol to engage specialised expertise for the baggage installation while retaining direct control over key system requirements. These segmentation decisions were made early in the VO phase to ensure that the basement could proceed independently.

Parallel and phased segmentation

The Schiphol baggage basement project follows a combination of parallel and phased segmentation. The overall phasing was primarily driven by the urgency to replace outdated baggage infrastructure and the delay in the terminal design.

In terms of overall structure, the project has a clear phased segmentation between substructure and superstructure. The baggage basement had to be delivered first due to the technical state of the existing baggage handling infrastructure. At the same time, the terminal project remained on hold due to political and planning uncertainties.

Within the basement project itself, the design phase initially followed a parallel approach. Schiphol aimed to synchronise the development of the basement structure with the baggage system design. The idea was that as the civil contractor developed the structural design, the installation contractor would work on the baggage layout and technical requirements. This parallel setup was intended to ensure proper integration, since the baggage system must fit precisely into the civil structure and requires dedicated interfaces for anchoring, ventilation, and routing.

However, this approach evolved over time. As F6 explained, delays in the baggage system design caused the parallel design tracks to diverge. The baggage contractor experienced ongoing scope revisions and remained in the early design phase, while the civil contractor continued advancing their design towards near TO level. This temporary decoupling turned the parallel development into a more phased process. As a result, the basement design had to anticipate system needs using assumptions, which introduced risks of mismatch and future rework.

In terms of construction execution, the project follows a strictly phased approach. The civil works for the basement are scheduled from 2026 to 2029. In 2028, the installation contractor is expected to begin installing the baggage handling system in the deep section of the basement, while civil construction continues in the shallow sections. The terminal will only be built after full completion of the basement. According to interviewees, simultaneous work by multiple contractors on the same site is both impractical and prohibited for safety and spatial reasons.

Scope	Description	Type of segmentation	Parallel or phased	Agreement	Type of contract	Contractor
Scope A	Kelderbak	Vertical	Parallel	Agreement A	D&C (Bouwteam)	Contractor A
Scope B	Ontwerp	Vertical	Parallel	Agreement B	TNR	Contractor B
Scope C	Bagagesysteem	Vertical	Parallel	Agreement C	D&C	Contractor C
Scope D	Terminal	Horizontal	Phased	Agreement D	TBD	TBD

Figure 12: Schiphol scope (made by author)

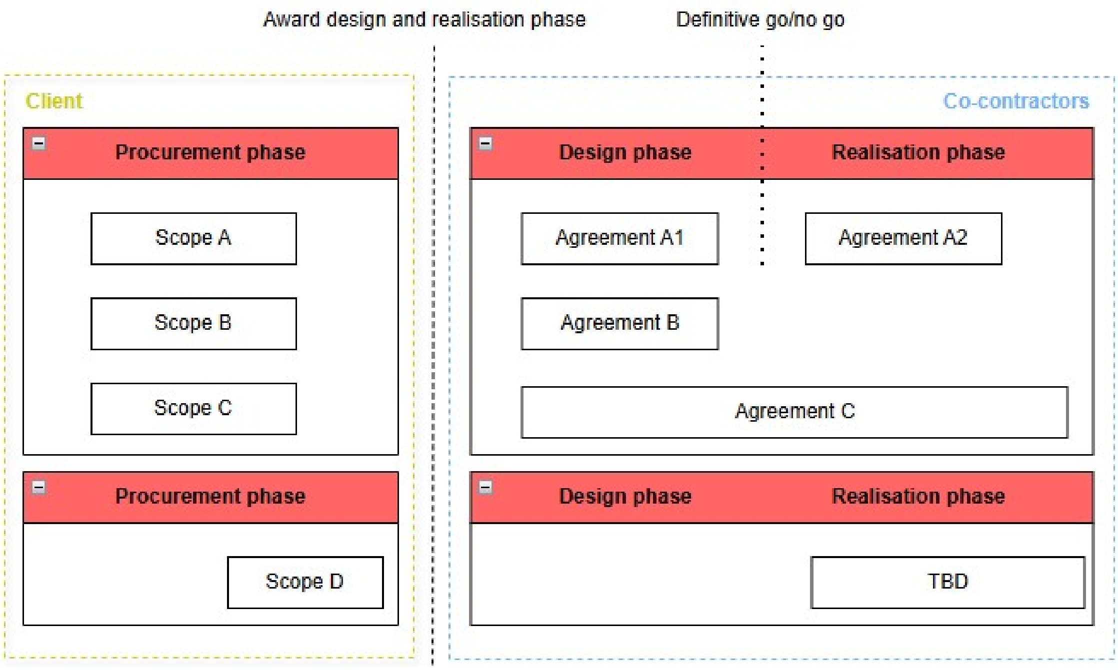

Figure 13: Schiphol contracts (made by author)

Project delivery method

It uses a phased project delivery method based on a Bouwteam 2.0 model. In this approach, the client collaborates with both the designer and the civil contractor under a TNR contract during the design phase. In this project, the first phase extends up to an advanced definitive design level, close to technical design (TO). At this point, a go/no-go decision is made. If the project proceeds, the civil contractor transitions into the execution phase under a UAC-IC contract. This integrated model is intended to improve predictability and reduce risks during implementation by ensuring early contractor involvement.

This approach reflects a deliberate choice to deviate from traditional contracting. Both interviewees emphasized that traditional models often delay market engagement until a detailed design is completed, which limits flexibility. In contrast, under a bouwteam 2.0, the contractor is already involved early in the design process. The contractor has had over a year to understand the project in depth, provide input on buildability, and co-develop the plan. This preparation is seen as a key investment in predictability. As one interviewee noted: ”If it gets boring for us during the execution phase, that means we did a good job in preparation.”

A separate project team manages the contract for the baggage handling system, which falls under a separate UAC-IC contract. This team includes its own project and contract managers and operates under a different governance structure. Although both projects must be technically integrated, the separation of roles has made coordination more complex.

Initially, several components of the broader program were already contracted under international FIDIC agreements. These were later adapted into Dutch agreements to align with Schiphol's internal quality and management frameworks. This shift from international to Dutch contracting practices created additional layers of coordination, especially during the transition from one project team to another internal at Schiphol Group.

For the terminal building above the basement, a different contracting strategy is followed. A traditional contract is expected for the terminal, reflecting the higher desire for control and lower tolerance for flexibility by the client. The UAC-IC model with early contractor involvement is preferred for complex, technically constrained projects like the basement, while traditional models with UAC may still be applied where integration risks are lower.

Design and execution responsibilities

The Schiphol project adopted a segmented design and execution approach, with separate scopes for the basement structure and the baggage handling system. During the initial design stage, both components were developed in parallel up to the preliminary design (VO) level. This was done intentionally to ensure that essential interfaces such as structural foundations, shafts, and vertical connection points, were clearly defined and coordinated from the start. At this point, the design responsibility rested with the client, who also carried the integration responsibility between both scopes. As interviewee E5 noted: "It's not ideal, but it's manageable. We're technically preparing the basement for the terminal by already including foundation points and connection interfaces. In that way, even if they are built separately, the design remains integrated."

Following the VO phase, the basement design advanced toward detailed design (DO) and was then developed further toward technical design (TO). The initial detailed design was developed by the bouwteam, after which the civil contractor continued development up to near-TO level during the bouwteam phase. This strategy aimed to reduce redesign needs during execution, particularly for the civil components such as foundations and load-bearing elements that are difficult to alter later.

However, a design maturity mismatch developed. Due to delays and scope adjustments on the installations side, the baggage system remained at a conceptual stage while the civil works progressed toward execution-ready detail. This created significant coordination challenges at the interfaces. The civil contractor had to proceed based on incomplete information and relying on preliminary layouts, indicative block plans, and educated assumptions for penetrations, cable routes, and load zones.

To manage these risks, Schiphol took several measures. A formal cooperation agreement and a shared RASCI responsibility matrix clarified design roles and supported governance. About twenty joint technical workshops were held to address issues such as foundation methods, construction logistics, technical space allocation, and integration planning. These sessions helped align the civil and systems teams and supported decision-making. Despite this, the pressure remained. As E6 reflected: "We really need each other for these interface discussions. The installations team should provide a clear layout, so we can account for it. But instead, we work with block plans and assumptions. That's difficult for the civil team, who are focused on buildability."

Coordination was further complicated by the need to maintain progress. As E6 noted: "We can't keep waiting for the baggage system design to be final. This means we have to make choices. So we're starting to prepare and even execute certain elements, even though the system design isn't fully fixed yet. Of course, we don't do this blindly. We try to anticipate what's coming as best we can. But full certainty is never possible."

This situation raised contractual and legal questions. Under the standard phasing, the bouwteam phase concludes with the definitive design, after which execution responsibility formally transfers to the contractor under UAC-IC conditions. However, the civil contractor proposed bringing forward some execution activities, such as parts of the excavation and foundations—into the bouwteam phase. This overlap challenged the distinction between design and execution responsibility.

To accommodate this, Schiphol created a separate subcontract for a small scope of early works. This subcontract included adapted provisions on responsibility, liability, and quality control. It enabled early progress while preserving the formal separation between design (under client responsibility) and execution (under contractor responsibility).

Role of coordination and contracts

To manage coordination between different parts of the project, Schiphol introduced a formal cooperation agreement. This agreement helped align the basement construction with the baggage handling system, even though these parts were handled by different project teams and contracts. Originally, Schiphol wanted to bring all parties (the designer, the civil contractor, and the installations contractor) into one joint construction team. However, due to the separate project team and contractual setup for the baggage handling system, this integration was not feasible. As a result, a cooperation agreement was introduced to facilitate collaboration across the different project components.

In this setup, Schiphol took the lead coordination role. Even though each contractor still followed their own contract for their specific scope, the cooperation agreement added rules for how to collaborate across team boundaries. Interviewees said that this agreement helped to create more openness and a shared sense of responsibility. Schiphol also paid close attention to team behavior and collaboration skills when selecting partners, and not just price or technical ability. As interviewee E5 noted, "The market appreciates that Schiphol takes equality and cooperation seriously. It creates a safe space to raise issues early."

Coordination happened through both formal and informal ways. Schiphol organized joint design meetings, kept track of progress, and helped solve problems at the interfaces between systems. Teams also worked together closely on site. However, coordination was not always easy. Within Schiphol itself, separate teams were responsible for the basement and the baggage system. This made internal communication and decision-making more difficult. The cooperation agreement was therefore also useful to align Schiphol's own teams, not just the contractors.

Below is a summary of what the cooperation agreement included:

- **Function and relation to other documents**
  The cooperation agreement aimed to describe the collaboration and alignment between the parties, as well as to define the roles and responsibilities of all involved parties. The individual contracts per contractor specify their respective scope and level of design.

- **Effectiveness of the agreement**
  The agreement does not explicitly define a clause on its own effectiveness, but it includes mechanisms for ongoing monitoring and joint evaluation during scheduled consultations.

- **Coordination and role division**
  Schiphol's role is explicitly described at the beginning of the document as the party that takes the lead in the collaboration and acts as chair of the bouwteam meetings. Schiphol is also assigned the authority to decide in case of disputes or differing interpretations.

- **Changes and escalation**
  If the contractors cannot reach a resolution through the agreed method, the matter is escalated to the responsible representatives of each party, namely the project directors. The project directors are given five working days from the date of escalation to jointly arrive at a solution. Until this solution is reached, all work, collaboration, and coordination must continue in accordance with the existing situation, as if the conflict had not occurred.

- **Collaboration**
  Teams were selected in advance based on behavior, experience, and shared vision on collaboration. Contractors are obligated to align their work, to exchange progress and interface information, to jointly identify issues, and to seek solutions together.

  Coordination meetings occurs at strategic, tactical, and operational levels. Meeting frequency, required functions from each party, and meeting objectives and durations are laid out in the agreement. Contractors must update each other regularly on the progress of their design activities to prevent the need for redesign.

  Joint consultations are held regularly. These must cover at least the following topics:
  a. evaluation and monitoring of the overall collaboration;
  b. progress of the collaboration;
  c. review of design decisions made;
  d. discussion of risks that may affect collaboration;
  e. any other relevant topics that may help avoid escalations between contractors.

- **Phasing of design and execution**
  The agreement explicitly applies to the design phase of the project. It governs how contractors, designers, and Schiphol collaborate during this stage. Once the design phase concludes, a new cooperation agreement will be drafted for the execution phase.

- **Design and interfaces**
  Contractors are expected to timely identify and report design risks and issues at interfaces. A shared RASCI matrix has been drawn up that defines the responsibilities and accountabilities of all parties for each interface-related deliverable.

- **Planning and delays**
  A construction team schedule and a milestone overview are added as appendices to the agreement. They define deadlines, deliverables, and responsible parties for each milestone. If any party anticipates a delay, it is required to report this to all involved parties as soon as possible without delay, to allow timely information sharing and joint problem-solving.

- **Communication and information sharing**
  The agreement includes a structured meeting schedule at strategic, tactical, and operational levels, listing the required participants, goals, and meeting frequency in an appendix.

  In case of conflicting sub-interests or views, the contractors are expected to jointly identify, describe, and substantiate their perspectives. They must then develop and evaluate possible solutions based on criteria of time, cost, and quality including feasibility, constructability, and executability. The proposed solutions are to be submitted, with justification, to the client for decision-making.

The role of the client in such cases is explicitly described as safeguarding the overarching strategic interests of the integrated project. When conflicts arise between sub-interests or views, the client will weigh these carefully against the overall project interests and make a final decision accordingly.

- **Incentives**
  The agreement does not include formal penalties or bonus incentives. Instead, it emphasizes shared responsibility and reliability. Payments are made upon delivery, with a retention of 10–15% until all required documentation has been completed and approved.

This is worked out in the following Figure 14 on the best effort versus result obligations, which has been constructed by the author based on an interpretation of the interview findings. This is based on an analysis of the case studies and contractual documentation.

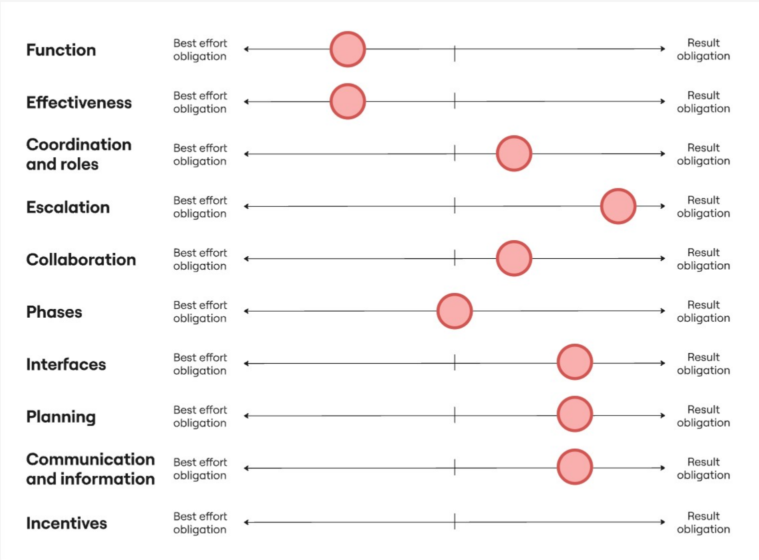

Figure 14: Obligations contract Schiphol (made by author)

4.3 AWS Zwanenburg

The project includes the expansion and renovation of the existing wastewater treatment plant (AWS) Zwanenburg, so that it can also process the wastewater coming from the pumping stations in Heemstede and Haarlem-Schalkwijk. These older plants have reached the end of their technical lifespan after about 30 years. A new pipeline system will transport the wastewater to Zwanenburg, where the plant is being upgraded to handle the increased volume (Croonwolterendros, n.d.).

The construction works include a new intake structure with air filtering, a new aeration tank, and a secondary settling tank with sludge return pumps. A new booster pit is also built to support the increased effluent flow. The current intake structure will be converted into a sludge pumping station, to allow sludge to be sent to AWZI Haarlem Waarderpolder for further treatment (Mobilis, n.d.).

Figure 15 shows a visualisation of the scope of the project with the types of segmentation, the agreements and contracts, and the contractors.

Scope	Description	Type of segmentation	Parallel or phased	Agreement	Type of contract	Contractor
Scope A	Energievoorziening	Vertical	Parallel	Agreement A	Framework agreement	Contractor A
Scope B	AWZI	Vertical	Parallel	Agreement B	UAC-IC	Contractor B
Scope C	AWTL	Vertical	Parallel	Agreement C	UAC-IC	Contractor C
Scope D	AWTG	Vertical	Parallel	Agreement D	UAC-IC	Contractor D

Figure 15: AWS Zwanenburg scope (made by author)

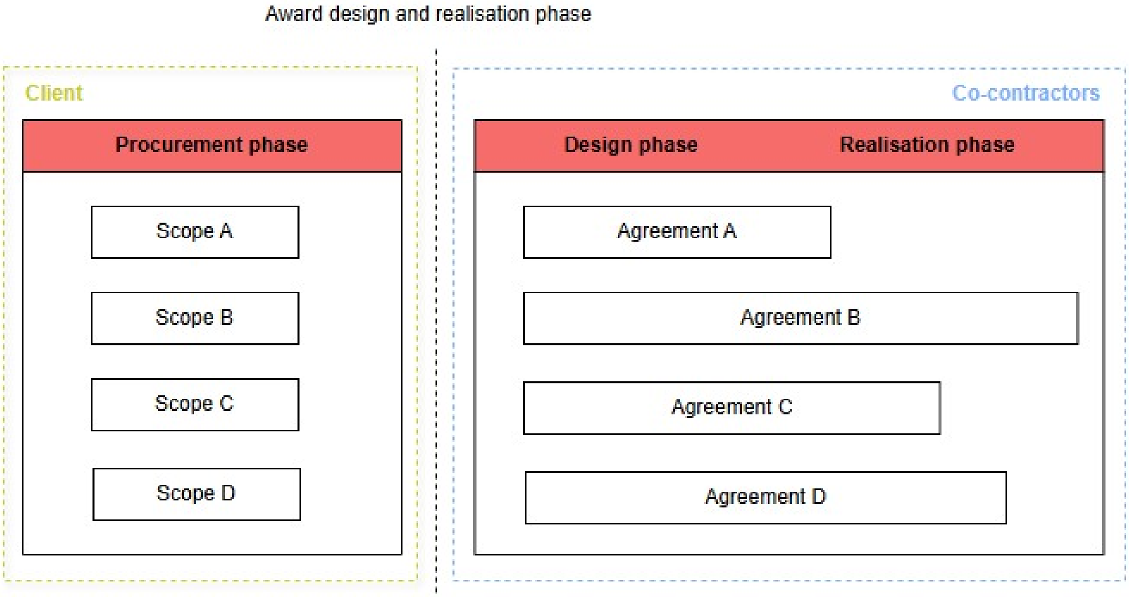

Figure 16: AWS Zwanenburg contracts (made by author)

Horizontal and vertical segmentation

AWS Zwanenburg combined vertical segmentation to match work with contractor expertise and reduce complexity. The project was split into four vertical scopes: civil engineering, mechanical works, electrical works, and energy supply.

The segmentation allowed the client to involve several SMEs. One large integrated contract would have excluded them. Additionally, this allowed Rijnland to retain more control and tailor contracts to the capabilities of the market.

Rijnland also conducted a market analysis to assess the availability of suitable contractors per segment. The research showed a healthy number of contractors for mechanical work such as pumping installations, while only a few had sufficient capacity and expertise for the renovation of the AWZI. This finding strongly influenced the segmentation approach, as it allowed Rijnland to better match work packages to the capabilities of available contractors, supporting broader market access and better execution outcomes.

The segmentation was successful due to early interface planning. Geographical coordination points, such as pipe sleeves in concrete and connection nodes between electrical and civil work, were documented clearly. The energy supply, seen as high-risk due to net congestion, was handled directly by Rijnland.

Parallel segmentation

The project initially followed a parallel approach for both design and execution. From the start of the procurement phase, the three design segments progressed in parallel, with simultaneous efforts across disciplines.

This approach was necessary due to the significant delays in initiating the renovation. The existing infrastructure had reached the end of its lifecycle, and further postponement was no longer viable. Once the decision was made to renovate, there was no room for a phased planning. Time constraints demanded rapid progress on all three segments. Working in parallel allowed the project to save time and ensure that the updated system could become operational as quickly as possible. Moreover, as a capital investment, early activation of assets was financially advantageous, by enabling immediate returns through usage.

Despite the intent for parallel development, delays occurred during the design phase. Each segment encountered its own issues, which led to temporary differences in progress and gave the impression of a phased approach. However, by the start of execution, these differences were resolved, and all three contractors began construction at the same time.

During execution, timelines again diverged. The differences in duration were largely due to the nature and complexity of each contractor's scope. For example, the work on the AWZI expansion took considerably longer than the installation of the pumping stations. As Interviewees E7 and E8 pointed out, this was expected and reflected in the planning: "The contractors were deliberately assigned different intermediate milestones based on the anticipated duration of their work." Contractor B, responsible for the main treatment facility, required more time for construction, whereas Contractor D, working on the pumping stations, had a shorter and more straightforward task. Contractor C's pipeline work was more linear and progressed at its own pace. These staggered timelines helped spread the coordination load and avoided bottlenecks, although they did demand careful management to ensure that all systems could be integrated at the final stage. To manage this, the client had arranged that the contractor who carries out the initial works must provide the exact coordinates of the pipeline to the subsequent contractor. This ensures that all parties have clarity about the situation and helps prevent one contractor from interfering with another's work or encountering unexpected issues during the handover. Ultimately, all contractors reconvened for the final system integration, testing, and handover, to ensure that the full system was operational as one cohesive unit.

The execution remained largely parallel. While certain technical sequences required phasing, such as completing concrete works before installing equipment, the preparations for these activities like cable planning and component positioning began earlier. Especially at external pumping stations, disciplines worked in a confined space simultaneously, which demanded strict scheduling and coordination. This blend of phased and parallel execution had clear advantages and some challenges. Working in parallel reduced the total project duration and encouraged early identification of interface issues. However, it also introduced coordination risks. Segments designed and implemented by different contractors could suffer from misalignment if not properly managed.

To address this, the team adopted a system-of-systems perspective. Inspired by ICT practices, a system architecture was created, outlining how all technical components like pumping stations, pipelines, treatment plant, and energy supply needed to function together. Beyond design, system integration was actively monitored during execution. Oversight ensured that connections between civil and mechanical components were accurate, electrical systems met requirements, and timing across segments was aligned. This required specific coordination roles and expertise to manage.

From a responsibility perspective, the segmented yet parallel execution meant that each contractor retained full responsibility for its design and delivery. However, they also had to engage more actively in joint coordination, especially at shared interfaces. The client, therefore, played a stronger role in managing integration and ensuring compatibility across all segments.

Project delivery method

The client made a deliberate choice to apply the UAC-IC contract form across all segments of the project. This contractual strategy was already established in the early planning phase and shaped the subsequent tendering and delivery approach. To streamline implementation and coordination, all three contracts followed the same contract type. This uniformity simplified management and supported consistent contractual expectations across contractors and client.

The primary motivation for choosing UAC-IC was the clients aim to retain strategic control over the project while assigning engineering and execution responsibilities to market parties. Definitive designs were initially developed by an engineering consultant commissioned by Rijnland. These designs served as the basis for the contracts with the contractors, after which contractors were selected to further elaborate the technical design and execute the work. According to interviewee E8, the contract form supported the need for both speed and clarity during the project. As the components had reached the end of their technical lifespan, delays were no longer acceptable. Furthermore, financial drivers were also present: operationalizing the new assets earlier would allow Rijnland to capitalize them on the balance sheet sooner.

Despite its benefits, the implementation of UAC-IC came with significant challenges. Some contractors were unfamiliar with the design-based contract management principles of UAC-IC and required additional support to fulfill their contractual responsibilities. For example as interviewee E7 elaborated, ”The contractor responsible for pipeline works encountered difficulties in meeting the administrative and procedural requirements of the contract. Although execution on site proceeded smoothly, the contractor lacked experience with UAC-IC's compliance procedures and quality assurance documentation.” Rijnland was compelled to provide intensive guidance and even contributed to parts of the contractual deliverables, which placed an unexpected administrative burden on the client organization.

From Rijnland's side, the transition to a more hands-off role also proved difficult. As a public client with long-standing experience under traditional UAC contracts, the organization struggled to fully adapt to UAC-IC principles, which assign more autonomy and responsibility to the contractor. In several instances, Rijnland stepped in to assist with interface management or offered unsolicited design input, thereby blurring the intended division of responsibilities. Although these interventions helped ensure quality and reduce execution risks, they also undermined the principle of transferring responsibility to the market.

This dynamic was particularly visible in the pipeline contract. While UAC-IC formally provides the contractor with design freedom, many parameters such as the route, technical specifications, and connection points, were already fixed in the tender documentation due to external constraints like land ownership and permits. As a result, the actual room for contractor-led design innovation was limited. In hindsight, a more traditional UAC contract could have sufficed for such standardized, low-complexity work.

In addition interviewee E8 added, ”Using different contract forms within a single project, such as a traditional UAC contract for one part and a UAC-IC for another does not inherently lead to complications. As long as interfaces are clearly defined, the approach can work effectively. If all involved contractors know the exact coordinates for connections, the design parameters at each interface, and their specific responsibilities, then the design and execution can generally proceed without major issues."

Under UAC-IC, the segmentation itself worked well from a coordination perspective. Rijnland ensured that interfaces were clearly defined between segments and that transfer of information between contracts was precisely managed.

Design and execution responsibilities

During the design phase, each contractor had full responsibility for its own design. Civil design focused on concrete and structural works, mechanical design included pumps and pipelines, and electrical design encompassed cabling and automation systems. The energy supply component was managed directly by the client due to the high risk and uncertainty related to grid connection in a congested area. This proactive move prevented delays and misalignment between packages.

The segmentation itself worked well from a coordination perspective. Rijnland ensured that interfaces were clearly defined between segments and that transfer of information between contracts was precisely managed. Each interface was explicitly defined in the contracts. For example, when pipeline works transitioned from one contractor to another, exact coordinates and interface conditions had to be handed over. This ensured that subsequent contractors had a clear starting point and reduced surprises. For example, when one contractor completed a section of pipeline, the exact coordinates of connection points were documented and communicated to the next contractor. This prevented misalignment and avoided conflicts at handover points. Although this increased the coordination burden on Rijnland, it also enhanced execution speed and provided clarity and autonomy to each contractor. When interface issues arose that were not clearly defined in either contract, the client stepped in to mediate. In some cases, joint sessions led to reallocation of tasks or temporary workaround solutions.

To manage interfaces, joint coordination sessions were organized during the design phase. Coordination drawings and joint planning exercises helped define physical and functional interfaces. For example, the civil contractor had to ensure that embedded parts and penetrations aligned with mechanical and electrical inputs. Close cooperation was needed in confined areas like pumping stations, where multiple disciplines worked together.

This responsibility model generally worked well, but it relied heavily on proactive client involvement. As E7 noted, "We chose not to package everything under one large contract. That gave us more control and allowed smaller firms to participate, but it also meant we had to do more coordination ourselves." This highlights the trade-off between segmentation and integration: segmentation allows specialization and market access but increases the coordination burden on the client.

Role of coordination and contracts

The coordination role was assigned to the contractor responsible for the overarching component of the works, the AWZI. This contractor was selected because their scope included the most interfaces with other contractors.

To formalize collaboration, a coordination agreement was established. Within this agreement, a specific Collaboration Plan was included, detailing the working arrangements, division of responsibilities, meeting structures, the client's role, and escalation procedures. The agreement served as an additional layer to the individual contracts of each contractor.

- **Function and relation to other documents**
  The coordination agreement supplements the individual contracts. The collaboration plan is included as an appendix to this coordination agreement. The division of roles, responsibili-

ties, and tasks between parties is documented in their individual contracts, the coordination agreement, and each party's project management plan.

- **Effectiveness of the agreement**
  Both the coordination agreement and the collaboration plan explicitly state their objective, which is to define how and why successful collaboration must be achieved throughout the project.

- **Coordination and role division**
  The agreement designates a single contractor as responsible for coordinating the project. This role includes aligning activities, schedules, data, drawings, and tools, as well as ensuring timely availability of these items. Coordination tasks are further specified as organizing meetings, maintaining up-to-date schedules, safeguarding information flows, managing interfaces, BIM, testing and handover procedures, as well as risks and change management. The responsibility for environmental coordination was separately assigned to another contractor.

- **Changes and escalation**
  The agreement includes a detailed escalation model describing when and how parties must escalate unresolved issues internally and, if necessary, to the client. In case of non-compliance or lack of effort, the coordinator or any contractor may inform the client, who then takes appropriate action. The collaboration plan defines escalation not as failure, but as a constructive mechanism to ensure progress. Disagreement is not unusual, but when it leads to stagnation or personal conflict, escalation is necessary to restore decision-making and momentum.

- **Collaboration**
  The collaboration plan outlines agreements on cooperation, internal division of tasks, meeting frequency, the client's role, and escalation procedures. It is divided into two main parts: interaction and realization. Interaction is built around five soft principles: basic attitude, open communication, mutual respect and empathy, shared responsibility, and initiative-taking with flexibility. Each principle is defined and elaborated with concrete behavioural expectations. The realisation section describes the expected outcomes of collaboration. Additionally, four distinct meeting types were defined: coordination, technical, BOT (commissioning), and environmental. For each, the required frequency, roles, and the coordinating contractor were specified.

- **Phasing of design and execution**
  No explicit information provided in this version.

- **Design and interfaces**
  A detailed interface matrix was added as an appendix. For each interface, it lists which contractors are involved, whether the interface is integrated, and — if so — which other contractors and interfaces are affected. It also defines how monitoring and corrective actions should occur. For example, when one contractor completes the first phase, they must record and communicate the exact pipeline coordinates to the next contractor. This clarity prevents overlaps or surprises during handovers and ensures continuity in execution.

- **Planning and delays**
  An integrated schedule was referenced in the agreement, covering the timeline for design, preparation, execution, and commissioning. If a contractor experiences delays, they are required to inform all other parties and the client immediately. The coordinator must then organize a meeting within eight days of notification. Meetings are recorded, and all parties jointly define how to avoid or mitigate delays without altering milestones, delivery dates, or contract

sums. If the issue remains unresolved, the coordinator escalates the matter to the client with a formal bottleneck analysis and proposal for resolution.

- **Communication and information sharing**
  Each party uses its own document management system. However, all parties actively collaborate on interface management and share relevant documents with each other. The coordinator provides a SharePoint platform to facilitate digital exchange of current documents, which helps manage interfaces and supports mutual learning. In the role per contractor is the use of BIM mentioned. A separate tool is used for environmental management to provide integral visibility and control.

- **Incentives**
  No incentives or penalties were included in the coordination agreement.

This is worked out in the following Figure 17 on the best effort versus result obligations, which has been constructed by the author based on an interpretation of the interview findings. This is based on an analysis of the case studies and contractual documentation.

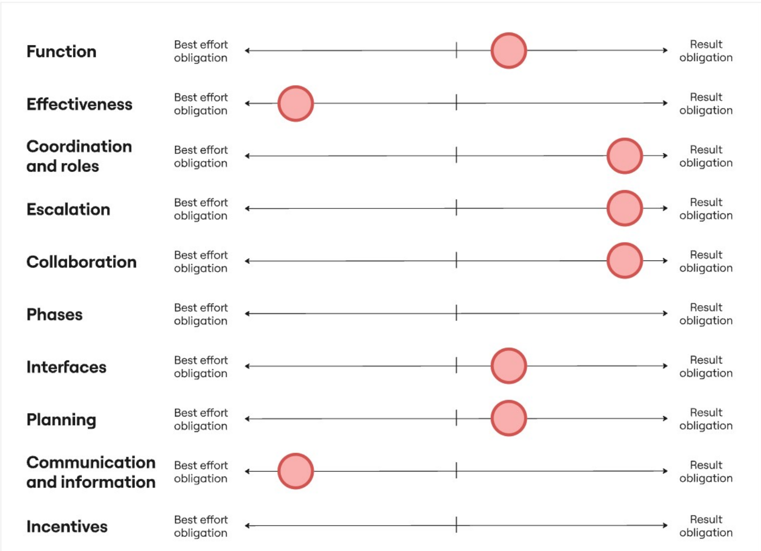

Figure 17: Obligations contract Zwanenburg (made by author)

4.4 Amsterdam Central Station

ProRail has initiated an extensive renovation of the historic Amsterdam Central Station to accommodate the growing number of passengers and improve rail capacity. The number of daily passengers is expected to increase from 200.000 to approximately 275.000. To create the necessary space, several major interventions are planned: additional access points to the platforms will be constructed, the East Tunnel will be widened, and the platforms themselves will be both widened and extended.

In addition, a new bicycle parking facility with space for nearly 8,500 bicycles will be constructed beneath the eastern tracks. The project also includes the renovation of all eastern access bridges and the construction of a grade-separated crossing near the Dijksgracht.

Construction work in and around Amsterdam Central Station began in 2021 and is expected to continue for approximately ten years, with completion anticipated around 2030 (“Amsterdam Centraal ”, 2024).

Horizontal and vertical segmentation

The renovation of Amsterdam Central Station represents one of the most segmented projects ProRail has undertaken in recent decades, as interviewee E10 mentioned. Due to the project's complexity, its extended duration, and the requirement to maintain full operational continuity throughout the works, segmentation was both a necessity and a strategic choice. The segmentation was implemented in two dimensions: vertical segmentation based on technical disciplines and horizontal segmentation based on geographical and logistical considerations. The contracts are referred to as the ”C-contracts” (e.g., C4, C7) The most important contracts are Dijksgracht (C2), railway infrastructure (C5), civil works (C9), Westknoop (C10) and station building (C11) and are visualised in Figure 18.

Vertically, the project was divided into three main technical domains: railway infrastructure, civil works, and the station building. This division reflected the highly specialized nature of each component. Railway infrastructure such as signalling, overhead lines, tracks, and ballast were bundled into a dedicated contract (C5), as these required certified contractors with unique technical capabilities. Similarly, the station building (C11) and civil works, including bridge replacements (C9), were assigned to separate contracts due to their distinct engineering and architectural demands. By separating these scopes, ProRail aimed to engage the most competent market players for each task and reduce the need for subcontracting, which can introduce quality and coordination risks.

In addition to vertical segmentation, horizontal segmentation was deliberately applied to specific areas of the project at the Dijksgracht (C2) and Westknoop (C10) zones. These segments were geographically isolated to facilitate safe and efficient construction in a highly congested and operational station environment. The Dijksgracht section involved the construction of a new grade-separated railway crossing, requiring substantial concrete work and heavy equipment. As E10 explained, “the Westknoop zone was designed to free up space for passenger flows at the western entrance of the station, creating room for other construction activities later in the project.” By isolating these areas, contractors were able to operate more independently.

Scope	Description	Type of segmentation	Parallel or phased	Agreement	Type of contract	Contractor
Scope A	C2 Dijksgracht	Horizontal	Phased	Agreement A	UAC-IC	Contractor A
Scope B	C5 Spoorinfra	Vertical	Parallel	Agreement B	UAC-IC	Contractor B
Scope C	C9 Civiele werken	Vertical	Parallel	Agreement C	UAC-IC	Contractor B
Scope D	C10 Westknoop	Horizontal	Phased	Agreement D	UAC-IC	Contractor C
Scope E	C11 Station	Vertical	Parallel	Agreement E	UAC-IC	Contractor A

Figure 18: Amsterdam Central Station scope (made by author)

Parallel and phased segmentation

The project combined both phased and parallel segmentation to manage complexity, maintain operational continuity, and optimise construction logistics. ProRails main idea was to pursue parallelism wherever possible to reduce the overall project duration. Phased segmentation was only applied when certain parts of the project were independent and could be executed earlier without interfering with other works.

The first instances of phasing occurred in two geographically and technically distinct zones: Dijksgracht and Westknoop. Both areas were relatively independent from the rest of the project in terms of interfaces and access. Since Dijksgracht required heavy concrete work and had limited dependencies, it was advanced early in the programme. Completing this section early would provide additional construction space and avoid later disruptions to the renovation of the station itself. Similarly, Westknoop was separated into an earlier phase.

While these two contracts were phased to deconflict construction stages, the core elements of the project of the railway infrastructure (C5), civil works (C9), and station redevelopment (C11), were executed in parallel. This was particularly evident during the design phase. Due to the high degree of interdependence between these components, it was essential that design activities progressed simultaneously. Shared design interfaces, such as bridge alignments, platform layouts, and mechanical, electrical, and plumbing systems, required real-time coordination and alignment. Sequential design would have significantly extended the timeline and created rework risks.

During the execution phase, these same contracts proceeded concurrently. At various points in the project, three different contractors worked on the same site: one focusing on the station building, one on track systems, and one on surrounding civil infrastructure. This introduced substantial coordination challenges, especially where physical overlaps and logistical routes intersected.

To manage this, the project team introduced careful daily phasing within parallel construction. Although multiple contractors operated in the same physical zone, their work was staggered in time. Construction logistics were explicitly planned to avoid overlap in access routes, equipment staging areas, and worker zones. By decoupling their daily operations, ProRail avoided unsafe working conditions and reduced the likelihood of planning conflicts.

This parallel yet phased approach allowed the project to maintain pace while still preserving safety, clarity, and control. As interviewee E9 noted, "We had three contractors on site at the same time, working in overlapping zones. That brings challenges on site, but it also makes the project manageable in time. You just have to carefully think through who is working where and when."

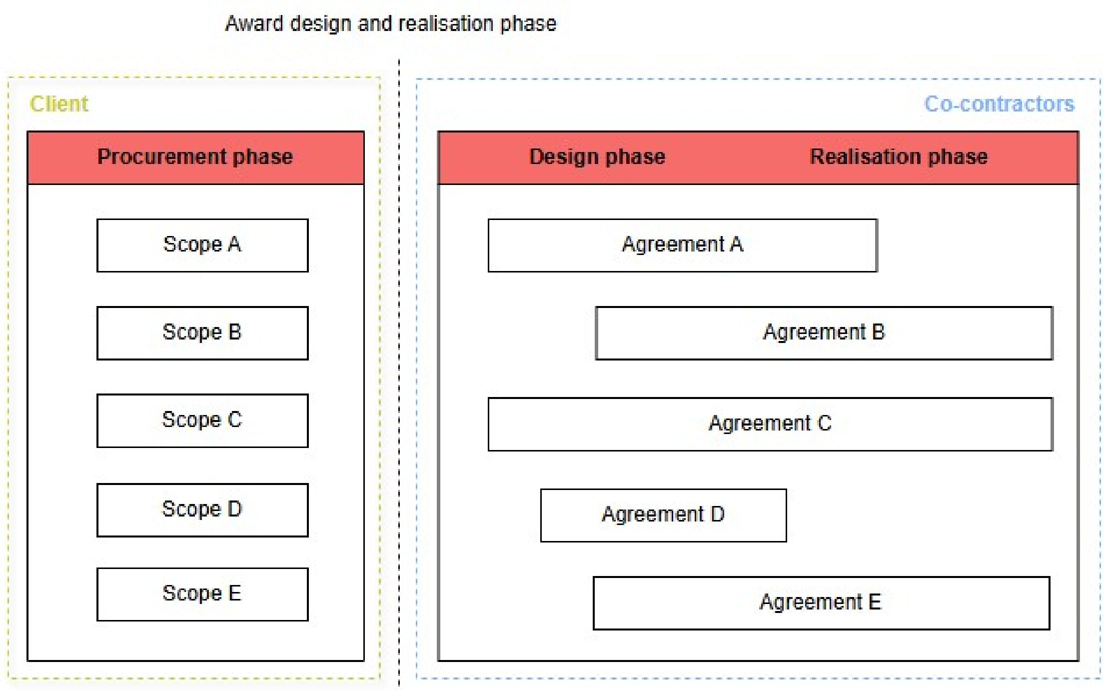

Figure 19: Amsterdam CS contracts (made by author)

Project delivery method

ProRail has extensive experience with integrated contracts and deliberately applied the UAC-IC form to all major contracts in this project. Each of the three main contracts was awarded to a different contractor, each specialized in their domain.

The choice for integrated contracting was closely tied to the segmented project approach. As interviewee E10 mentioned, "Due to the parallel and vertical segmentation, there are naturally many interfaces physically, as well as in terms of planning and logistics. Multiple contractors are working in the same location during the same period. This requires careful consideration of who is working where at any given time. Contractors are often better positioned to assess this than the client. For that reason, the choice was made to use integrated contracting."

However, ProRail did choose to phase daily execution activities to prevent overlap in the same physical location, ensuring that construction logistics remained manageable.

In terms of design responsibility, ProRail typically develops the design internally up to the Definitive Design (DO) level, in collaboration with an engineering consultant. This approach allows ProRail to maintain strong control over project requirements, systems integration, and compliance. Design coordination is actively steered through Systems Engineering and formal verification checkpoints. Once the DO is finalized, it is handed over to the contractor, who is then responsible for developing the final construction-ready design (UO/TO) and executing the works.

This approach offers ProRail a high degree of control over technical specifications and project direction but comes with trade-offs. For instance, in the case of the railway infrastructure, ProRail retained design responsibility during the early stages and continued designing even as execution had begun on the other parts. As interviewee E9 noted, "in this way we remain at the helm, but can't always see far ahead. This led to challenges in maintaining overall coherence as design and execution overlapped."

The use of integrated contracts allowed ProRail to transfer part of the coordination effort to the market, particularly in the context of complex and parallel project execution. Yet it also required clear definition of interfaces, strong client oversight, and continuous planning to avoid clashes and delays.

Design and execution responsibilities

The segmentation of the project led to a dense network of interfaces, both during the design and execution phases. The railway, station, and civil engineering contractors often operated in the same physical area, but each within their own scope of work. This made interface management a critical aspect of project delivery. As interviewee E9 put it, "If you make a cut, you must also make a joint. That means agreements, documents, and responsibilities. If you don't arrange that properly, you'll run into problems during execution."

To manage the segmented contracts internal, ProRail appointed a construction manager for each segment. These managers worked closely with their respective contractors and oversaw the execution of their specific scopes. In parallel, a project control manager was responsible for overseeing integrated aspects such as risks, planning, and finances across all segments. However, during the initial execution works, no overarching role was assigned specifically to coordinate interfaces between the contracts. This led to a lack of overview in how the different designs and works interacted.

Design responsibilities formally lay with the contractors under the UAC-IC contract form. However, in practice, ProRail retained significant influence over the design process. Most designs were developed internally by ProRail and its engineering consultants up to the Detailed Design (DO) level, after which they were handed over to contractors for further detailing and realization. This allowed

ProRail to maintain control over technical content and sequencing but also introduced ambiguity in role division. As one stakeholder noted, “We design some segments ourselves as the client. That doesn’t always work well. We also have a design coordination meeting to define who does what at the interfaces, but that hasn’t yet delivered what we need. We’re still figuring that out.”

To clarify expectations, ProRail embedded design obligations into so-called milestone booklets that accompanied the contracts. These booklets specified not only the required level of design completion, but also how and in what sequence certain works were to be executed. For example, the sequencing of bridge construction from left to right was explicitly mandated to avoid conflicts later in the process. A notable coordination failure occurred when railway cables were not accounted for in the platform design. The design suggested that no work was needed in the area, but the station contractor had to demolish the platform, exposing the cables. Since no contractor had been assigned to handle them, the issue fell through the cracks. This highlighted how even small oversights in coordination could cause major issues on site.

Due to the insufficient focus on coordination between segments, ProRail decided to appoint a coordinating construction manager. This role was created to provide an view across all contracts and to actively monitor and align interfaces between contractors, especially during execution. Initially, this manager also had responsibilities within one of the segments, but this dual role proved ineffective. The coordinating construction manager was therefore made independent of the segment teams, enabling better focus on cross-contract alignment. While final decisions remained with ProRail, they were informed by this coordinating layer, based on input and escalation from the worksites.

The digital tool BIM was intended to support coordination, but the usage of BIM varied significantly between contracts. The station contractor worked fully in BIM, while the railway infrastructure contractor relied on traditional methods. These differences complicated the alignment of design information and hindered interface management. As one construction manager noted, “BIM could help, but its use still differs across contracts.”

Successful coordination required more than just contractual clauses. It depended on proactive interface management, ongoing consultation, and a clear understanding of responsibilities across design and execution. The project’s complexity made this particularly challenging, and as the experience showed, strong coordination mechanisms were essential to bridge the gaps between segmented scopes.

Role of coordination and contracts

Although ProRail coordinated the design phase centrally, no formal multilateral coordination agreement was established between all contractors. Instead, contractual tools were employed to manage interdependencies. Interface documents were appended to each contract, clarifying mutual expectations such as sequencing, prerequisite deliverables, and handover conditions. In addition, milestone booklets and phasing overviews were developed. These visually outlined the order and timing of tasks per contract, highlighting interdependencies. For example, the booklet detailed the order in which bridge segments were to be built, explicitly from left to right, to avoid spatial conflicts. These booklets, while simple in form, became essential during execution when pressure on collaboration increased. They provided a shared reference when responsibilities became unclear or when sequencing risks emerged.

During execution, one contractor assumed a more proactive coordinating role, mainly due to the number and criticality of their interfaces. This contractor took the lead in initiating interface discussions, aligning worksite planning, and holding others accountable for their commitments. Still, ProRail maintained a central oversight role. As interviewee E9 stated, “They [the contractor] had the overview and the boots on the ground, but if it didn’t work out, we [ProRail] had to step in.”

However, when contractors failed to reach consensus or when issues risked stagnating progress, escalation was required. In such cases, the issue was brought to ProRail, who retained an overarching steering role. Depending on the nature of the problem (technical, planning, or procedural) different escalation pathways existed, but ultimately the client had the authority to resolve deadlocks.

At the project level, various coordination meetings were held to manage interfaces across segments. These included the Coordinating Technical Meeting, the Construction Management Meeting, and the Project Control Meeting. Attendees included technical leads, construction managers, environmental coordinators, and project controllers from all major contracts. Above these meetings sat the Project Management Team, consisting of the project managers of the three main contracts. This forum was responsible for making ”best-for-project” decisions by prioritising the interests of the overall programme over those of individual contracts.

In addition to formal meetings and contract documents, informal coordination also played a key role. When a contractor initiated bilateral discussions with other contractors, this often helped clarify discrepancies in interfaces. By jointly reviewing interface documents and asking questions like “What do you see?” and “What do I see?”, misalignments were surfaced early and could be resolved before they escalated. These conversations were typically brought back to the formal coordination meetings with ProRail’s involvement.

This is worked out in the following Figure 20 on the best effort versus result obligations, which has been constructed by the author based on an interpretation of the interview findings. This is based on an analysis of the case studies and contractual documentation.

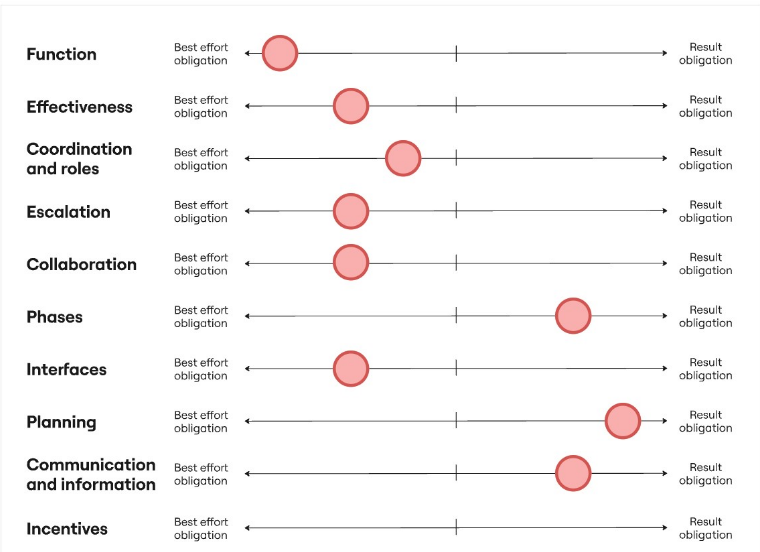

Figure 20: Obligations contract Amsterdam Central Station (made by author)

A key lesson was that coordination tools such as interface documents or milestone booklets, only proved effective when actively used and embraced by the project team. As interviewee E9 noted, “Having a document is not enough. It has to live in the project.”

No financial incentives were included in the contracts to promote coordination or joint outcomes.

5 Legal expert interviews

This chapter presents the results of the interviews with legal professionals regarding the role and structure of a coordination agreement in the context of segmented contracting. The aim of these interviews was to explore the respondents' general views on current market dynamics, inter-organisational relations, and the practical challenges of coordination in multi-contractor settings.

The findings focus on how a coordination agreement should be structured to facilitate effective collaboration and interface management between segments. This includes which legal and procedural elements should be added or clarified in order to improve coordination outcomes.

In this thesis three legal professionals with extensive experience in construction contracting and public infrastructure were interviewed. Table 5 provides an overview of the respondents involved in the legal expert interviews. For each interviewee, their professional role is listed, as well as whether their primary experience lies in advising public clients or contractors.

Table 5: Interview respondents legal experts

Interview number	Position	Client or contractors side
F1	Lawyer specialized in construction and public procurement law	Contractor
F2	Lawyer specialized in construction and public procurement law	Client
F3	Lawyer specialized in construction and public procurement law	Client

Based on the themes identified in the literature review, a series of interview questions was developed. These can be found in Appendix D. The questions focused on key aspects of coordination, collaboration, planning, interface management, responsibilities, and communication within segmented contracting. The following sections present the results of the legal expert interviews, structured according to these thematic areas.

5.1 Function and relation to other documents

All three interviewees independently emphasized that a coordination agreement should not be confused with the individual contracts signed between the client and each contractor. Interviewee F3 explained that the coordination agreement functioned more as a framework over the separate agreements, defining the practical rules of engagement between the parties. This includes procedures for communication, the obligation to share information, timing requirements, and the handling of changes that affect other contractors' work. According to F3, "It acts like a shell over the individual contracts, outlining how coordination and collaboration should be managed in practice."

Interviewee F2 highlighted that the setup of coordination had a direct impact on pricing and organizational structure. He noted that when contractors are informed early that coordination is required in the project, they adjust their bids, staffing, and working methods accordingly. This shows that the contractual approach to coordination could influence practical project preparation.

Regarding the timing of coordination agreements, all interviewees separately stressed the importance of arranging these agreements before the start of the project. Interviewee F1 pointed out that problems often arise when coordination is arranged after the project has started. F1 stated, "Everything you want to regulate, you must arrange beforehand. Once the project starts, it's too late. Then it becomes a political issue, not a contractual one."

Interviewee F2 added that coordination agreements were often overlooked during contract formation. In many cases, the agreements were either missing or added too late, when the project structure was already established. F2 believed this leads to coordination challenges because the project is not originally designed to accommodate such agreements. Also these agreements are often excluded from early contract discussions. In many tenders, they are missing or not meaningfully developed.

Additionally, F2 mentioned the difficulty in making coordination a contractual deliverable. While a coordination plan might be submitted, its effectiveness would depend on how well the involved parties worked together. The behavior of parties plays a larger role than the formal delivery of a plan.

F1 emphasized that a coordination agreement should primarily clarify expectations between parties, especially from the client's perspective. F1 argued that the agreement should not dictate actions but rather document what has already been agreed upon, serving as a tool for expectation management.

5.2 Effectiveness of agreement

The interviewees shared separate and differing views on the effectiveness of coordination agreements.

F1 focused on human behavior as the key factor. According to F1, successful coordination does not depend solely on contracts or formal arrangements but on the willingness of parties to collaborate. He stated that a coordination agreement is "a toothless tiger", it contains no enforceable obligations between contractors. Since only the client has formal authority over all parties, conflicts between contractors must always be handled through the client. Coordination contracts, according to F1, should primarily serve to allocate risks and responsibilities.

F2 offered a different perspective, pointing out that the legal strength of a coordination agreement could vary. Sometimes it is a binding contract, while other times it was merely a declaration of intent. F2 emphasized that effectiveness depends on how well the client organizes the coordination process. If the client is passive, the agreement has little impact. In contrast, when the client defines responsibilities and actively manages coordination, the agreement could function effectively.

F2 also mentioned that in many tenders, these agreements are missing or not meaningfully developed. F2 believed this limites their usefulness. Meaningful dialogue during tendering about coordination needs is essential for creating effective agreements.

F3 emphasized that coordination requires more than just technical alignment. It must include clear agreements about the consequences of changes and, above all, who holds responsibility when adjustments arise from collaboration between contractors. According to F3, it does not work to let contractors resolve such issues among themselves. A neutral party must be in place to make decisions when needed. Questions of time and money, which are central to most construction disputes, cannot be resolved between contractors alone, since they do not control the project's budget.

Therefore, the client must actively manage this process, take ownership of risk allocation, and intervene when coordination issue s arise. The client should not only act as a project owner, but also as the director of the collaborative process. This includes identifying issues early, actively guiding communication and coordination, and ensuring that risks are fairly distributed. The client must establish a clear structure in which responsibilities and risks are logically divided and must remain available to intervene when necessary. It cannot be expected that individual contractors manage risks arising from outside their own scope, such as changes in another party's design or unclear system integration. As he mentions "the client must take responsibility for such issues; not only legally, but also morally and practically".

They all pointed to the critical importance of how coordination is organized and managed, particularly by the client.

5.3 Design and execution phasing

Intervierwees F1 and F3 both highlighted the increased risks associated with parallel execution. F1 highlighted that parallel execution creates significant interface risks. He explained that these risks can be mitigated legally by ensuring a high level of design completion beforehand. Historically, government agencies like Rijkswaterstaat acted as engineering organizations, and used to develop highly detailed, sometimes overengineered designs. This allowed contractors to work with fewer uncertainties. However, with the shift to integrated contracts, much of this in-house knowledge has disappeared. The respondent noted that a lack of early coordination leads contractors to accept risks they do not fully understand, often resulting in unrealistic offers or underestimated tasks. He emphasized that thorough preparation and risk distribution are key when parallel execution is involved. F3 emphasized the heightened risk of friction in parallel execution, as contractors must rely on each other simultaneously without always having aligned timelines or scopes. He argued that these risks could be minimized by clear planning and defining expectations in advance. As he put it, "cooperation must be contractually mandatory rather than a non-binding intention." He contrasted this with phased execution, which offers more room to learn from earlier stages, resolve issues, and implement improvements in subsequent phases.

F3 described the design phase as the critical window for integrating system designs across different parties. He emphasized that paper-based integration must occur early to ensure technical alignment. This process requires structured review procedures, timely sharing of draft designs, and central oversight by a coordinating body. He highlighted that design changes are most cost-effective at this stage, reinforcing the importance of early coordination. He also emphasized that true coordination starts during the design phase, where different systems must be aligned on paper before construction begins. To support this, contracts should include explicit terms for communication, deadlines, and mechanisms for resolving disagreements. Escalation models are particularly important, giving the client final authority if consensus cannot be reached. Without such arrangements, F3 noted, coordination often remains vague and ineffective, resulting in delays and interface issues during execution. F1 supported this by pointing out that comprehensive design development before execution used to reduce uncertainties and improve coordination effectiveness. F2, in turn, connected design phase coordination with contract models. In traditional contracts, consultants work for the client and design coordination occurs before execution, with the client (or the supervising engineer) playing a key role. Delays often stem from late information delivery. F2 observed that coordination in these settings is rarely documented formally, as there's no overarching agreement between the client and all consultants. In contrast in the execution phase, in Bouwteam contracts, early contractor involvement can result in the contractor coordinating client-appointed consultants. Who leads coordination can differ; sometimes it is the contractor, other times the client takes that role. In integrated contracts, the contractor manages all subcontracted advisors, and formal coordination agreements with the client are typically absent.

In contrast, the execution phase requires different coordination: physical logistics, site access, and schedule management. According to F3, contracts must reflect these differences explicitly. He often sees agreements that fail to distinguish between design and execution coordination, which leads to misunderstandings, inefficiencies, and claims. He advised that contracts must specify coordination responsibilities for each phase, designate a lead party, and allocate resources accordingly. As he mentioned, ”only with such clarity can the client guide the process effectively from start to finish”.

5.4 Coordination

The interviews revealed a shared understanding that coordination must be clearly structured, with roles, responsibilities, and processes explicitly defined in the contract. However, the respondents differed in their views on who should hold the coordination role and how responsibilities should be allocated.

F1 argued that when the project is divided among several contractors, the client must decide whether to retain coordination responsibilities or delegate them to one of the contractors. He warned that obligations only work when they relate to something a contractor can realistically influence. He emphasized that, in cases where no contractual agreement exists between contractors, any coordination is likely to remain a best-effort obligation rather than a result obligation.

Interviewees F2 and F3 highlighted the importance of specifying coordination responsibilities in more detail. F2 explained that coordination duties often shift from the design phase to the execution phase, for example from the main structural contractor to other parties like installers as their activities become more prominent in that phase. When this shift is not reflected in the contract, it leads to confusion about accountability. F2 recommended that coordination obligations be carefully modelled from the outset, defining who coordinates whom, what information is shared, when it is shared, and how it impacts scheduling. He stressed the importance of assigning clear roles, such as identifying who must raise alarms if issues arise, and how those alerts should be communicated. F2 also warned that appointing a coordinator without a mandate reduces their role to merely scheduling and flagging issues, which is insufficient to resolve conflicts. Therefore, it should be contractually defined what a coordinator is allowed to decide independently, what must be reported to the client, and how the coordinator is supported in that role. He suggested giving the coordinator the authority to adjust work sequences if necessary for progress, within predefined limits. For instance, allowing a shift of up to two days without approval of the client, with anything beyond that requiring client consent. He emphasized that the coordinator must not only operate between parties but also have access to the information and powers needed to act effectively, which should be secured both in the contract and in the project’s governance structure.

F3 added that coordination is often too loosely defined in contracts. General statements like ”Contractor A is the coordinator” or ”Parties shall coordinate their activities” lack operational clarity. He pointed out that such vague formulations leave room for conflicting interpretations, leading to misunderstandings, frustration, and ultimately delays, budget overruns, or disputes. Therefore, clients must take the time to clearly define what coordination means in the context of their specific project. This includes specifying what responsibilities coordination entails, what information must be shared, at what moments, through which channels, and how that information affects planning. Furthermore, contracts should describe the procedures to follow when coordination results in changes to work packages or schedules, and designate who will evaluate and approve these changes. F3 advocated for escalation models that allow the client to act as the final decision-maker in case of disagreement. He concluded that only by explicitly defining coordination can it function as an effective contractual tool for managing collaboration, evaluating performance, and avoiding conflict.

There was also divergence on who should take the lead. F1 stated that clients often assign the coordination role to the main building contractor, as they are expected to oversee the full scope and align with other parties. However, he cautioned that this approach can break down when roles are not clearly defined: one contractor might question whether a task falls within their responsibility, while another cannot proceed until that task is resolved, resulting in a coordination issue that transcends any single party's scope. F2 observed that the lead coordinator role could shift depending on the project phase and that this fluidity must be contractually addressed to prevent disputes.

F3 emphasized the difference between basic logistical coordination and what he called ”real coordination.” While the basic logistical coordination involves simple scheduling (e.g., who is on-site when), real coordination requires mutual understanding and adjustment of designs to prevent conflicts between work packages. This level of coordination should be formally required, and not left to informal cooperation.

All three respondents agreed that the client plays a crucial role, even when not acting as coordinator. F1 and F3 highlighted that only the client has a contractual relationship with all contractors and can therefore mediate or enforce decisions. F2 underlined that if the client chooses to delegate coordination, it should still define how responsibilities are distributed and establish control mechanisms. As the client, you must manage based on accurate information, which means explicitly requesting the necessary data. This requirement should be clearly defined in the coordination agreement. The information must then be incorporated into an updated project schedule by the coordinating contractor.

Finally, F3 stressed that coordination should not be treated as a generic clause in a contract. It must be project-specific, with defined outputs and measurable obligations. Otherwise, coordination remains an ambiguous term that can lead to delays, disputes, and inefficiencies. Each respondent, in their own way, emphasized the need for clients to take an active and structured approach in defining, assigning, and managing coordination throughout the project lifecycle.

5.5 Collaboration and conflict resolution

The interviewees highlighted that clients must take the lead in shaping how collaboration is expected to function throughout the project. F3 noted that the client should assume a clear leadership role in managing cooperation and cannot remain on the sidelines when tensions arise between parties. To support this, collaboration expectations should be made explicit in the contract. All three interviewees agreed that detailed annexes or appendices to the coordination agreement are crucial. These documents should describe in concrete terms what is expected from contractors in terms of collaboration: how they are to cooperate, communicate, and resolve issues. The more specific these provisions are, the easier it becomes for the client to guide contractor behavior, verify compliance, and resolve disputes when cooperation breaks down.

F3 warned that vague or generic terms such as “collaboration” tend to lose meaning without such detail, making them ineffective as governance tools. What must be avoided at all costs is allowing conflicts to linger unresolved. When no party is empowered to make decisions, disagreements can simmer beneath the surface, gradually escalating into serious disruptions. This is particularly problematic in projects with parallel execution, where the interdependence between contractors means that delays by one party have immediate and often significant consequences for the progress of others. In such cases, even minor coordination issues can quickly escalate into critical path delays affecting the overall project timeline. To mitigate this, F3 argued that the client must be granted the authority to make binding decisions when coordination stalls. Whether temporary or permanent, these decisions enable the project to move forward while more complex financial or legal matters are addressed in parallel.

F2 added that these expectations can also be clarified during the tender process. Clients can ask contractors to submit a proposal on how they intend to approach collaboration during the project. This encourages early thinking about cooperative behavior and provides a benchmark for later evaluation.

However, even with well-defined expectations, disagreements are sometimes unavoidable. When collaboration breaks down, all interviewees underlined the value of a well-designed escalation model. F3 explained that such a model should define the chain of escalation clearly: who takes the lead at each level, which roles are involved, and within what timeframe action must be taken. Initial resolution attempts should occur between the involved parties themselves, with the client informed early. If unresolved, the issue should escalate to higher levels, often involving the client directly. F3 noted that the client typically serves as the final decision-maker and must have and take the authority to intervene decisively when needed. He argued that preserving project progress must take priority: technical problems should be solved quickly, while financial or legal resolution can follow later. Delays are often the most costly outcome in large infrastructure projects.

F1 supported this view, pointing to international examples such as Dispute Adjudication Boards (DABs), which involve neutral experts embedded in the project. These professionals can offer early guidance or binding rulings before issues escalate. Although such models are less common in the Netherlands due to perceived cost, F1 argued that their preventive value outweighs the expense.

F2 focused on the legal side of conflict resolution. He emphasized that the coordination agreement must clearly state how to handle delays, claims, and risk allocation. Without this clarity, disputes become subject to interpretation, which is risky and inefficient. It not only improves project management but strengthens the legal position of the client in the project and even in the event of conflict. As he noted, “We have been involved in lawsuits where it was indeed possible to successfully hold the contractor accountable for poor coordination.” Clearly defined collaborative duties make contractor behavior assessable both in daily operations and, if necessary, in court.

5.6 Planning and delays

The interviewees all emphasized that collaborative planning is essential in every construction project. F1 noted that such planning is generally in place, but highlighted that its effectiveness hinges on communication. According to him, coordination meetings should serve as moments of reflection to evaluate the feasibility of the planning, identify which contractors are falling behind, and assess what that means for the rest of the project. Discrepancies in interpretation or unforeseen obstacles must be surfaced during these discussions. Issues such as whether a delay could have been anticipated, whether sufficient warning was given, and who bears the cost of resulting disruptions often form the core of disputes. F1 explained that expectations and financial implications drive these conflicts.

F2 similarly stressed the importance of communication in managing planning and delays, particularly due to the dependencies contractors have on subcontractors and suppliers. If those parties fail to deliver required inputs on time, delays are unavoidable. To support this, F2 recommended the use of layered planning structures. At the top level, an overarching master schedule should be developed in coordination with the client. Beneath that, increasingly detailed plans should be developed, such as six-week rolling schedules. These short-term plans should be updated regularly (weekly, biweekly, or every three weeks) and coordinated between all involved contractors. These additional layers help teams manage their workloads in more detail and react to changes before they escalate into major issues. F2 observed that these planning layers are often missing just before the execution phase, precisely when they are most needed.

F2 also emphasized the use of milestones in planning. These serve various purposes: some milestones help track progress and verify whether contractors are staying on schedule, while others serve to coordinate activities with external stakeholders, such as utility companies. For example, in a recent urban project, a milestone ensured that a construction pit would be available for use by a utility provider; if missed, the consequences would have been significant, potentially incurring large penalties. According to F2, milestones should be tailored to the dependencies between contractors. If one contractor's work is highly dependent on the progress of another, it is advisable to make the use of milestones explicit. Furthermore, the contract must clearly define the function of each milestone, whether it applies uniformly to all parties or only to specific roles, to avoid misinterpretation and ensure enforceability.

Lastly, F2 distinguished between public and private clients in how they deal with delays. Public sector clients, managing taxpayer funds, may accept delays more readily, prioritizing long-term delivery over strict enforcement. In contrast, private investors often have immediate financial stakes, such as rental income or operational revenue, and are thus less flexible. Regardless of the type of client, all respondents agreed that escalation mechanisms related to delay and planning issues must be embedded in the coordination agreement to facilitate timely and coordinated interventions.

5.7 Integration and interfaces

Effective integration in construction projects begins with a clear understanding of how the various system components connect and contribute to the overall functionality of the final structure. F3 argued that it is not sufficient to define technical performance criteria only for individual parts; integration requires that all parts function as a whole system. This calls for alignment not just in terms of interfaces or physical connection, but in meeting overarching functional requirements, such as safety, accessibility, or technical interoperability. According to F3, by explicitly stating these higher-level system goals in the contract, derived from the program of requirements (PvE), clients provide a shared structure within which coordination and interface management must occur. As F3 mentioned, "Coordination is about connecting those interface parts, and it starts with a shared understanding of the common goal." If certain performance demands still need to be refined during the project, particularly where multiple disciplines overlap, these must be identified early as unresolved interface items and contractually acknowledged as such. Transparency at this stage prevents downstream confusion about evolving requirements.

To make this process effective, risks around interfaces must be openly discussed and deliberately allocated. F1 emphasized that too often, interface risks are hidden in contracts, not known to the contractors. This creates false certainty and pushes issues downstream, where they become more difficult and expensive to resolve. He noted that if responsibilities are clearly assigned e.g., "you are responsible for making the connection", then the risk logically follows. However, the more vague the description, the higher the contingency contractors will price in. Instead, risks should be discussed early and openly, allowing shared understanding and acceptance to develop. According to F1, project teams need to surface and categorize major uncertainties, leading to ownership and preparedness rather than strategic avoidance. In addition, F3 recommended that contracts should explicitly distinguish between fixed and flexible elements of the program of requirements. When certain interface-related elements are still dependent on future decisions or third-party inputs, they should be flagged as provisional. This encourages proactive planning and prevents disputes later when such issues inevitably emerge.

F1 also highlighted the dangers of contractors acting in isolation when interface conditions are unclear. For example, if the structural contractor pours concrete without knowing where openings should be made due to lack of information from the installer, problems compound quickly. This underlines the importance of clear coordination rules, such as not proceeding with irreversible work until dependencies are resolved. Yet, F1 acknowledged the practical tension: contractors face real costs when crews stand idle. Without synchronized planning and communication, even well-written contracts cannot prevent friction.

The process of integration is further complicated by the reality that design development is rarely linear or perfectly sequenced. F2 explained that although clients often hope for a neat flow from conceptual (VO) to preliminary (DO) to execution-level (UO) design, the reality is that contractors depend on subcontractors and suppliers who engage at different times. This results in what he described as "sawtooth" progress: DOs and UOs are completed at varying moments in projects, disrupting coordination and delaying alignment on critical interfaces. To mitigate this, F2 strongly recommended ensuring that the designs at the most risk-sensitive interfaces are developed and coordinated simultaneously, and that this coordination is explicitly arranged in the project agreements and planning documents. This is particularly important where the performance of one contractor is directly dependent on accurate and timely input from another. Without such planning, the likelihood of errors and miscommunication increases significantly.

F2 also stressed that dependencies between parties shift over time. A contractor may want to begin work as soon as possible, especially when payment flows are tied to milestones. At the same time, the client may push for visible progress due to public or political pressures. These dynamics can undermine good design integration. F2 referred to these shifting dependencies as "subjective risks"—difficult to quantify, but heavily influenced by stakeholder behavior and interests. He warned that they are a major driver of interface failures as design of interfaces is pushed due to the pressure.

To manage these challenges, F3 argued that the client must act as the central authority when changes in one scope affect another. If one contractor's work is modified and impacts another's responsibilities, coordination cannot be left to informal bilateral negotiation. The client must intervene, communicate the implications, and arrange compensation where appropriate. F3 noted that fixed-sum contracts limit contractors' ability to absorb external changes, making client-led change management essential.

5.8 Communication and information sharing

Effective coordination depends heavily on structured communication and timely information sharing. Both F1 and F2 emphasized that establishing formal meeting structures is a key tool to support communicative and collaborative behaviour. Regular coordination meetings allow parties to review progress, raise concerns, and identify bottlenecks in the planning and the results.

To address this, both respondents stressed the importance of contractual obligations related to information delivery. F2 especially emphasized the need to make data-sharing requirements legally binding by including data provision schedules or data requirement schedules in the agreement. These schedules specify which design documents, drawings, or calculations are needed at which moments. When these timelines are contractually binding, a delay in information provision can lead to formal consequences such as claims for damages. Without such enforcement, delays at one point in the process often trigger a domino effect, causing a slowdown throughout the design chain.

Moreover, F2 advocated for placing particular emphasis on these obligations during the design phase, not only in the execution phase. Aligning critical design deliverables specifically on those interfaces through shared milestones is vital to ensure that interfaces between disciplines are resolved before construction begins. Such milestones allow for the early detection of inconsistencies and improve the integration of design packages. According to F2, this level of coordination is too often left informal, which undermines the integrity of the planning and increases the risk of cascading delays later in the project lifecycle.

5.9 Incentives

Penalties are commonly used and are typically embedded in standard conditions such as the UAC or UAC-IC. According to F1, these provisions are generally sufficient to enforce compliance with deadlines or specific deliverables, making it unnecessary to repeat them in coordination agreements. F2, however, warned that penalties may provoke strategic behavior by the contractor. Contractors might seek arguments or justifications for why the penalty should not apply, which can result in legal debate rather than improved collaboration. He advised limiting penalty clauses to the main construction agreement, rather than extending them to coordination agreement.

The interviewees held more divergent views on the use of bonuses. F1 saw potential in using financial incentives to stimulate cooperation, provided that they are agreed upon in advance. Een bonus later toevoegen kan wel, maar dan moet dit opnieuw contractueel worden vastgelegd. He referred to the North/South metro line project, where a joint risk fund was established, which covered unforeseen risks. If the risks were effectively managed, the unused portion of the fund was distributed among the parties according to a pre-agreed key. This created a shared interest in minimizing disruptions and cooperating efficiently. However, F1 emphasized that such mechanisms must be arranged at the start of the project; introducing them mid-course is rarely successful.

On the other hand, F2 noted that when bonuses are introduced early on, contractors may factor them into their bid pricing. If the bonus is later withheld, this can lead to disputes or even claims for damages. Moreover, he observed that public clients often avoid bonuses altogether due to budgetary constraints, political sensitivities, and concerns about losing control over financial commitments. As a result, he rarely advises clients to include bonuses in their contracting strategy. In his experience, a bonus may only be effective in case of delay, when acceleration is requested. In such instances, it functions as a mitigation tool rather than a motivational reward.

F3 shared an additional view on the use of bonuses. He explained that incentives are especially effective in large and complex projects, where delays can be extremely costly and the stakes are high. In such cases, even a small bonus compared to the total project budget can have a significant impact, because it helps to prevent delays and encourages collaboration. For smaller projects with fewer risks and simpler interfaces, bonuses are often less relevant. He also noted that bonuses should be linked to the final outcome of the project, such as timely delivery and meeting the overall performance requirements. While coordination during the design phase is important, its success can only truly be assessed during execution, when all parts must fit together on site. Therefore, he advised against using bonuses for partial design milestones, and instead recommended focusing incentives on the final result.

To make incentives work in practice, F1 and F3 both mentioned a model they found effective: the shared risk fund. In a risk-sharing arrangement, a predefined sum is set aside at the beginning of the project to address potential setbacks during execution. This acts like a mutual insurance fund, and allows participants to resolve issues without immediate conflict over liability. Remaining funds are divided among the stakeholders, encouraging careful risk management. This gives everyone a reason to work efficiently and avoid extra costs, and it stimulates collaboration between contractors.

6 Results

This chapter presents the findings of the case studies and interviews, focusing on how segmentation choices and project delivery methods were applied in practice. The analysis is structured by segmentation types of horizontal vs. vertical and phased vs. parallel segmentation, and highlights how these choices affected design and execution responsibilities, coordination needs, and contractual arrangements. For each form of segmentation, practical examples are used to illustrate both the benefits and challenges that occurred during project implementation. In addition, this chapter examines how coordination was organised and which legal instruments were used to manage interface risks. Together, these insights form the empirical foundation for the conclusions and recommendations of this thesis.

6.1 Horizontal and parallel segmentation

Horizontal and parallel segmentation is particularly effective when the physical layout of the project allows for a clear spatial separation between segments and when the different parts are functionally independent. In such cases, contractors can carry out their activities in parallel without interfering with each other, which can significantly accelerate the execution phase. The Zwanenburg project offers a practical illustration of this strategy. Although not formally segmented as such, both E5 and E6 mentioned its technical division coincided almost entirely with geographical separation. This allowed each contractor to operate independently in its designated area, which led to high execution efficiency and minimal spatial overlap (E5, E6).

In terms of design responsibilities, horizontal and parallel segmentation can be advantageous when the technical complexity of each segment is relatively low or repetitive. When interface boundaries are limited and predefined, contractors can develop their designs independently, enabling concurrent progress and shortening the overall design phase. At Zwanenburg, for instance, the individual scopes of the contractors were sufficiently autonomous to allow for decentralized design development. As E5 explained, this facilitated a faster and more flexible design process. Only at the interfaces itself it is necessary that the contractors align their designs.

Similarly, execution responsibilities can be clearly divided in this segmentation form. Since the contractors are physically separated, they do not depend on temporary access to each other's work zones. This minimizes logistical interference, allowing for high productivity. According to E8, the geographical division of work at Zwanenburg meant that construction activities could proceed in parallel without causing mutual delays, making it an effective setup from a planning perspective.

Nevertheless, this segmentation model also introduces coordination challenges when there are less interfaces. Because contractors do not physically encounter one another during execution, they have few natural moments for collaboration. There is no single contractor with oversight over the whole project. This makes it less effective to delegate coordination responsibilities to one of the contractors. Interviewee F1 emphasized that in such cases, the client must take a central role in coordination to maintain oversight of dependencies. F2 added that when multiple contractors are working in isolation, information management becomes fragmented unless the client sets up clear protocols and tools for coordination. This must be worked out up front and not during the project.

Interface management is particularly critical in this form. While the spatial separation reduces direct overlap, shared systems or technical connections still require integration. This needs to be worked out at the beginning of the project together with all the contractors together. In Zwanenburg, some interfaces and especially those involving the design of connections between pipes and pumps were underestimated during early design stages, which later led to rework and execution mismatches (E7). Interviewee E8 noted that these dependencies often only become visible after contract award, at which point reactive solutions are needed that disrupt planning and increase costs.

Another key limitation lies in the lack of collaboration and conflict resolution mechanisms. Because contractors work in their own zones, issues at interfaces are often discovered late and addressed bilaterally rather than collectively. Interviewees F1 and E7 described how such situations led to tensions and inefficiencies, especially in the absence of shared design reviews. F3 warned that cooperation in these cases must be made contractually mandatory as informal coordination is rarely sufficient in parallel execution scenarios.

Communication and information sharing are also more fragmented in horizontally segmented projects. Without a central data environment, each contractor tends to develop their models and assumptions independently. At Zwanenburg, the inconsistent use of BIM across contracts led to clashes and mismatches during execution (E7). F2 stressed that data provision and the use of specific tools should be made a legal obligation in the contract, with clear timelines and content definitions, to prevent delays in the design chain.

Moreover, the design process may suffer from fragmentation. Without joint design reviews or integration sessions, contractors tend to optimize their own segments without accounting for adjacent parts. E2 warned that this often results in misaligned boundary conditions and causes problems at the execution stage. Even when segments are spatially separate, technical interfaces may require more integrated planning than initially assumed.

Finally, although parallel execution promises schedule advantages, these can quickly be undermined if planning is not well integrated. Unexpected interdependencies or delays in one segment can ripple through the rest of the project. As E7 described, disruptions in Zwanenburg's planning were caused by dependencies that had not been properly mapped beforehand. F2 recommended using layered planning methods by combining a master schedule with rolling short-term plans, to ensure that parallel activities remain aligned.

6.2 Horizontal and phased segmentation

Horizontal and phased segmentation can be a highly effective strategy when project components are physically separated and either have minimal technical interfaces or must be delivered in a specific sequence. This segmentation method works particularly well in geographically constrained areas, or where staging and construction logistics require space to be created before subsequent works can begin. At Amsterdam Central Station, this approach was applied to the Dijksgracht and Westknoop areas: two segments that were physically distant from other work zones and had virtually no interfaces with surrounding components. This geographical and technical independence allowed these packages to be isolated from the rest of the project and executed ahead of time. The early execution of Westknoop, in particular, was strategically planned to create physical space for subsequent construction activities and reduce on-site congestion later in the program. In such settings, both design and execution can be handled by a single contractor with little dependency on others, minimizing complexity and coordination needs.

This segmentation form is also appropriate when components must be delivered in a fixed sequence due to structural or functional dependencies. Schiphol's baggage basement exemplifies this: the basement (substructure) had to be completed before construction of the terminal (superstructure) could begin. In this case, phasing was not just practical, it was necessary. The sequential execution avoids overlapping activities on the same site, reducing safety risks and contractor interference. As noted by F3, phased execution allows more room to learn from earlier phases, resolve issues, and implement improvements in subsequent stages. This can be especially beneficial in complex technical environments where early insights can inform later solutions.

In the execution phase, phased segmentation can reduce coordination pressure. Since contractors do not operate on the same site simultaneously, coordination focuses more on milestone tracking and transfer points than on day-to-day interaction between contractors. As such, the demands on physical site coordination and conflict resolution are lower, provided that planning is well-structured and transitions are clear. However, as F3 emphasized, coordination requirements vary per phase and must be clearly defined in contracts. Execution coordination differs significantly from design coordination and requires tailored roles, responsibilities, and resource allocation for each phase.

Nonetheless, horizontal and phased segmentation also introduces significant challenges, particularly in the design phase. When parts of the project are developed at different speeds or levels of maturity, misalignment risks increase. This was evident in Schiphol's basement project, where the civil contractor had to proceed to near-technical design level (TO) while the terminal's baggage system design was still conceptual. As a result, the basement design was based on assumptions, leading to potential mismatches and rework later in the process. Ideally, the design of interdependent components, such as a basement and the structure above, should be developed in parallel or at least brought to a definitive (DO) or semi-technical level before execution begins (E5, E6). F2 emphasized this need, warning against assuming a linear design progression and advocating for simultaneous coordination of high-risk interfaces. He also highlighted the importance of formal agreements that explicitly define how such design interfaces will be handled.

From a planning perspective, phased segmentation brings both benefits and risks. On one hand, it enables milestone-based project control, which is especially useful when later work is dependent on timely delivery of earlier phases. This was the case at Amsterdam Central Station, where early completion of Westknoop was essential for enabling the rest of the renovation (E9, E10). As F2 noted, clearly defined and enforceable milestones are critical to ensure that such dependencies are effectively managed. On the other hand, if early phases suffer delays or design immaturity, subsequent phases may be forced to proceed based on incomplete or outdated information, compounding risks further down the line (E5, E6).

Communication and information sharing are essential for mitigating those risks. Relying solely on documentation is often insufficient; active knowledge transfer mechanisms must be in place to ensure continuity between phases. At Schiphol, insufficient design coordination between the basement and the terminal raised concerns about the future integration of systems.

6.3 Vertical and parallel segmentation

Vertical and parallel segmentation is particularly suitable for projects where components are functionally distinct and require specialized knowledge. In this form, work packages are split by system or discipline such as civil structures, technical installations, and finishing works, and are developed and executed in parallel. This segmentation offers strong benefits during the design phase, especially when the interfaces between systems are known and well-managed. The Uithoornlijn provides a good example: the project was divided into segments for civil infrastructure and technical systems such as detection and switch control. These packages were handled by different contractors, each selected for their domain-specific expertise and their familiarity with existing urban systems. In such configurations, contractors can coordinate directly and align their design efforts early on.

The effectiveness of this segmentation approach is strongest during the design phase. When co-contractors are procured early, as was done on the Uithoornlijn (E2, E3), they can begin their design work simultaneously and coordinate their interfaces in real time. This enables early detection of spatial or technical conflicts and avoids costly rework. For instance, detection elements designed by one contractor were directly integrated into the BIM model of the rail infrastructure, enabling fast and transparent feedback loops. A shared BIM platform is highly recommended in such parallel designs to maintain visibility and alignment across disciplines. As F1 and F3 note, integrated and timely design coordination reduces uncertainty and increases the effectiveness of downstream execution.

Vertical and parallel segmentation can also be advantageous when project timelines are tight. Since each contractor works on a different layer or system, the overall construction period can be reduced. This was observed at Zwanenburg, where civil, electrical, and mechanical works were executed in parallel to meet urgent deadlines. In theory, this concurrency makes the method time-efficient and reduces dependencies between contractors, as long as physical overlap is minimal. At Amsterdam Central Station, daily execution activities were carefully phased within this parallel strategy, illustrating that spatial sequencing can mitigate conflicts even under a parallel regime.

However, the benefits of vertical and parallel segmentation diminish significantly during the execution phase, particularly in projects with limited space or overlapping work zones. Physical interference becomes a major challenge when multiple contractors must work on the same structure concurrently. At Amsterdam Central Station, contractors occasionally needed to transport materials through each other's workspaces, leading to small delays and tensions. This illustrates the importance of detailed spatial planning and strong logistical coordination during execution. As F3 pointed out, execution requires different forms of coordination than design—focused on site access, schedule integration, and conflict resolution—and these must be explicitly defined in contracts.

Interface management is another critical concern in this segmentation form. Since technical systems often intersect in shared spaces—such as shafts, risers, or technical rooms—roles and responsibilities must be unambiguously assigned. At Schiphol, lack of clarity around core responsibilities led to inefficient execution and frequent clashes (E5). F1 warned of the dangers when contractors act in isolation without knowledge of interface requirements, citing the example of concrete being poured before installation needs were coordinated. To prevent such outcomes, contracts must go beyond general statements like "the contractor shall coordinate," and instead specify exact coordination duties, information exchanges, timelines, and escalation procedures (F3).

Design coordination is only effective when interfaces are known and agreed upon early. If significant scope changes or additional systems are introduced late—as occurred with the hall addition at Uithoornlijn or the baggage system delays at Schiphol—previous design alignments may become invalid. F2 described this as the "sawtooth" nature of real design progress, where different subcontractors become involved at different times. He emphasized the need to develop and coordinate high-risk interfaces simultaneously and to make these agreements explicit in planning and contract structures.

From a communication standpoint, the use of BIM is a major enabler during the design phase but is insufficient if not coupled with shared practices and synchronized models. At Schiphol, fragmented BIM environments caused overlaps and omissions because separate models did not align properly (F3). Weekly meetings alone proved ineffective when parties lacked the authority or willingness to act on interface issues (F2). Furthermore, the administrative burden on the client increases significantly in this segmentation model. Simultaneously managing multiple specialized contracts requires a high level of internal coordination and contract management discipline.

Planning in vertical and parallel segmentation is inherently complex due to high interdependency between disciplines. A delay in one contractor's schedule almost immediately affects the others. At Schiphol, delays in structural execution prevented technical installation work from proceeding, illustrating the domino effect that occurs when plans are not tightly aligned (E6). Without an integrated planning approach and a central authority to enforce sequencing, such delays quickly become systemic.

6.4 Vertical and phased segmentation

Vertical and phased segmentation can be highly effective in environments where different construction phases require distinct logistical or technical conditions. This segmentation form is particularly suited to complex projects such as stations and airports, where the structural base and the technical fit-out demand different planning and execution strategies. A key advantage is the ability to separate work packages such that they do not physically interfere. At Amsterdam Central Station, this phasing enabled technical installations to be executed in a clean and controlled environment, well after the structural works had been completed (E10). As a result, technical contractors could work without disruption, improving the quality of execution and reducing risks tied to concurrent operations.

Execution benefits significantly from this clear phasing. At Schiphol and the Uithoornlijn, civil contractors first completed foundation works before technical systems were installed. This reduced spatial congestion and ensured a safer working environment. At Uithoornlijn, for instance, each contractor was allocated a designated window of several months for execution, which was further specified six months in advance. This method provided clarity and flexibility, helping to avoid conflicts on site and allowing contractors to plan their resources accordingly.

When properly managed, vertical and phased segmentation can also support learning across project stages. As F3 observed, this strategy allows issues encountered in early segments to be resolved and improvements implemented in subsequent ones. This staged learning is particularly useful when similar technical systems recur across phases. Additionally, because contractors are not simultaneously active on site, the burden of coordination during execution is significantly reduced, especially in shared or constrained areas (E9, E10).

A major benefit of this segmentation form lies in its ability to provide clear division of responsibilities. Structural contractors focus exclusively on delivering a complete base structure, after which the technical teams take over. This sequential approach limits role ambiguity, provided that handovers are well defined and enforced. Milestones and handover protocols are essential in this regard. As E10 emphasized, sequencing and formal checkpoints help ensure that contractors understand their obligations and can prepare adequately.

However, the benefits of vertical and phased segmentation rely heavily on preparation during the design phase. Problems arise when early-phase designs fail to anticipate the needs of later systems. At Amsterdam Central Station, tolerances and routing information for technical systems were sometimes omitted from the structural design, leading to redesigns and coordination problems downstream (E9). A similar issue occurred at Schiphol, where the baggage basement had to be designed before the technical installation scope was fully known. This mismatch led to incomplete coordination and adjustment, particularly for penetrations and load-bearing structures, which in turn introduced uncertainty and rework (E5).

Coordination during design is therefore a critical success factor. F3 stressed that coordination in the design phase must be explicitly distinguished from execution-phase coordination in contracts. Design coordination should include early integration of high-risk interfaces, particularly where disciplines overlap vertically. At Uithoornlijn, the project scope was revised late to include a new hall. Although this change was known before the floor was poured, the hall's design had not yet been developed in sufficient detail. Because the execution of the floor could not be postponed, it was over-engineered to ensure that it could support any future hall design (E1). This solution, while necessary, was inefficient and costly, and illustrates the risks that arise when critical design information is unavailable at the time of execution due to phased coordination.

Another risk relates to interface design and planning dependencies. When interfaces are not aligned early, or are subject to changes mid-process, it becomes difficult for contractors in later phases to adapt. F2 noted that interface development rarely follows a linear trajectory. He emphasized that designs on risk-sensitive interfaces should be developed and coordinated simultaneously, even if broader phasing is desired. Without this, shifting dependencies driven by milestones or pressures for visible progress, can introduce ”subjective risks” and undermine integration.

From a planning perspective, vertical and phased segmentation offers both advantages and challenges. On one hand, buffers between phases can absorb delays and decouple risks between contractors. On the other, these buffers can extend total project duration if not carefully managed. Moreover, compressing timelines, especially in the structural phase, to protect follow-up activities can backfire if handovers are rushed or incomplete (E10). Therefore, the effectiveness of this segmentation depends on reliable planning, clear protocols, and a disciplined approach to milestone enforcement.

Collaboration between contractors is generally limited in this model, since each party enters the project at a different phase. This reduces the potential for real-time alignment and demands stronger leadership from the client to maintain project continuity. F1 and F2 both emphasized the importance of clear communication structures and detailed documentation to support this handover model. Without accurate as-built information, later contractors face delays or are forced to redesign systems already assumed resolved.

The four segmentation types discussed above are summarized in Table 6. For each segmentation type, the key advantages and disadvantages are listed, along with the most relevant implications for the design and execution phases. This overview highlights the most important characteristics that emerged from the case studies and interviews for each segmentation approach.

Table 6: Comparison of segmentation types

	Horizontal (geographical)	**Vertical (technical)**
Parallel	✓ High execution efficiency due to spatial separation, and low logistical interference between contractors ✗ Lack of natural coordination moments, and risk of fragmented information management *Design:* Decentralized design is possible when interfaces are limited and defined. *Execution:* High productivity due to minimal overlap, but coordination depends on upfront agreements and unexpected dependencies can disrupt planning.	✓ Technically easy to separate, efficient in early design and tight deadlines ✗ High dependency between systems increases planning pressure, late changes cause delay, and coordination burden is significant *Design:* Effective when contractors are procured early, allows real-time interface coordination, but needs integrated planning and early interface definition. *Execution:* Physical overlap causes interference, so strong site logistics and spatial planning are required as delays in one system affect others immediately.

Continued on next page

	Horizontal (geographical)	Vertical (technical)
Phased	✓ Suitable for spatially separate segments with limited interfaces, and allows early phases to create space for later works ✗ Weak knowledge transfer between phases *Design:* Misalignment risks due to asynchronous development, as later phases depend on assumptions from earlier phases. *Execution:* Learning from earlier phases could improve outcomes, but slow due to sequencing, and handover clarity is essential for smooth transitions.	✓ Clean separation between structure and systems, improves site safety and execution quality, and supports learning and adaptation between phases ✗ Late design changes can lead to rework, and poor handover causes risk *Design:* Must anticipate future system needs in early designs, especially on risk-sensitive interfaces. *Execution:* Handovers reduce overlap and site congestion.

6.5 Project delivery methods

The use of segmented project delivery methods across the studied cases reveals the crucial importance of clear design responsibility allocation, interface definition, and coordination mechanisms. Although all four projects employed some form of segmentation and integrated contracting, their implementation differed considerably, especially in terms of how design responsibilities were distributed and how early coordination was organized.

Traditional contracting

Although traditional contracting (UAC) was not formally applied in the projects studied, several segments within the Uithoornlijn project exhibited characteristics that closely resemble traditional delivery. In these cases, the client developed relatively simple or standardized designs, which were then executed by contractors without substantial redesign. Examples include smaller infrastructural works such as fencing, retaining walls, or prefabricated components, which were procured directly and incorporated into the integrated contractor's work scope without bespoke engineering. These cases illustrate that traditional contracting can be effective when the design is straightforward and the interfaces are limited or well-understood.

Interviewees also explicitly reflected on the suitability of traditional contracting for certain types of work. As interviewee E8 stated: "Using different contract forms within a single project, such as a traditional UAC contract for one part and a UAC-IC for another, does not inherently lead to complications. As long as interfaces are clearly defined, the approach can work effectively." This reflects the idea that contract strategy should be aligned with task complexity. In line with this, interviewee E7 emphasized that not all segments required the design flexibility provided by UAC-IC: "For the pipeline works, a traditional contract would have sufficed. It was a straightforward job that didn't need further design development."

These observations suggest that for low-complexity, highly standardized scopes of work such as utility relocations, simple concrete works, or supply-driven components, traditional contracting may offer a more efficient route. It reduces the coordination burden, accelerates procurement, and aligns well with suppliers' standard deliverables. Moreover, it limits the client's exposure to variability in contractor-led design interpretations.

A broader application of traditional contracting is also conceivable for entire projects. If the client retains full design responsibility and ensures that the complete and integrated design is ready before tendering, then traditional contracting can be used to procure all segments under separate UAC contracts. This approach maximizes control over interfaces, as all connections and alignments are pre-designed by the client. However, this model comes with significant trade-offs. First, it places a heavy workload on the client's engineering team, who must not only produce complete designs, but also ensure consistency, quality, and compatibility across all segments. Second, it concentrates design risk with the client. If any mismatches or coordination errors occur during execution, the responsibility for resolving them typically lies with the client.

Integrated contracting

In the cases of Uithoornlijn, AWS Zwanenburg, and Amsterdam Central Station, the UAC-IC contract form was applied consistently across all major work packages. This meant that contractors were contractually responsible for both design and execution. In theory, this approach allows the contractor to tailor the design to their construction methods and optimize the integration of systems. In practice, however, the division of responsibilities between client and contractor often remained ambiguous.

At Uithoornlijn, UAC-IC allowed contractors to begin parallel design processes based on system-specific responsibilities defined in system notes and interface documents. Interviewees E2 and E3 emphasized that early selection of co-contractors was key to enabling timely and integrated design. According to E2, ”The earlier you know who is involved, the better you can coordinate the overall design and let the contractors collaborate.” BIM was used effectively to integrate design models across segments. However, when scope changes occurred mid-design with the late addition of a hall, coordination issues emerged. The structural contractor placed the floor based on assumptions, resulting in overengineering due to unknown load requirements. This case illustrates that when segmentation and integrated contracting are combined, successful coordination hinges on timely scope definition and complete interface descriptions.

In the case of AWS Zwanenburg, Rijnland similarly applied UAC-IC across the project. Each contractor held design and execution responsibility for their respective segment. Interface clarity was achieved by explicitly defining connection coordinates and handover protocols in the contract. For example, the contractor completing one pipeline segment had to document and communicate the exact coordinates of the transition point to the next contractor. This segmentation enhanced clarity and speed, although it placed a high coordination burden on the client. As interviewee E7 explained, ”We chose not to package everything under one large contract. That gave us more control and allowed smaller firms to participate, but it also meant we had to do more coordination ourselves.”

At Amsterdam Central Station, ProRail developed the design internally up to the Definitive Design (DO) level before handing it over to the contractors. Although this gave ProRail significant control over the technical content, it also undermined the autonomy intended under UAC-IC. Contractors were responsible for detailing the design (UO/TO) and executing the work, but with limited flexibility to alter structural or system-wide design elements. This division blurred the boundary between design control and execution responsibility. As one ProRail stakeholder remarked, ”We design some segments ourselves as the client. That doesn't always work well.” Additionally, the early phases lacked an overarching interface coordinator, leading to misalignments such as missing cable allowances in platforms. This problem prompted ProRail to later install a coordinating construction manager across all segments to align execution and interface management.

The experiences across these cases suggest that when applying integrated contracting in segmented projects, the design must be developed up to a more advanced level than in traditional setups, particularly at interfaces. Interface zones require early elaboration and must be coordinated across all segments, even before detailed designs are finalized. In such setups, parallel design by all contractors is strongly recommended. This allows interfaces to be co-developed rather than retroactively adjusted. Delays or misalignment in one segment can otherwise cascade into others, as seen in Uithoornlijn and Amsterdam Central Station.

Collaborative contracting

The Schiphol project employed a collaborative ”Bouwteam 2.0” model for the civil basement, wherein the contractor, client, and designer collaborated during the design phase under a TNR contract. This team jointly advanced the design to a near-Technical Design (TO) level before transitioning into execution under a UAC-IC contract. This model offered clear benefits in terms of early contractor involvement and buildability input.

However, segmentation into civil and systems packages, managed by separate teams and contracts, led to significant challenges. The baggage handling system, still under development, lagged behind the civil works. The civil contractor had to proceed with structural works based on incomplete information from the baggage team. This mismatch in design maturity created uncertainty and necessitated workaround measures such as separate subcontracts and adapted RASCI matrices. Over twenty technical workshops were held to align both teams, but misalignment persisted due to reliance on preliminary block diagrams and indicative layouts. Interviewee E6 highlighted the issue: ”We can't keep waiting for the baggage system design to be final. That means we have to make choices.”

The Schiphol experience underlines that collaborative models like Bouwteam work best when scopes are stable and develop at the same pace. If scopes evolve unevenly, as happened here, then early coordination must be reinforced by contractual provisions and flexible governance. Parallel design can still work under segmentation, but only when all parties actively engage in joint planning and information sharing.

Mixed contracting strategies

Most cases demonstrate that combining different contract types within a single project is possible, provided that interfaces are clearly defined and coordination is well managed. Interviewee E8 argued, ”Using different contract forms within a single project does not inherently lead to complications. As long as interfaces are clearly defined, the approach can work effectively.”

However, design maturity and scope clarity are critical preconditions. When different contract types are combined, interface assumptions must be made explicit in all agreements. For example, in Rijnland's case, energy supply was managed directly by the client due to its risk profile. The remaining systems were segmented, but with strict interface protocols and detailed coordination drawings to ensure alignment. Where interfaces remained ambiguous, Rijnland stepped in to facilitate or mediate.

The role of the client in such setups is essential. Segmentation offers flexibility and specialization, but also shifts integration responsibilities upstream. Clients must either accept a more active role in coordination, or delegate integration to a lead contractor—and structure the contracts accordingly.

6.6 Role of coordination

Effective coordination is a critical component in segmented project delivery methods, especially when multiple contractors work simultaneously or sequentially within a shared physical and functional environment. Across all studied projects, the success of coordination strongly depended on how responsibilities were assigned, formalised, and managed throughout the project lifecycle.

A recurring insight across all projects and interviews is that coordination cannot be fully outsourced. Even when the coordination role is formally assigned to a contractor, the client remains the only party contractually connected to all actors and therefore retains a crucial steering function. This was clearly illustrated in the AWS Zwanenburg project, where Rijnland segmented the project across several contractors but soon realised that this approach required significant internal coordination effort. As interviewee E7 reflected, “We thought the contractors could handle it, but we quickly realised that the client needs to stay much more involved. It asks a lot from your own organisation.” Similarly, legal experts F1 and F3 underlined that the client must manage based on accurate information and retain control mechanisms, even if the execution of coordination is delegated. F3 emphasized that “only the client can act as the final decision-maker in case of disagreement.”

Another insight is that the coordination role must be clearly and functionally defined. Simply naming a coordinator is not enough; it must be clear what this role entails, what falls within its scope, and which tasks remain with the client. The Amsterdam Central Station project illustrates this risk. Although one contractor took an informal lead due to their central scope, unclear boundaries meant that the client often had to step in. As E9 noted, “They had the overview and the boots on the ground, but if it didn’t work out, we [ProRail] had to step in.” This shows that even when a contractor acts as coordinator, the client must remain closely involved to safeguard project-wide alignment when tasks are not clearly distributed.

Assigning the coordination role to a contractor can work well when that contractor holds a central and integrated position in the project. In the Uithoornlijn project, a single main contractor was formally appointed as coordinator for all co-contractors. This setup proved effective because it was supported by clear documentation (e.g. interface notes), technical meetings, and strong initial involvement by the client to support behavioural alignment. As E2 noted, “It really helps if one party has the lead, but you also need to make sure that person has the authority, time, and mandate to actually coordinate effectively.” Importantly, the contractor’s internal organisation also needed to align internally, as the different teams inside the contractor itself operated with different cultures and approaches.

However, coordination by a contractor becomes more difficult when work packages are highly segmented or when responsibilities shift over time. F2 warned that coordination duties often shift between phases, e.g. from civil works to installations, and that this must be reflected in contracts. Schiphol’s experience with the basement and baggage handling systems confirms this: although a formal cooperation agreement was used to align teams, design maturity was asynchronous. This forced the civil contractor to act on assumptions, leading to practical and contractual complexities. As E6 observed, “We really need each other for these interface discussions. But instead, we work with block plans and assumptions.”

Therefore, a further recommendation is to anticipate shifting coordination needs across project phases. This includes designing layered coordination structures, such as overarching agreements for high-level integration and specific instruments for operational alignment. ProRail applied such a layered structure through interface documents, milestone booklets, and separate project-level coordination meetings, including the Construction Management Meeting and the Coordinating Technical Meeting. Yet, as E9 stressed, “Having a document is not enough. It has to live in the project.” Formal structures only work when they are actively used, monitored, and supported by a shared project culture.

Another finding is that coordination tools are most effective when contractors themselves have incentives or mandates to cooperate. Interface notes, BIM, joint planning, and shared schedules can support coordination, but require commitment. Interviewees F2 and F3 emphasized that cooperation cannot be a non-binding intention but must be made contractually mandatory. In the Uithoornlijn, interface notes were signed by all parties, which increased accountability. At Schiphol, technical workshops and a shared, signed RASCI matrix were used to formalise alignment. These structures helped improve interface management despite organisational fragmentation.

6.7 Coordination agreement

The previous subsections outlined how different segmentation strategies, project delivery methods, and the coordination role should be structured and what considerations are essential in each case. As discussed in subsection 3.9, ten key elements should be addressed in a coordination agreement.

Based on lessons learned from the cases in **??** and expert insights from the interviews in section 5, this section presents a set of recommendations on the coordination agreement per element.

1. **Function and relation to other documents**
   The coordination agreement should be contractually positioned as an overarching document supplementing the individual contracts. It must explicitly state that it governs coordination across segmented packages, covering elements not addressed in bilateral contracts, such as interface alignment, communication protocols, and shared planning. Without this clarity, the agreement risks being viewed as non-binding. As F3 emphasized, “The coordination agreement acts like a shell over the individual contracts” and should therefore have clear legal status. In the Uithoornlijn project, the agreement was formally annexed to the overarching contract, giving it enforceability and visibility.

   Also the agreement should be arranged before the project begins. F1 warned: ”Once the project starts, it’s too late. Then it becomes a political issue, not a contractual one.”

   The document must also clarify its boundaries: what it governs and what it does not. As F1 warned, “It has to supplement them, not replace them.” For example, responsibilities related to design liability or cost remain within the bilateral contracts and should not be duplicated.

   And the agreement can also serve an internal alignment role. At Schiphol, it helped coordinate between internal project teams responsible for separate scopes, in addition to guiding external contractors (E5). A clear scope and legal positioning are thus essential to ensure the agreement supports both external coordination and internal governance.

2. **Roles and coordination**
   Coordination responsibilities must be defined in operational and unambiguous terms. As F3 emphasized, ”General statements like ‘Contractor A is the coordinator’ lack operational clarity and lead to conflicting interpretations.” To be effective, coordination should be described in concrete terms, covering:

   - What coordination entails (e.g., planning alignment, interface checks, information validation, mandate of the coordinator)
   - What it does not entail (e.g., safety management or final decision-making, unless explicitly delegated)
   - Who is responsible for coordination, and who are they coordinating
   - Who performs coordination during design and who during execution

- How coordination obligations interact with other contractual obligations (e.g., deadlines, design dependencies)

A clear definition serves multiple purposes. F2 noted that it helps the coordinating party understand exactly what is expected, while also allowing the client to monitor, manage, and enforce the coordination obligations. By defining the scope explicitly, deviations can be more easily identified and addressed. F2 emphasized that this is especially important when coordination breaks down: "If you don't define who does what and when, then nobody takes responsibility, and things fall through the cracks."

To avoid such failures, F2 stressed the importance of assigning a coordinator with a clearly defined mandate. If a coordinator is appointed but lacks decision-making power or access to key project information, their role becomes limited to scheduling and signalling, which is insufficient to resolve conflicts. Therefore, contracts should specify what the coordinator may decide independently, which decisions must be escalated, and how the coordinator is supported in their role. For example, F2 suggested that the coordinator be authorized to adjust work sequences and planning for progress purposes within predefined boundaries, such as shifting activities up to two days without prior approval, while anything beyond that requires client consent. This approach was applied in both the Zwanenburg and Uithoornlijn projects, where coordinators had limited authority to make minor changes autonomously, while the client was informed or consulted only for more substantial deviations.

Moreover, F2 emphasized that the coordinator must not only operate between parties but also have access to the information and contractual levers necessary to act effectively. This requires embedding the coordination role not only in the contract but also in the project's governance and decision-making structure.

The Amsterdam Central Station case illustrates the risk of vagueness. Although interface documents and milestone booklets were used, the lack of a formal multilateral agreement led to coordination ambiguities. As E9 explained, "They [the contractor] had the overview and the boots on the ground, but if it didn't work out, we [ProRail] had to step in." This example shows that coordination cannot rely on informal practices or assumptions—it must be precisely described and contractually embedded.

Finally, it is essential to specify what role the client plays in coordination. Even when the coordinating role is delegated, the agreement should state clearly what the client will and will not do. As F1 and F3 noted, only the client has contractual ties on bilateral level to all parties and may need to mediate or enforce alignment. When this role remains undefined, it becomes difficult to intervene effectively when problems arise.

3. **Communication and meeting structure**

   Define mandatory coordination meetings in terms of:

   - Frequency and level (strategic, tactical, operational)
   - Required participants or functional roles per level per contractor
   - Standard agenda points, such as interface status, delays, approvals
   - Obligations to document and share decisions

   As F2 emphasized, "Such structures must be binding to ensure information is shared predictably and early." This was confirmed in projects like Uithoornlijn and Schiphol, where regular technical meetings and joint workshops helped surface interface issues early and created a shared rhythm of coordination.

Interviewee F3 added that communication structures must be contractually enforceable: if meetings are missed or decisions ignored, the agreement should provide a basis to hold parties accountable. Similarly, E9 stressed that documents like milestone booklets only have value when actively used in discussions; coordination must live in the project, not just on paper.

A recurring lesson is that fixed meeting structures are essential not only for timely coordination, but also to create transparency, ensure mutual awareness, and enable escalation when needed.

4. **Interface management**

Interfaces between work packages must be defined in detail and operational terms to prevent ambiguities and conflicts during execution. Key elements to describe include:

- **Technical content and connection points:** Clearly identify the systems or components involved and the exact boundaries of each contractor's responsibility.
- **Responsible and contributing parties:** Specify per interface who holds final responsibility for the physical and functional integration. This includes describing in what way a contractor must connect to another system, and who supports or contributes to this task.
- **What documents or models define the interface:** Refer explicitly to interface documents, BIM models, system notes, or design drawings that describe each connection and how it should function. At Uithoornlijn, this was operationalized by including both subsystem-specific and overall system-level notes in the contract. These described how each contractor's subsystem had to connect to the central operational transport system and made the required integration a results obligation rather than a best-effort one.
- **Timeline and planning dependencies:** Indicate when interfaces are expected to be designed, verified, and delivered. Include any sequence logic or prerequisites for physical or functional integration (F2).

To ensure coordination obligations are enforceable, use an interface matrix or RASCI table as a contractual annex. This tool should:

- Enumerate all critical interfaces between contractors
- Identify per interface which parties are involved
- Assign clear responsibility (Responsible, Accountable) and support roles (Consulted, Informed)
- Describe how coordination at the interface should take place, including information exchange and alignment procedures
- Define escalation procedures, including when an issue should be escalated, by whom, and to which governance level

Such structuring was applied at AWS Zwanenburg and Schiphol, where matrix-based coordination overviews helped manage the many interdependencies between technical systems and construction elements. As interviewee F1 warned, "Hidden interface responsibilities lead to false certainty and later conflict." Ensuring explicit allocation and documentation reduces this risk and enhances contractor accountability.

Importantly, avoid assigning interface responsibilities or coordination duties to parties who do not have either contractual leverage or physical presence on site to manage the task effectively. Clarity in interface management is not only crucial for successful delivery but also enables clients to monitor and enforce coordination throughout the project.

5. **Planning and scheduling obligations**

   Require a multi-level planning structure that aligns both design and execution phases. This should include:

   - A shared master schedule that covers all contractors and identifies key interdependencies.
   - Short-term rolling schedules (e.g., six-week plans) to enable operational coordination on site.
   - Milestones that reflect physical and functional interfaces, not just internal progress points.
   - Procedures for updating, reviewing, validating and signing these plans collaboratively.

   Such layered planning structures were applied at AWS Zwanenburg and the Uithoornlijn project. At Uithoornlijn, coordination agreements embedded shared milestones and clarified time slots per contractor, improving predictability and reducing on-site conflicts. Contractors were informed early about general scheduling, with specific work zones allocated later, enabling phased but aligned execution.

   Interviewee F2 emphasized that, "Milestones should not be generic. They must reflect interface logic and be legally enforceable." Generic milestones risk being meaningless across contracts if they are not tied to interdependent deliverables. Instead, interface-related milestones such as the availability of connection points or access dates, should be explicitly included to ensure mutual alignment.

   Moreover, design-related milestones should be included as well. As F2 recommended, design milestones can serve as checkpoints to validate that contractors are developing their designs in parallel and in alignment, particularly at shared interfaces. This supports earlier detection of incompatibilities and is especially critical under segmented parallel delivery models. It also enables clients to monitor design maturity per interface, intervene when needed, and maintain control over the overall design integration process.

   Properly structured planning obligations not only support effective coordination but also help enforce accountability across contracts. They provide the basis for evaluating progress, initiating escalation when delays occur, and protecting the critical path of the overall project.

6. **Changes, escalation and decision-making**

   Change and escalation procedures must be clearly structured and hierarchically organized to prevent stagnation and ensure timely resolution of coordination issues. The agreement should specify:

   - What steps must be taken when an issue arises. Recommended is a model where involved contractors first jointly meet and attempt to propose a solution. This proposal can then be formally submitted to the client for review or approval.
   - Who initiates a change or delay notification, when a coordination meeting must be convened, and how quickly it must happen. For example, Uithoornlijn imposed a one-week timeframe for initiating coordination after delay signals.
   - Who escalates to whom, at what level, and within what timeframe. This should follow a tiered escalation model, including both coordination conflicts and delay or change notifications.
   - When and under what conditions the client intervenes as final decision-maker. Typically, this follows if contractors cannot reach consensus within a defined period (e.g., 5 to 10 working days).

- How re-planning due to changes or delays is validated, documented, and communicated across all segments and participants.
- What procedures apply if no resolution is found, such as escalation to a Dispute Avoidance Board, mediation, or other contractual conflict resolution mechanisms.

Interviewee F3 emphasized, “The client must remain the final arbiter of coordination decisions, especially under pressure.” This view was echoed across multiple projects. At AWS Zwanenburg, the agreement gave the coordinating contractor 8 days to resolve a delay or interface conflict; failure to do so triggered escalation to the client. This approach balanced contractor autonomy with overarching client control.

In Schiphol’s project, escalation was more embedded in collaborative workshops and shared sessions, yet final decision-making authority on integration remained with Schiphol. As E5 remarked, “We try to solve issues together, but the final say is with us. That’s the only way to keep progress.”

Combining change and escalation protocols into a unified structure ensures that deviations from plan, whether technical or procedural, are addressed swiftly and transparently. Without such mechanisms, even minor interface conflicts or misaligned schedules can escalate into major bottlenecks.

7. **Collaboration**

   Collaboration must be defined in concrete, assessable terms. Avoid generic clauses like “Parties shall collaborate,” as these offer no operational guidance and cannot be monitored or enforced. Instead, the agreement should specify:

   - Which behaviors are expected (e.g., open communication, early signalling of risks, constructive attitude during conflicts).
   - Which documents or models must be shared, reviewed, and mutually validated.
   - What process follows if collaboration breaks down (e.g., escalation, facilitated workshop).

   Effective collaboration starts with clear expectations. As F3 emphasized, “Collaboration only works when it’s made assessable. Use annexes to define what it looks like in practice.” At AWS Zwanenburg, parties co-developed a framework of five collaboration pillars, which were used in joint sessions to define and agree on behavioral expectations. These sessions helped to clarify mutual dependencies and foster a sense of shared responsibility.

8. **Design versus execution phase distinction**

   Clearly distinguish coordination obligations in:

   - The design phase: technical integration, document alignment, risk identification
   - The execution phase: logistics, work sequencing, physical interfaces

   F3 warned against conflating these phases in one clause. Contracts should assign specific roles and obligations per phase. Schiphol’s team made this shift explicit through different agreements in the design phase and the execution phase in their Bouwteam 2.0.

9. **Information obligations and deliverables**

   Information sharing must be contractually defined with clear expectations and enforceable deadlines. Specify what information must be exchanged, in what format, and when:

- Timing and format of design documents
- Shared models or drawings, including use of BIM environments by all parties
- Review and sign-off procedures to confirm mutual understanding

F2 recommended including a detailed data requirement schedule with binding deadlines and responsibilities. As he warned, "Delays in design inputs cascade quickly through dependent packages." Failure to deliver must be met with legal consequences, particularly in parallel design settings.

To improve transparency and coordination, BIM can be adopted as the standard data environment. By contractually mandating a shared BIM model, parties are required to upload, review, and validate design data in a uniform and traceable manner. This fosters early conflict detection and better interface integration. However, as seen in Amsterdam Centraal, inconsistent use of BIM between contractors hampers coordination efforts.

Sign-off procedures are equally crucial. In the Uithoornlijn project, interface documents and coordination drawings were reviewed and explicitly signed by all involved contractors. These documents served as formal records of agreement. As noted in the interviews, this was particularly useful during execution when disputes or confusion arose: project teams could refer back to the signed interface documents to clarify responsibilities. This practice ensured that design intent and division of work were preserved throughout execution.

10. **Incentives and penalties**

Incentives can serve as powerful instruments to stimulate cooperation, alignment, and performance across contracts. When well-designed, they create a shared interest in project-level success and reduce opportunistic behaviour. However, their effectiveness depends heavily on timing, contract structure, and the degree of control parties have over the incentivized outcomes.

In the Uithoornlijn project, a bonus was awarded to the contractor responsible for delivering a key component within the operational system. This was done to safeguard timely delivery of a critical interface. The example shows that targeted incentives can be useful, when focused on a specific interface.

The analysis revealed several key aspects that shape the effective implementation of incentives:

- In practice, standard penalties included in the general terms of UAC or UAC-IC were rarely supplemented with additional clauses. Interviewees noted that repeating such penalties was seen as unnecessary and risked creating redundancy.
- Bonus payments were typically linked to final outcomes that signalled shared success, such as overall system performance, timely commissioning, or the absence of interface-related delays. These outcomes were regarded as the most legitimate triggers for collective incentives.
- Different views were expressed on the timing of bonuses. Some interviewees emphasised the value of introducing bonuses during the project, as this allows the client to target coordination at specific moments and steer behaviour when challenges arise. Others underlined that bonuses defined at the start can also be effective, since they provide contractors with certainty and can reinforce common goals from the outset. In such cases, contractors may account for the bonus in their tender price as additional margin, whereas mid-project bonuses are perceived as genuine rewards on top of the contract sum.

- Linking bonuses to early milestones was considered problematic unless these were very clearly defined, objectively measurable, and fully within the contractor's sphere of control. Vaguely formulated targets were reported to increase the likelihood of disputes or unintended strategic behaviour.
- In several interviews, the idea of a shared risk or incentive fund was mentioned. Such a mechanism could allocate the financial consequences of unresolved interface issues or delays across contractors. However, for such a fund to function, clear and transparent rules for attribution, eligibility, and decision-making were seen as essential.

Interviewees offered mixed views on incentives. F1 and F3 saw clear benefits in risk-sharing mechanisms, particularly in complex projects with many contractors and interdependencies. F2, however, warned against such structures for public clients, citing transparency concerns and the difficulty of enforcement. As such, the use of incentives should be carefully weighed against administrative complexity and legal robustness. If chosen, their contractual structure must be unambiguous and enforceable.

6.8 Conclusion

This chapter has analysed segmented contracting in practice through four infrastructure projects and complementary interviews with legal experts. The case studies showed how segmentation choices influenced the division of design and execution responsibilities. Horizontal and vertical segmentation required the client to actively manage interfaces, while phased and parallel segmentation created challenges in aligning planning and information flows. The interviews with legal experts confirmed that such dependencies cannot be managed informally; coordination agreements are necessary and should clearly define tasks, escalation routes, and the mandate of the coordinator.

The analysis demonstrated that while segmentation provides flexibility and opportunities for efficiency, it also increases the risk of fragmentation if coordination is not properly organised. Examples from the projects showed delays due to insufficient alignment of parallel contracts and disputes about responsibilities at interfaces. This underlines that segmentation choices must always be accompanied by a tailored coordination agreement. These findings form the basis for the discussion, conclusion and recommendations in the next chapters.

7 Discussion

This chapter reflects on the main findings of the study and places them in the broader context of coordination challenges in segmented construction contracts. It synthesises the empirical results with expectations derived from the theoretical framework and prior literature, highlighting both anticipated and surprising insights. The chapter also discusses the practical relevance of the findings, their theoretical contribution, and the methodological limitations of the research.

7.1 Interpretation of key findings

A central insight from this study is that the success of segmented contracting hinges on a clearly structured coordination process, documented in detail in a dedicated coordination agreement. This confirms earlier research by Dortmundt (2024), who already emphasized that segmented delivery increases the organisational burden on a project. In line with this, Strang (2018) argued that coordination in segmented contracting requires explicit mechanisms to enable communication, planning, interface management, and decision-making. My findings build on these insights by demonstrating how such mechanisms can be made concrete, for example by defining interface responsibilities, establishing escalation protocols, and formalising collaborative behaviors.

Given this theoretical background, it was expected that specifying coordination roles and obligations in advance would be important. This expectation is confirmed by the cases and interviews. Coordination proves most effective when roles are operationalised in clear, detailed terms, allowing project teams to measure performance and intervene early when deviations occur. The Uithoornlijn project exemplified this by detailing not only the technical but also the procedural aspects of system interfaces, and requiring each contractor to explicitly connect their subsystem to a shared operational model.

One surprising finding was that, contrary to concerns raised in both literature and practice, interface responsibility can be effectively managed contractually, provided it is defined early and precisely. Interviewees stressed that assigning responsibility for connection to the overarching system (rather than just one's own scope) helps shift coordination from a best-effort duty to a result-oriented obligation. Moreover, this enables targeted design efforts in the early stages, where interface design and joint detailing can prevent future conflict. Thus, coordination is not just about communication and planning, but about setting shared expectations and concretely defining deliverables at critical touchpoints.

These findings reinforce the call from Strang (2018) to assign the coordination role to a capable party, equipped with clear mandates and obligations, and to facilitate early information exchange and collaboration. However, this research extends his insights by showing that such structuring is not only necessary but also practically achievable, provided the client takes an active and guiding role from the outset.

7.2 Limitations

This research provides detailed insights into the coordination challenges and contractual strategies used in segmented contracting, yet several limitations should be considered regarding the study's methodology and scope. These limitations concern the subjectivity inherent in qualitative methods, the reliability and validity of the findings, and the generalisability of the results to broader contexts.

7.2.1 Subjectivity of qualitative research

This study used a qualitative research design, which allows for rich, context-dependent insights into complex coordination dynamics and relations. However, such an approach also introduces a degree of subjectivity in the interpretation of data. The analysis was conducted without a formalised coding structure; instead, key insights were derived inductively from case-specific observations and interview content. This method was chosen to retain the specificity and nuance of each case. While this helped to uncover detailed linkages between segmentation forms and coordination outcomes, it inevitably introduced a risk of researcher bias in data interpretation and topic prioritisation.

Another factor that may have influenced the subjective quality of the data is the potential for misunderstanding or divergent interpretations of the term ”segmented contracting.” Although each interview began with a verbal clarification of the concept, including examples of segmentation in project phases and contractor responsibilities, it became apparent during several interviews that some respondents still held differing assumptions about what the term encompassed. This discrepancy may have steered their responses in unintended directions and led to answers that were not fully aligned with the study’s conceptual framework. While interviewers attempted to resolve confusion through real-time clarification and reiteration of definitions when necessary, the risk remains that some responses were shaped by alternative understandings of segmentation.

7.2.2 Reliability and validity of data collection

The empirical basis of this study consists of thirteen semi-structured interviews: ten project-specific interviews with twelve respondents, and three additional interviews with legal professionals. The selection of interviewees ensured a mix of project managers, contract managers, and legal experts, offering valuable perspectives from different organisational levels. Nonetheless, several factors limit the reliability and validity of the findings.

First, the case study of Schiphol was still in the design phase at the time of research. As a result, findings from this case reflect expectations and anticipated challenges during the execution phase rather than confirmed outcomes. Without access to execution phase data, it is difficult to evaluate how contractual and organisational design choices at the beginning of the project played out in practice in the later phases. This limits the robustness of conclusions drawn from this case, especially in terms of implementation.

Conversely, although the Uithoornlijn project was completed as recently as July 2024, the strategic decisions underlying the project were made much earlier. The contracts and coordination agreement were signed in 2019, and most key organisational and legal choices were formalised at that time. This means that nearly six years had passed since those decisions were taken. In two of the four interviews conducted for this case, respondents explicitly noted that this time gap made it difficult to recall certain processes or motivations. This may have affected the accuracy of their responses. However, the answers of these two respondents were largely consistent with those of the other two interviewees, suggesting that the overall reliability of the case data remained intact. Nevertheless, future research may benefit from selecting projects where the contractual and organisational decision-making is more recent, to ensure more accurate recollection and up-to-date insights.

Second, the legal expert interviews revealed clear differences in perspective based on client affiliation. The legal advisor representing contractors often focused on limiting liability and maintaining commercial advantage, whereas those advising public clients were more concerned with risk management and process integrity. These underlying incentives may have influenced their recommendations regarding coordination roles, risk allocation, and contractual clarity. While this contrast provided valuable insight into stakeholder interests, it also introduced a potential bias.

7.2.3 Generalisability of findings

This study included four infrastructure projects commissioned by four different (public) clients. The diversity of project ownership increases the representativeness of the findings and ensures that they are not overly tied to a single organisational culture. However, generalisability remains limited due to several factors.

It is important to note that the applicability of the recommendations depends strongly on the specific context of each project. Project characteristics such as size, scope, technical complexity, stakeholder environment, and market conditions vary greatly, which influences the feasibility and relevance of different segmentation strategies and coordination measures. As a result, the findings and recommendations in this research should not be seen as one-size-fits-all solutions, but rather as guiding principles that must be tailored to the unique requirements and constraints of each individual project.

Secondly, many of the coordination mechanisms identified in the projects were not codified in the contracts themselves but functioned as informal working agreements. This raises questions about the enforceability and legal status of such practices. Without formal documentation, it is difficult to assess whether these practices can be translated into repeatable contract clauses or are context-specific arrangements reliant on interpersonal trust and client leadership.

Additionally, the study only considered the perspective of public clients. While this was in line with the research objective, namely to improve the coordination role in project of public clients, it means that the findings do not account for contractor-side constraints and perceptions. There may be gaps between what clients propose and what contractors consider feasible or reasonable.

7.2.4 Analytical limitations

The chosen analytical approach did not use a formal coding framework to categorise and compare data across interviews. Instead, emphasis was placed on extracting project-specific mechanisms, outcomes, and implications. While this allowed for a detailed understanding of each case, it also limited the potential for high-level comparison and theory-building. A more systematic coding of interview content across all cases could enhance thematic consistency and allow for broader pattern recognition.

Furthermore, the current study adopted a purely qualitative approach. While this was suitable given the exploratory nature of the topic, future research could benefit from quantitative validation. For instance, surveys could be used to assess the perceived importance and effectiveness of different coordination measures across a larger sample of projects. Metrics such as perceived interface maturity, number of interface conflicts, or coordination effort hours could help quantify relationships and test hypotheses developed in this study.

7.2.5 Conceptual and terminological ambiguity

Finally, despite repeated efforts to clarify definitions, some concepts used in the study, particularly ”segmented contracting” was subject to multiple interpretations. This was not only evident in the interviews but also reflected in the broader literature and legal commentary. Inconsistent terminology complicates cross-case comparison and weakens the analytical precision of findings. Further conceptual clarification and standardisation within the field are necessary to improve both scholarly and practical discourse.

These limitations do not undermine the value of the study, but they do highlight important considerations for the interpretation and application of its findings. They also provide a roadmap for how future research can build upon and improve the current study design.

8 Conclusion

This research investigated how clients can adopt segmented contracting in complex infrastructure projects by selecting appropriate segmentation options and how coordination agreements should be structured to support these choices. The study addressed four subquestions, each contributing to a better understanding of segmentation strategies and their contractual implications.

Subquestion 1: What segmentation choices does a client have in segmented infrastructure projects, and which contract types best support these choices?

The literature study revealed that segmentation choices available to clients include horizontal segmentation (dividing work based on geographical areas) and vertical segmentation (dividing work based on technical disciplines), as well as phased and parallel execution (sequential versus simultaneous segment design and execution).

Four segmented project delivery methods were identified:

- **Traditional:** Each segment is contracted separately using a traditional contract (UAC), where the client retains responsibility for design. This method gives the client full control over design and coordination, allowing for step-by-step decision-making. However, it requires substantial internal capacity to manage interfaces, align schedules, and ensure technical consistency across contracts.
- **Integrated:** Segments are contracted using integrated contracts (UAC-IC), in which design and execution are combined within one contract per segment. This reduces the coordination burden for the client within a segment but increases complexity across interfaces between contractors.
- **Bouwteam:** In this method, the design is developed by the advisor, while the contractor is already involved during the design phase to give input on feasibility and constructability. After this phase, the contractor executes the works under either a traditional (UAC) or integrated (UAC-IC) contract. This approach allows for early alignment and risk mitigation but requires strong cooperation and trust between parties. It offers flexibility and quality in the design phase, but the transition to the execution contract can be complex and time-consuming.
- **Two-phase contracting:** Each segment is awarded through a two-phase contract, where the contractor first contributes to the design together with the client in a collaborative phase before the contractors execute the works. This encourages early contractor involvement and risk reduction but requires more preparation and careful alignment between phases and segments.

Furthermore, clients decide on the level and distribution of coordination responsibilities: whether assigned to one party, shared among contractors, or retained by the client.

The standard Dutch contracts UAC, UAC-IC, and TNR each offer varying levels of support for these segmentation choices. While these general conditions are widely used, they often lack provisions to facilitate coordination across segments. The lack of provisions is on the following topics: function and relation to other documents, effectiveness of the agreement, coordination and role division, escalation, collaboration and conflict management, phasing of design and execution, design and interfaces, planning and delays, communication and information sharing, and incentives.

Subquestion 2: How do phased and parallel segmentation, and horizontal and vertical segmentation, influence design and execution responsibilities in segmented contracting?

The research demonstrated that segmentation choices strongly influence the allocation and coordination of design and execution responsibilities. Parallel segmentation was generally associated with advantages in the design phase, as it allows for the simultaneous development of multiple design packages. This supports early interface coordination and reduces the overall design timeline. By contrast, phased segmentation appeared more effective during execution, where it enables a controlled rollout of activities, minimizes on-site interference, and allows for clearer division of responsibilities across sequential work packages.

Similarly, horizontal and vertical segmentation shape the types of interfaces that need to be managed. Horizontal segmentation works best in cases where segments are physically distinct and dependencies are limited. Vertical segmentation, by contrast, is more suited to areas where technical disciplines converge, but also creates additional dependencies and demands stronger coordination.

The cases illustrated these dynamics through the following patterns:

- **Horizontal & phased:** Provides predictability in execution with relatively few on-site conflicts, but risks misalignment if design phases are insufficiently coordinated.
- **Horizontal & parallel:** Effective for geographically independent segments, as long as interface definitions are clear. Execution can proceed efficiently, but requires mechanisms to coordinate concurrent works.
- **Vertical & phased:** Allows sequential handling of technical disciplines, but risks bottlenecks if designs are delivered late or misaligned. Execution becomes vulnerable to cascading delays.
- **Vertical & parallel:** The most coordination-intensive option, as disciplines must design and build simultaneously. This scenario often leads to overlapping responsibilities and timing conflicts, making structured planning and role division essential.

Subquestion 3: What should clients consider when implementing multiple (different) segmented project delivery methods in a complex infrastructure project?

The analysis shows that clients face various challenges when combining multiple segmented project delivery methods within a single infrastructure project. Each method has specific strengths and risks, and their combination demands extra attention to coordination, alignment, and legal consistency. The following insights were derived for each method:

Traditional contracting In the cases, traditional segmented contracting was mainly applied to relatively simple or preparatory works with a clearly defined scope. It offered clients strong control and familiarity, since the client retained design responsibility and could coordinate directly across the various segments. This made it effective for enabling works or segments that were relatively independent of others. At the same time, the approach placed the full burden of integration and coordination on the client, particularly during the design phase. Managing interfaces, aligning designs, and ensuring consistency across contracts required significant client capacity. Where designs were insufficiently aligned across segments, handovers to contractors sometimes proved problematic, highlighting the limits of this method in more complex or interdependent scopes.

Integrated contracting Integrated segmented contracting was observed to be most valuable in technically complex segments where buildability and efficient sequencing were crucial. Combining design and execution within one contract per segment enabled continuity and provided contractors with greater responsibility for integration within their own scope. This reduced the client's internal workload on a segment level, but at the same time increased the complexity of managing interfaces between integrated contracts. The cases showed that this approach could promote efficiency and early risk identification, yet it also created tensions between the freedom given to contractors and the need for the client to retain overall control. Without robust frameworks for interface management, integrated contracts risked developing in isolation, leading to coordination challenges downstream.

Collaborative contracting (two-phase / bouwteam / bouwteam 2.0) Collaborative models such as two-phase contracts and bouwteam arrangements were found to be particularly valuable for technically complex or high-risk segments. In these approaches, contractors were involved during the design phase, either alongside advisors or in a structured first phase before execution. This early involvement allowed for better feasibility assessments, constructability input, and proactive identification of interface risks. The cases demonstrated that this could significantly improve alignment between design and execution. However, these models also demanded a high level of trust and cooperation between client and contractors, and they created dependencies between segments that were developed in parallel. Transitioning from the collaborative design phase to a formal execution contract sometimes proved complex, requiring careful alignment of expectations, role divisions, and responsibilities.

Mixed contracting In some projects, a mix of delivery methods was applied, often as a response to political deadlines, market conditions, or budgetary constraints. This flexibility allowed clients to tailor approaches to the specific requirements of each segment. For example, using traditional contracts for enabling works while applying integrated contracts for main works. While such combinations provided adaptability, they also introduced additional coordination challenges. When combining different project delivery methods, this asks for harmonized planning milestones, unified governance structures, and consistent interface protocols. In practice, the cases showed that mixed contracting could work effectively, but only when the client actively maintained oversight and alignment across segments. Without such central coordination, the risk of fragmentation, inconsistent responsibilities, and conflicting contractual interpretations increased substantially.

In conclusion, each segmented project delivery method comes with its own requirements for coordination, interface management, and planning. Clients must tailor their contract strategy per segment while ensuring overarching alignment through governance structures, shared interface protocols, and harmonized contract terms. The combination of methods is often necessary but must be approached with a deliberate segmentation logic that aligns with the project's technical and organizational needs.

Subquestion 4: What contractual elements should be included or adapted to adequately support phased, parallel, horizontal, and vertical segmentation in infrastructure projects?

The study confirmed that standard Dutch contracts such as UAC, UAC-IC, and TNR provide only limited provisions for coordination across segments. This gap has led to the development of additional contractual instruments, particularly coordination agreements, which act as overarching frameworks to address issues that exceed the scope of individual contracts.

Across the cases and interviews, several recurring themes emerged as central elements of coordination agreements. These were not presented as abstract recommendations, but rather as provisions that were consistently observed to play a critical role in enabling segmented contracting to function effectively:

- **Legal function and relation to other documents:** Agreements were found to be most effective when their legal status and relationship to individual contracts and general conditions were explicitly defined. In practice, this ensured that the agreement was not treated as a non-binding guideline, but as a binding and enforceable framework that complemented the segment contracts.
- **Role descriptions for coordination:** The cases showed the importance of clearly stating who coordinates what, who is coordinated by whom, and at which point in time. Ambiguity in scope of authority or deliverables often led to disputes, whereas explicit definitions of the roles and functions provided clarity and accountability.
- **Communication and meeting arrangements:** Structured consultation formats covering frequency, topics, reporting duties, and representation per party, proved essential for maintaining alignment across design and execution phases. In the absence of such structures, coordination risks escalated quickly.
- **Interface management:** Effective agreements consistently included system-based breakdowns of the project, interface registers, and supporting design documentation such as system notes or integrated models. These tools were seen as critical for managing technical dependencies between segments.
- **Integrated planning:** Obligations to develop and maintain an integrated project planning across all segments emerged as a central theme. Shared milestones and defined handover points helped to align otherwise independent schedules and reduce delays at interfaces.
- **Escalation and decision-making:** The agreements often incorporated escalation models distinguishing day-to-day coordination from strategic project-level issues. This proved vital for resolving conflicts in a timely manner and for preventing technical disputes from stalling project-wide progress.
- **Collaboration and conflict management:** Several projects supplemented the formal agreement with a collaboration charter or informal rules of conduct. These provisions aimed to strengthen cooperative behaviour and provide mechanisms for resolving disputes outside of formal legal escalation.
- **Design versus execution distinction:** The need to distinguish obligations between the design and execution phases was a recurring finding. Clear arrangements on the handover of design deliverables to execution contracts reduced the risk of interface gaps or unaccounted responsibilities.
- **Information obligations:** Obligations regarding design deliverables, risk logs, approval processes, and the use of digital tools such as BIM were consistently emphasized. The cases demonstrated that unclear or delayed information flows often translated directly into coordination failures.
- **Incentives and penalties:** Finally, agreements that linked incentives and penalties to collective outcomes such as the absence of interface-related delays or timely commissioning, were seen to support alignment across contractors. The precise design of these mechanisms varied, but their role in shaping behaviour and accountability was evident in multiple projects.

Main research question: How can clients adopt segmented contracting in complex infrastructure projects by making appropriate segmentation choices, and structuring contractual frameworks to support these choices?

This research showed that segmented contracting can provide flexibility and adaptability in complex infrastructure projects, but only when applied with a clear understanding of its organizational and legal consequences. Segmentation was observed not to be a goal in itself, but a way to align contract strategy with project-specific conditions such as limited market capacity, complex interfaces, and technical interdependencies.

The findings demonstrated that clients made segmentation choices along two main dimensions: across scope (horizontal or vertical) and across time (phased or parallel). In practice, parallel segmentation proved most effective during the design phase, as it enabled simultaneous development of packages, early identification of interface issues, and shorter design timelines. By contrast, phased segmentation was more often applied in the execution phase, where it allowed for a controlled rollout of activities, reduced logistical interference, and clearer allocation of responsibilities. Horizontal segmentation was most effective for geographically separable scopes with limited dependencies, whereas vertical segmentation was primarily applied in complex nodes where multiple technical disciplines converged, though this also increased the need for structured coordination.

The choice of segmentation was closely tied to the selection of project delivery methods. Traditional contracting was found to be effective for preparatory works or segments with clearly defined scopes, but it placed the integration and coordination burden heavily on the client. Integrated contracting reduced the internal coordination load within segments, but increased complexity across segment interfaces. Collaborative forms, such as two-phase or bouwteam contracting, provided benefits of early contractor involvement and shared risk discussions, though they required strong alignment mechanisms between phases and across segments. Mixed contracting approaches were frequently observed in practice, often driven by political deadlines, market conditions, or budget constraints. While this flexibility allowed tailoring to segment characteristics, it simultaneously heightened the importance of harmonized planning, unified governance, and consistent interface management.

The study also showed that standard Dutch contracts (UAC, UAC-IC, TNR) provided only limited support for managing the additional dependencies introduced by segmentation. Across almost all cases, supplementary coordination agreements were used to fill this gap. These agreements can address the precise definition of roles, interface management, communication and meeting structures, integrated planning, escalation procedures, and collaboration mechanisms. Their legal enforceability proved essential to prevent uncertainty and disputes. Incentives and penalties were sometimes included to stimulate collective behaviour, though their design varied significantly across projects.

In sum, the research demonstrated that segmented contracting in complex infrastructure projects requires alignment between segmentation choices, delivery methods, and contractual frameworks. Segmentation offered opportunities for flexibility and market responsiveness, but also created additional dependencies that demanded structured coordination. The observed practice highlighted that clients often retained a central role in managing interfaces, supported by legally binding coordination agreements and supplementary collaboration mechanisms. Segmented contracting thus emerged as a feasible and widely applied approach, but one that only functions effectively when its organizational and legal dimensions are aligned from the outset.

9 Recommendations

Based on the limitations identified in this research, several recommendations can be made for both practitioners in the field of infrastructure project management and for future academic research.

9.1 Recommendations for practice

To improve coordination in segmented contracting practices, public clients and practitioners should consider several adjustments in both the preparation and execution phases. First and foremost, clients should invest more effort in explicitly formulating coordination expectations early in the project lifecycle. A coordination agreement should not only list general intentions, but clearly define what is expected from each contractor in terms of planning alignment, communication procedures, and interface responsibilities. As multiple interviewees emphasized, this upfront clarity supports consistent execution and facilitates accountability throughout the project.

In addition, the findings of this study suggest the value of standardising the coordination agreement for segmented contracting contexts. The contractual elements outlined such as interface definitions, meeting structures, escalation paths, and data exchange obligations, should be legally embedded in a comprehensive and precise way. Based on this legal structure, a template agreement could be developed to serve as a practical tool for public clients. Such a template would provide a consistent starting point for projects facing similar segmentation challenges, while allowing for project-specific modifications where necessary. Over time, the template could be tested and refined across various projects to assess whether it achieves the intended coordination improvements and to identify areas for enhancement. This would contribute to greater professionalisation and legal robustness of coordination practices in the construction sector.

Second, public clients are advised to take a proactive and facilitating role in establishing coordination structures. Especially in segmented projects involving multiple contractors, it is essential that the client brings parties together early and regularly. This role cannot be fully outsourced to a coordinating contractor; rather, the client's involvement sets the tone for the collaborative dynamic. To support clients in making informed segmentation decisions, the development of a structured decision-making guide ("handreiking") is recommended. Such a guide could help clients assess key choices regarding vertical versus horizontal segmentation, phased versus parallel delivery, the preferred project delivery model, and the allocation of coordination responsibilities. By standardising this decision process, clients can better tailor their contractual and organisational setup to project complexity, and improve the conditions for effective coordination from the outset.

Third, practitioners should carefully consider the timing and design of incentive mechanisms. Both early and later-stage bonuses were observed to have distinct advantages. Bonuses defined upfront can support shared project objectives from the outset, give contractors clarity about potential gains, and strengthen collective alignment. However, contractors may also incorporate these bonuses into their bid pricing, treating them as part of the expected margin. By contrast, bonuses introduced during execution function more as true rewards, allowing clients to steer contractor behaviour at specific moments and to target pressing coordination or integration challenges. A balanced incentive strategy may therefore combine upfront clarity with the flexibility to address project-specific needs as they arise. Furthermore, future coordination agreements should continue to distinguish between informal collaboration efforts and binding contractual provisions to ensure enforceability and legal certainty.

Moreover, better alignment between contract design and project execution can be achieved by systematically collecting feedback on coordination successes and failures during and after project delivery. This feedback loop will help refine the templates and practices used in future projects and reduce reliance on ad-hoc agreements.

Finally, it is essential to recognise that the success of coordination does not only lie in the agreement itself, but also in its execution. As interviewees F1, F2, and F3 emphasised, contracts are ideally instruments set up at the beginning of the project and then used only when needed and not as day-to-day management tools. Therefore, the coordination agreement should serve as a document to foster alignment and cooperation between parties. It should offer concrete talking points for initiating discussions on how collaboration will take shape, what behaviours and responsibilities are expected, and how parties will respond when coordination fails. Above all, the agreement should help manage expectations. As F2 noted, "In the end, it's all about managing expectations." By explicitly aligning on expectations upfront, clients can help reduce ambiguity and conflict throughout the project.

9.2 Recommendations for future research

First, future research should explore the perspective of contractors in greater depth. This study focused primarily on public clients, meaning it did not assess whether the proposed coordination mechanisms are considered feasible, effective, or desirable from a contractor's point of view. A more balanced understanding of coordination dynamics could be achieved by interviewing contractors, subcontractors, and technical advisors who are directly involved in segmented infrastructure projects. Such research would offer valuable insights into how coordination demands are experienced in practice, and whether they align with contractual expectations from the client's side.

Moreover, this approach would allow researchers to validate which aspects of the coordination role are truly workable for contractors and which are not. By engaging with contractors in a neutral and open-ended manner, future studies can uncover their perspectives on what effective coordination and collaboration between multiple contractors should look like, what they perceive as realistic and implementable, and which forms of contractual guidance or facilitation they find most helpful. Understanding these practical boundaries and operational realities can help refine coordination agreements to ensure they are both enforceable and operationally viable across all involved parties.

Second, future studies could adopt a mixed-methods approach to complement qualitative case insights with broader quantitative validation. For example, surveys among project professionals could assess the perceived effectiveness of coordination mechanisms, or measure relationships between segmentation choices and project performance indicators such as delay frequency or interface conflict occurrence.

Furthermore, it is advised that future case studies focus on projects that are either currently in execution or have been recently completed. This would help improve the reliability of findings by minimizing issues related to recall bias. For instance, studying projects in the construction phase (such as Amsterdam Central Station) or recently delivered projects (like AWS Zwanenburg) can yield richer empirical evidence of coordination practices and outcomes.

Additionally, this study assumed that the client had already chosen to adopt a segmented contracting strategy. The research thus focused on how to best organise coordination once segmentation is a given. However, future research could take a step back and examine the decision to segment in the first place. Under what conditions is segmentation actually beneficial? When might it be better to avoid segmentation altogether, such as by using a single contractor, defining separate work packages without mutual interfaces, or relying on subcontractor chains? Exploring these strategic choices in a comparative framework would support more conscious, evidence-based decision-making by public clients. This would help shift segmentation from a reactive or necessity-driven measure as is often the case as seen in section 1, to a deliberate and well-informed strategy tailored to project characteristics.

Lastly, future research should examine a broader and more diverse set of case studies. By including projects of varying size and complexity from smaller regional works to large-scale, multi-billion-euro infrastructure programmes, this would enable comparative analysis of coordination strategies across different sizes. Such variation would help determine whether specific coordination mechanisms are more effective at certain scales, or whether larger and more interface-dense projects require fundamentally different contractual or organisational solutions. A wider case selection would not only enhance the generalisability of findings, but also offer deeper insight into how segmentation strategies should be tailored to project characteristics.

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A Use of AI

Artificial intelligence was used in this thesis to support the reading of academic sources and the writing of research text. During the literature study, AI tools were applied to summarize academic articles and books, and to identify relevant sections that aligned with the research topic.

In the writing phase, AI was used to improve the clarity and quality of the language. After drafting the interview results, conclusions, and analysis, AI was used to rephrase sentences, improve structure, and enhance English phrasing. This was done only to improve readability and not to alter the content.

Examples of prompts used include:
"Rewrite this text in English",
"Rephrase these sentences to make it more readable and better understandable",
and "Rewrite the points in this text as an itemization".

It is important to note that AI was not used to draw conclusions, identify relations, or formulate analytical insights. All interpretation, reasoning, and academic judgments were conducted by the researcher.

B Informed Consent Form

Formulier voor geïnformeerde consent

Graag nodig ik u uit om deel te nemen aan mijn onderzoek genaamd “The first phase of segmented contracting”. Dit onderzoek wordt uitgevoerd door Job Versantvoort, student aan de masteropleiding Construction Management and Engineering aan de TU Delft, in samenwerking met AT Osborne.

Het doel van dit onderzoek is om te bepalen welke overwegingen opdrachtgevers maken bij het kiezen voor gesegmenteerd contracteren in complexe infrastructuurprojecten. Daarnaast wordt onderzocht welke gesegmenteerd bouworganisatievormen, welke contractvormen deze ondersteunen en welke specifieke contractuele elementen belangrijk zijn bij gesegmenteerd contracteren. Dit onderzoek zal opdrachtgevers helpen bij het maken van goed onderbouwde keuzes voor bouworganisatievormen en contracten.

Dit interview zal ongeveer 60 minuten duren en richt zich op uw ervaring en inzichten met gesegmenteerde contracteren. Tijdens het gesprek zullen open vragen worden gesteld over onder andere de afwegingen die opdrachtgevers maken bij gesegmenteerd contracteren, de invloed hiervan op de keuze voor een bouworganisatievorm, en de daaruit voorvloeiende contractkeuzes. U wordt aangemoedigd om voorbeelden te geven uit uw eigen praktijkervaring.

Zoals bij elke digitale activiteit is er een risico op datalekken. Wij doen ons uiterste best om uw gegevens vertrouwelijk en veilig te bewaren. Het interview wordt opgenomen via Microsoft Teams en automatisch getranscribeerd. De transcriptie wordt nagekeken en met u gedeeld ter verificatie. U heeft de mogelijkheid correcties of aanvullingen door te geven. Zodra de transcriptie is goedgekeurd, wordt de opname permanent verwijderd en het transcript geanonimiseerd. Persoonsgegevens, zoals namen en contactgegevens, worden apart opgeslagen en zo snel mogelijk verwijderd na het anonimiseren. De geanonimiseerde transcripten kunnen worden gebruikt in het eindrapport en opgeslagen worden in de TU Delft repository voor academische doeleinden. Dit betekent dat geanonimiseerde citaten kunnen worden opgenomen in publicaties, maar uw identiteit blijft altijd beschermd.

Uw deelname aan dit onderzoek is volledig vrijwillig. U kunt op elk moment stoppen of uw deelname intrekken, zonder opgave van reden. Ook bent u vrij om vragen niet te beantwoorden.

Indien u akkoord gaat met deelname, wil ik u vriendelijk vragen om de vragen op de volgende pagina te beantwoorden en dit document ondertekend naar mij terug te sturen. Dit formulier wordt veilig opgeslagen gedurende het onderzoek en verwijderd na afronding van de studie.

Hartelijk dank voor uw tijd en medewerking. Voor vragen of verdere informatie kunt u contact met mij opnemen.

____

GELIEVE HET JUISTE VAKJE AAN TE VINKEN	Ja	Nee
A: ALGEMENE VRAGEN		
1. Ik heb de informatie over het onderzoek (gedateerd DD/MM/YYYY) gelezen en begrepen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord.	☐	☐
2. Ik doe vrijwillig mee aan dit onderzoek en ik begrip dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven.	☐	☐
3. Ik begrijp dat deelname aan dit onderzoek betekent dat: • dit interview wordt opgenomen (in audio en video) en er een automatische transcriptie mee zal lopen; • de transcriptie handmatig nog verbeterd zal worden en ter inzage naar mij opgestuurd wordt; • de opnames van het interview 10 dagen na het versturen van de transcriptie verwijderd worden, tenzij hier nog aanmerking op zijn; • de transcriptie geanonimiseerd wordt en quotes hieruit gebruikt kunnen worden in het rapport; • de oorspronkelijk niet-geanonimiseerde transcriptie verwijderd wordt direct na het anonimiseren.	☐	☐
4. Ik begrijp dat mijn deelname aan dit onderzoek niet wordt gecompenseerd.	☐	☐
5. Ik begrijp dat dit onderzoek naar verwachting in juli of augustus 2025 zal eindigen.		
B: POTENTIËLE RISICO'S VAN DEELNAME		
6. Ik begrijp dat mijn deelname betekent dat er persoonlijke identificeerbare informatie en onderzoeksdata worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden.	☐	☐
7. Ik begrijp dat binnen de Algemene Verordening Gegevensbescherming (AVG) een deel van deze persoonlijk identificeerbare onderzoeksdata als gevoelig wordt beschouwd, namelijk: • Naam; • E-mailadres en telefoonnummer; • Functie en ervaring; • Andere contactgegevens voor digitale communicatie; • Beeld- en geluidsopname van dit interview.	☐	☐
8. Ik begrijp dat de volgende stappen worden ondernomen om het risico van een databreuk te minimaliseren, en dat mijn identiteit op de volgende manieren wordt beschermd: • De data zal zo snel mogelijk geanonimiseerd worden; • De niet-geanonimiseerde data zal in een aparte map worden opgeslagen, en wordt na anonimiseren verwijderd.	☐	☐
9. Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals naam, contact informatie en beeld- en geluidsopname, niet gedeeld worden buiten het studieteam.	☐	☐

GELIEVE HET JUISTE VAKJE AAN TE VINKEN	Ja	Nee
10. Ik begrijp dat de persoonlijke data die over mij verzameld wordt, vernietigd wordt uiterlijk ten laatste bij het publiceren van het rapport.	☐	☐
C: Publicatie, verspreiding en toepassing		
11. Ik begrijp dat na het onderzoek de geanonimiseerde informatie die in het rapport gebruik is, mogelijk gebruikt kan worden voor verder onderzoek en onderwijs.	☐	☐
12. Ik ga ermee akkoord dat mijn antwoorden, meningen of andere input anoniem geciteerd kunnen worden in onderzoeksresultaten.	☐	☐

Handtekeningen

____________________________	____________________________	_________
Naam deelnemer	Handtekening	Datum

Ik, de onderzoeker, verklaar dat ik de informatie en het instemmingsformulier correct aan de potentiële deelnemer heb voorgelegd en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Job Versantvoort______	____________________________	_________
Naam onderzoeker	Handtekening	Datum

Contactgegevens van de onderzoeker voor verdere informatie:

Job Versantvoort

C Data Management Plan

Plan Overview

A Data Management Plan created using DMPonline

Title: The first phase of segmented contracting

Creator: Job Versantvoort

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2025)

ID: 170690

Start date: 10-02-2025

End date: 31-08-2025

Last modified: 12-03-2025

The first phase of segmented contracting

0. Adminstrative questions

1. Provide the name of the data management support staff consulted during the preparation of this plan and the date of consultation. Please also mention if you consulted any other support staff.

Xinyan Fan, Data Steward at the Faculty of Civil Engineering and Geosciences, has reviewed this DMP on 11 March 2025.

2. Is TU Delft the lead institution for this project?

- Yes, leading the collaboration – please provide details of the type of collaboration and the involved parties below

In this project, TU Delft is leading the research design and developing the research hardware. AT Osborne is sharing commercial data on the performance of current projects. A graduation agreement has been established to support this partnership. The graduation agreement is submitted in MyCase.

I. Data/code description and collection or re-use

3. Provide a general description of the types of data/code you will be working with, including any re-used data/code.

Type of data/code	**File format(s)**	**How will data/code be collected/generated?** *For re-used data/code: what are the sources and terms of use?*	**Purpose of processing**	**Storage location**	**Who will have access to the data/code?**
Interview recordings (audio and video)	MP4	Recording the interview in both audio and video with Microsoft Teams	To understand the use of segmented contracting for clients especially on project delivery method and contract level	Personal One Drive at TU Delft	Me
Interview transcriptions	PDF and Word	Transcript the interview with a tool in Microsoft Teams	To understand the use of segmented contracting for clients especially on project delivery method and contract level	Personal One Drive at TU Delft	Me, and per transcription the interviewee to agree with the copy
Anonymized interview transcriptions	PDF	Anonymize the transcripted interviews	To understand the use of segmented contracting for clients especially on project delivery method and contract level	Personal One Drive at TU Delft	Me, TU Delft supervisors: A. Straub, E.M. Bruggeman, and L.P.I.M. Hombergen AT Osborne supervisors: W.J.P. de Rooij and D. Dortmundt
Anonymized project data and documents	PDF and other	Gathered from AT Osborne and partners, confidential for everyone outside of the company	To make the framework, test and validate it, and to get information about specific contracts	Personal One Drive at TU Delft	Me, AT Osborne supervisors: W.J.P. de Rooij and D. Dortmundt
Project data and documents	PDF and other	Gathered public data, gathered from Scholar and Scopus	To make the framework, test and validate it	Personal One Drive at TU Delft	Me, TU Delft supervisors: A. Straub, E.M. Bruggeman, and L.P.I.M. Hombergen AT Osborne supervisors: W.J.P. de Rooij and D. Dortmundt
Informed Consent Forms	PDF	Digitalized forms	To collect informed consent	Personal One Drive at TU Delft	Me
Personally Identifiable Information (PII): name, email, phone numbers, informed consent forms	PDF, Word and other	Contact information for participants taking part in interviews, received from participant sign-ups.	To collect interviewee names, email addresses, and phone numbers, which are used only for administrative purposes to obtain consent and communicating with participants.	Personal One Drive at TU Delft	Me
Personally Identifiable Research Data (PIRD): professional background, past projects and function, type of contracts	PDF, Word and other	Professional information of participants taking part in interviews, received from participant sign-ups.	To collect the professional background and job title of interviewees, which are used only for administrative purposes to obtain consent and communicating with participants.	Personal One Drive at TU Delft	Me

II. Storage and backup during the research process

4. How much data/code storage will you require during the project lifetime?

- < 250 GB

5. Where will the data/code be stored and backed-up during the project lifetime? (Select all that apply.)

- TU Delft OneDrive

III. Data/code documentation

6. What documentation will accompany data/code? (Select all that apply.)

- Data – Methodology of data collection
- Other – please explain below

Data will be shared in the appendix of my Msc Thesis

IV. Legal and ethical requirements, code of conducts

7. Does your research involve human subjects or third-party datasets collected from human participants?

If you are working with a human subject(s), you will need to obtain the HREC approval for your research project.

- Yes – please provide details in the additional information box below

I intend to apply for ethical approval from the Human Research Ethics Committee, but have not yet done so.

8. Will you work with personal data? (This is information about an identified or identifiable natural person, either for research or project administration purposes.)

- Yes

Participants will be interviewed. For administrative reasons personal data will be stored (on the informed consent forms for example). The interviews will be recorded in video format, and thereafter they will be transcribed. The transcriptions will be anonymized before they're shared with others.

9. Will you work with any other types of confidential or classified data or code as listed below? (Select all that apply and provide additional details below.)

If you are not sure which option to select, ask yourFaculty Data Steward for advice.

- Yes, politically-sensitive data (such as research commissioned by public authorities, research in social issues)
- Yes, confidential data received from commercial, or other external partners

There is the possibility that project data from AT Osborne will be confidential and/or politically-sensitive. Which data I require depends on my interviews and cases so only later on I know for sure whether or not there will be confidential and/or politically-sensitive data or not.

10. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your[Faculty Contract Manager] when answering this question

I am the owner of the data and the data will be restricted to me during the thesis. Only anonymised data will be shared with the supervisors and will be in the thesis.

Moreover, the intellectual property rights are framed by a graduation agreement between Delft University of Technology, myself and AT Osborne.

11. Which personal data or data from human participants do you work with? (Select all that apply.)

- Audio recordings
- Video materials
- Proof of consent (such as signed consent materials which contain name and signature)
- Telephone number, email addresses and/or other addresses as contact details for administrative purposes
- Names as contact details for administrative purposes

Names, email addresses or Microsoft Teams contact information and data collected in informed consent forms will be stored. As the interviews will be done with Microsoft Teams, a video and audio recording of the interview will be stored as well. After the interviews have been transcribed

and the interviewee has no comments, the (video and audio) recording will be deleted immediately. Other personal data can be deleted after the research has finished.

I will retain the signed informed consent forms securely for as long as the associated personal data is kept.

12. Please list the categories of data subjects and their geographical location.

I will interview professionals working on Dutch construction projects and contracts with experience in projects with segmented contracting. Depending on the results of the first sets of interviews, other experts can also be added.

13. Will you be receiving personal data from or transferring personal data to third parties (groups of individuals or organisations)?

- No

16. What are the legal grounds for personal data processing?

- Informed consent

17. Please describe the informed consent procedure you will follow below.

I will inform the potential participants about the goals and procedures of the research project. I will also inform them about the personal data that are being processed and for what purpose. This information will be provided to the potential participants as follows: a digital version of the informed consent forms will be emailed to participants before the interview. All participants will be asked for their consent for taking part in the study and for data processing by signing a digital informed consent form before the start of the interview.

18. Where will you store the physical/digital signed consent forms or other types of proof of consent (such as recording of verbal consent)?

The proof of consent (digital copy of signed document) will be preserved on the TU Delft One Drive.

19. Does the processing of the personal data result in a high risk to the data subjects? (Select all that apply.)

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data in your research project.

If any category applies, please provide additional information in the box below. Likewise, if you collect other type of potentially sensitive data, or if you have any additional comments, include these in the box below.

If one or more options listed below apply, your project might need a DPIA. Please get in touch with the Privacy team (privacy-tud@tudelft.nl) to get advice as to whether DPIA is necessary.

- None of the above apply

23. What will happen with the personal data used in the research after the end of the research project?

- Anonymised or aggregated data will be shared with others

I will share all my research data. Anonymized data will be used in my thesis and shared with my thesis group, and all personal data will be destroyed after the end of my thesis.

24. For how long will personal research data (including pseudonymised data) be stored?

- Personal data will be deleted at the end of the research project

25. How will your study participants be asked for their consent for data sharing?

- In the informed consent form: participants are informed that their personal data will be anonymised and that the anonymised dataset is shared publicly

V. Data sharing and long term preservation

27. Apart from personal data mentioned in question 23, will any other data be publicly shared?

Please provide a list of data/code you are going to share under ‘Additional Information’.

- No other data/code can be publicly shared – please explain below why data/code cannot be publicly shared

Aside from personal data, I will also work with contracts and sensitive project information/documents. I will not publicly share these documents in my thesis. I will only make use of the option to use anonymized quotes or sections.

VI. Data management responsibilities and resources

33. If you leave TU Delft (or are unavailable), who is going to be responsible for the data/code resulting from this project?

My chair Dr.ir. A. Straub, Department Management in the Built Environment (MBE) at the Faculty Architecture and the Built Environment.

34. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

I will do the data-management myself and therefore no other resources are necessary

35. Which faculty do you belong to?

- Faculty of Civil Engineering and Geosciences (CEG)

D Interview Guide

The interview guide used for the interviews is presented below. All interviews were conducted in Dutch, in accordance with the overall research procedure. To preserve the original phrasing and intent of the questions, the guide is also provided in Dutch.

As described earlier in subsection 2.2, a semi-structured interview approach was applied. The questions listed here represent the intended structure and is used as an indicative guideline. Not all questions were asked in exactly this order and phrasing. Depending on the context and the interviewee, supplementary questions were asked to clarify responses or explore relevant issues in more depth.

D.1 Interview richtlijnen project specifieke experts

Introductie

Het interview begint met een korte introductie waarin zowel de interviewer als de respondent zich voorstellen. Vervolgens wordt het doel van het afstudeeronderzoek toegelicht, inclusief de onderzoeksvragen, de rol van het project binnen de studie, en de manier waarop het interview bijdraagt aan het onderzoek. Er wordt daarbij stilgestaan bij praktische zaken zoals de duur van het gesprek, de manier van dataverwerking (de opname en transcriptie), en de vertrouwelijkheid van de verstrekte informatie. Ook wordt het geïnformeerde toestemming formulier kort besproken. Tot slot is er ruimte voor vragen of toelichting van de kant van de respondent, zodat beide partijen goed voorbereid het inhoudelijke gesprek kunnen starten.

Table 7: Richtlijnen vragen introductie

Nr.	Vraag	Uitleg of doel
1	Heeft u nog vragen vooraf over het interview of het onderzoek?	Onduidelijkheden weghalen.
2	Heeft u geïnformeerde toestemming gegeven? Bent u akkoord met de informatie in het formulier?	Controleren of alle informatie duidelijk is en de respondent akkoord is met de verwerking van data uit het interview.
3	Introductie onderzoeker	Achtergrond schetsen van onderzoeker.
4	Introductie onderzoek en interview	Uitleg geven van het onderzoek en manier van interviewen.
5	Kunt u iets vertellen over uzelf en uw rol binnen het project	Achtergrond schetsen van respondent.
6	Kunt u meer vertellen over het project waar u betrokken bij bent (geweest)?	Beter beeld krijgen van de casus.

Context

In dit deel van het interview wordt ingegaan op de algemene context van het project en de manier waarop segmentatie is toegepast. Het doel is om te achterhalen hoe het project organisatorisch en contractueel is opgezet: welke partijen betrokken zijn, hoe het werk is opgedeeld in segmenten, en of deze segmenten los van elkaar zijn aanbesteed. Ook wordt verkend welke aannemers verantwoordelijk zijn per segment, hoe de opdeling tot stand is gekomen, en of deze is ingegeven door vooraf gemaakte keuzes of door omstandigheden tijdens het proces.

Hierbij wordt aandacht besteed aan zowel horizontale als verticale segmentatie. Deze vragen helpen om scherp te krijgen hoe het project in de praktijk gesegmenteerd is, en vormen daarmee een belangrijke basis voor de verdere verdieping in bouworganisatievormen en contractuele structuren.

Table 8: Richtlijnen vragen context

Nr.	Vraag	Uitleg of doel
1	Uitleg segmentatie binnen een project, inclusief visuele voorbeelden	Beeld schetsen van segmentatie zodat respondent en onderzoeker op één lijn staan.
2	Hoe is het project waar u bij betrokken bent gesegmenteerd?	Controleren hoe en of project X daadwerkelijk gesegmenteerd is opgezet.
3	Was deze segmentatie horizontaal (geografisch) of verticaal (technisch)?	Begrijpen welk type segmentatie is toegepast binnen het project.
4	Welke bouworganisatievormen zijn per segment gebruikt? Wijken deze per segment af? Heeft u hiervan een schematisch overzicht?	Inzicht krijgen in de toegepaste bouworganisatievorm(en) en verschillen tussen segmenten.
5	Welke partijen waren betrokken? Denk aan opdrachtgever, aannemers, nevenaannemers, consultants. Heeft u een visualisatie van de contractuele en functionele relaties?	Begrijpen welke partijen betrokken waren en hoe de onderlinge relaties eruitzien.

Parallel en gefaseerde segmentatie

In dit onderdeel van het interview wordt dieper ingegaan op hoe de uitvoering van het project is georganiseerd in termen van parallelle of gefaseerde uitvoering. We willen begrijpen op welke manier de verschillende segmenten in tijd ten opzichte van elkaar zijn gepositioneerd, en wat dit betekent voor de samenwerking en verdeling van verantwoordelijkheden.

Hiermee wordt een antwoord gezocht op de tweede onderzoeksvraag:
How do phased and parallel execution, as well as horizontal and vertical segmentation, influence design and execution responsibilities in segmented contracting?

De vragen zijn erop gericht om te achterhalen of fasering of juist gelijktijdigheid invloed heeft gehad op ontwerpverantwoordelijkheden, uitvoeringsrisico's en de noodzaak tot coördinatie tussen segmenten. Daarbij wordt ook gekeken hoe deze keuzes in de praktijk zijn gemaakt: strategisch vooraf, of organisch tijdens het project. Antwoorden op deze vragen helpen om te bepalen in hoeverre segmentatie in tijd impact heeft op het functioneren van gesegmenteerde contracten in complexe projecten.

Table 9: Richtlijnen vragen parallel en gefaseerde segmentatie

Nr.	Vraag	Uitleg of doel
1	Zijn de segmenten parallel (gelijktijdig) of gefaseerd (achter elkaar) uitgevoerd?	Inzicht krijgen in de uitvoering van de segmenten over tijd.
2	Op basis waarvan en wanneer is de keuze voor parallelle of gefaseerde uitvoering gemaakt?	Begrijpen wat de achterliggende redenen zijn en wanneer de keuze is gemaakt voor parallelle of gefaseerde uitvoering.

Vervolg op volgende pagina

Nr.	Vraag	Uitleg of doel
3	Wat is de invloed van de keuze voor parallel of gefaseerd segmenteren geweest op de ontwerp- en uitvoeringsverantwoordelijkheden voor project X?	Inzicht krijgen in de invloed van parallel en gefaseerd segmenteren op het project.
4	Hoe beïnvloedde de gekozen segmentatievorm de samenwerking of risicoverdeling in de praktijk?	Achterhalen wat de impact van segmentatie is op samenwerking en verdeling van risico's tussen partijen.

Meerdere gesegmenteerde bouworganisatievormen

In dit deel van het interview wordt verkend hoe verschillende bouworganisatievormen binnen één project naast elkaar zijn toegepast. Denk hierbij aan situaties waarin bijvoorbeeld één segment via een traditioneel model wordt aanbesteed, terwijl een ander segment onder een geïntegreerde of bouwteam-constructie valt. De focus ligt op de manier waarop deze verschillende modellen zich tot elkaar verhouden, hoe de verantwoordelijkheden tussen partijen verdeeld zijn en of dit in de praktijk tot knelpunten of juist voordelen heeft geleid.

Deze vragen zijn erop gericht om dieper inzicht te verkrijgen in de dynamiek tussen segmenten met verschillende juridische en organisatorische afspraken. Dit betreft zowel het ontwerp- als het uitvoeringsproces, en de eventuele overlap of afhankelijkheid tussen segmenten.

Hiermee wordt tevens de derde onderzoeksvraag behandeld:
What should clients consider when implementing multiple (different) segmented project delivery methods in a complex infrastructure project?

De antwoorden bieden inzichten in hoe verschillende bouworganisatievormen samenwerken of juist kunnen botsen, welke coördinatie-inspanningen daarbij nodig zijn, en welke overwegingen een opdrachtgever moet maken bij het combineren van verschillende modellen binnen één project.

Table 10: Richtlijnen vragen bouworganisatievormen

Nr.	Vraag	Uitleg of doel
1	Wanneer zijn de bouworganisatievormen per segment gekozen? Is dat allemaal in één keer besloten of juist stap voor stap? En was dat een bewuste keuze of meer uit noodzaak ontstaan?	Inzicht krijgen in het moment en de reden van keuze voor specifieke bouworganisatievormen.
2	Wat waren de voordelen van de gebruikte bouworganisatievormen naast elkaar en waarom?	Inzicht in wat goed werkt in combinatie.
3	Wat waren de nadelen van de gebruikte bouworganisatievormen naast elkaar en Waarom?	Inzicht in wat niet goed werkt in combinatie.
4	Wat is meegenomen in de afweging voor de keuze van deze bouworganisatievormen?	Begrijpen welke factoren meespeelden bij de keuzes.
5	Wat had volgens u meegenomen moeten worden in de afweging voor de keuze van deze bouworganisatievormen?	Achterhalen wat eventueel over het hoofd is gezien.

Vervolg op volgende pagina

Nr.	Vraag	Uitleg of doel
6	Heeft u verder nog relevante informatie met betrekking tot de keuzes die gemaakt zijn in dit project?	Ruimte geven voor aanvullende inzichten.

Contracten

In dit laatste onderdeel van het interview wordt ingezoomd op de contractuele inrichting van het project. Er wordt onderzocht hoe segmentatie contractueel is vormgegeven, welke afspraken zijn gemaakt over samenwerking en coördinatie, en welke elementen in contracten zijn opgenomen om dit in goede banen te leiden. Daarbij is er aandacht voor zowel positieve ervaringen als knelpunten uit de praktijk.

Met dit onderdeel wordt de basis gelegd voor het beantwoorden van de vierde onderzoeksvraag: *What specific contractual elements should be included when structuring contracts for the implementation of segmented project delivery methods?*

De focus ligt hier op de contractuele uitwerking van coördinatie en samenwerking binnen het project. In vervolgfase van het onderzoek zullen aanvullende interviews met advocaten plaatsvinden, die dieper ingaan op de inhoudelijke invulling van contracten en juridische structuren.

Table 11: Richtlijnen vragen contracten

Nr.	Vraag	Uitleg of doel
1	Welke contracten zijn per segment gehanteerd?	Overzicht krijgen van contractuele inrichting.
2	Is er naast de algemene voorwaarden een contractmodel opgenomen ter bevordering van de coördinatie of samenwerking? Wat stond er in dit model? Denk hierbij aan bijvoorbeeld een coördinatie- of samenwerkingsovereenkomst	Begrijpen of en hoe samenwerking is vastgelegd.
	Als er geen model is: Had een gezamenlijk model zoals een coördinatie- of samenwerkingsovereenkomst geholpen? Welke onderdelen zouden in dit model moeten staan	Inzicht krijgen in potentiële verbeteringen.
3	Was er één partij of persoon aangewezen als integraal coördinator tussen de segmenten? Zo ja, hoe was dit formeel geregeld?	Inzicht in centrale aansturing binnen het project.
4	Hoe werd onderlinge afstemming tussen aannemers gecoördineerd (praktisch en juridisch)?	Begrijpen hoe coördinatie is georganiseerd en of dit formeel vastligt in contracten of afspraken.
5	Hoe zijn verantwoordelijkheden juridisch vastgelegd tussen de segmenten?	Inzicht krijgen in de contractuele borging van verantwoordelijkheden tussen verschillende aannemers.
6	Welke juridische uitdagingen waren er tijdens het project?	Begrijpen welke knelpunten juridisch zijn ontstaan.

Vervolg op volgende pagina

Nr.	Vraag	Uitleg of doel
7	Welke contractuele elementen hebben juist goed gewerkt?	Leren van wat wel goed ging.
8	Welke (financiële) prikkels zijn opgenomen om uitvoering te bevorderen? Denk bijvoorbeeld aan een bonus, een pain/gain mechanisme, of uitbetaling na levering	Inzicht in de gebruikte incentives en hun effect.
9	Heeft u verder nog relevante informatie over de contracten in dit project?	Ruimte geven voor aanvullende opmerkingen.

Afronding

Aan het einde van het interview volgen nog enkele afsluitende vragen. Deze bieden de respondent de mogelijkheid om eerdere antwoorden aan te vullen, nieuwe inzichten te delen die nog niet besproken zijn, of aanvullende documentatie aan te dragen. Daarnaast wordt hiermee op een zorgvuldige manier het gesprek afgerond en ruimte geboden voor eventuele laatste opmerkingen of reflecties.

Table 12: Richtlijnen vragen afronding

Nr.	Vraag	Uitleg of doel
1	Bent u tevreden met de gegeven antwoorden? Zijn er punten die u graag nog zou willen aanpassen of aanvullen?	Mogelijkheid om antwoorden aan te vullen of te herzien.
2	Is er iets belangrijks dat we niet hebben besproken, maar dat u wel relevant vindt om te benoemen?	Mogelijkheid bieden om nieuwe onderwerpen te benoemen die in het gesprek niet aan bod zijn gekomen.
3	Beschikt u over documenten of projectinformatie die u met mij zou kunnen delen en die relevant zijn voor dit onderzoek?	Verzamelen van aanvullende projectdocumentatie

D.2 Interview richtlijnen advocaten

Introductie

Het interview begint met een korte introductie waarin zowel de interviewer als de respondent zich voorstellen. Vervolgens wordt het doel van het afstudeeronderzoek toegelicht, inclusief de onderzoeksvragen en de rol van de vragen binnen de studie. Er wordt daarbij stilgestaan bij praktische zaken zoals de duur van het gesprek, de manier van dataverwerking (de opname en transcriptie), en de vertrouwelijkheid van de verstrekte informatie. Ook wordt het geïnformeerde toestemming formulier kort besproken. Tot slot is er ruimte voor vragen of toelichting van de kant van de respondent, zodat beide partijen goed voorbereid het inhoudelijke gesprek kunnen starten.

Table 13: Richtlijnen vragen introductie

Nr.	Vraag	Uitleg of doel
1	Heeft u nog vragen vooraf over het interview of het onderzoek?	Ongemakken of onduidelijkheden wegnemen.
2	Bent u akkoord met de geïnformeerde toestemming zoals beschreven in het formulier?	Controleren of u toestemming juist heeft verleend.
3	Kunt u kort iets vertellen over de onderzoeker en het onderzoek?	Context geven over het onderzoek en de interviewer.
4	Bent u bekend met het concept van gesegmenteerd contracteren? Heeft u hier vragen over?	Zorgen voor gedeeld begripskader.
5	Kunt u iets vertellen over uzelf en uw rol binnen bouwprojecten?	Inzicht krijgen in uw achtergrond en ervaring.

Verantwoordelijkheden en taken partijen

In deze sectie worden vragen gesteld over hoe verantwoordelijkheden in een coördinatie- of samenwerkingsovereenkomst kunnen worden vastgelegd. Doel is om te begrijpen hoe juridisch houdbaar en handhaafbaar zulke afspraken zijn.

Table 14: Richtlijnen vragen verantwoordelijkheden en taken partijen

Nr.	Vraag	Uitleg of doel
6	Kunt u in een contract per partij benoemen wat ieders precieze verantwoordelijkheden zijn? Hoe specifiek en meetbaar moet dit zijn om juridisch haalbaar te maken?	Begrijpen hoe ver u kunt gaan in het specificeren van verantwoordelijkheden.
7	Kunt u terugverwijzen naar de taken van een partij in dit document wanneer iemand zich niet aan zijn taak houdt?	Controleren of het contract juridische houvast biedt bij niet-naleving.

Coördinatie

Deze vragen gaan in op de manier waarop coördinatie contractueel kan worden vastgelegd. Er wordt gekeken wie de verantwoordelijkheid draagt, welke bevoegdheden de coördinator heeft en hoe aansprakelijkheid geregeld kan worden.

Table 15: Richtlijnen vragen coördinatie

Nr.	Vraag	Uitleg of doel
8	Legt u de coördinatie bij de aannemer of de opdrachtgever neer?	Inzicht krijgen in de positionering van coördinatieverantwoordelijkheid.
9	Wanneer u de coördinatie bij een aannemer legt, kunt u deze partij dan ook juridisch bevoegdheden geven ten aanzien van andere aannemers? Hoe richt u dit contractueel in?	Begrijpen hoe bevoegdheden juridisch kunnen worden geregeld.
10	Moet u in het contract specifiek benoemen wat de taken en bevoegdheden van de coördinator zijn?	Vaststellen of expliciete omschrijving nodig is.
11	Kunt u een coördinerende aannemer ook juridisch aansprakelijk stellen als de coördinatie niet goed verloopt?	Begrijpen of juridische aansprakelijkheid mogelijk is bij gebrekkige coördinatie.

Samenwerking en conflicten

In dit onderdeel wordt onderzocht hoe samenwerking juridisch geborgd kan worden. Er wordt stilgestaan bij inspanningsverplichtingen, samenwerkingsplichten, en conflictoplossing.

Table 16: Richtlijnen vragen samenwerking en conflicten

Nr.	Vraag	Uitleg of doel
12	Hoe effectief zijn inspanningsverplichtingen? Hoe maakt u dit juridisch houdbaar? Kunt u een samenwerkingsplicht afdwingen?	Achterhalen of samenwerking juridisch afdwingbaar is.
13	Wat gebeurt er als aannemers er samen niet uitkomen? Wat is dan de procedure voor conflictbeslechting? Denk bijvoorbeeld aan een escalatiemodel.	Inzicht verkrijgen in juridische conflictoplossing.
14	Kunt u juridisch afdwingen hoe transparant of open een partij moet zijn richting andere partijen?	Begrijpen of transparantie juridisch vastgelegd kan worden.

Planning en vertraging

In dit onderdeel staat de gezamenlijke planning centraal, evenals de juridische gevolgen wanneer één partij vertraging oploopt en anderen daardoor worden beïnvloed.

Table 17: Richtlijnen vragen planning en vertraging

Nr.	Vraag	Uitleg of doel
15	Hoe kunt u een gezamenlijke planning leidend maken binnen het contract?	Begrijpen hoe planningen juridisch geborgd kunnen worden.
16	Dient u integrale toetsmomenten of mijlpalen al op te nemen in het contract, of kunt u die ook later toevoegen?	Achterhalen hoe flexibel het opnemen van mijlpalen is.
17	Wat gebeurt er wanneer een partij vertraging oploopt en daardoor andere partijen belemmert?	Inzicht verkrijgen in juridische gevolgen van verstoring in planning.

Integratie en raakvlakken

Deze vragen gaan over het juridisch vastleggen van verantwoordelijkheden rondom integratie en raakvlakken tussen segmenten. Ook het gebruik van tools zoals BIM wordt hierin betrokken.

Table 18: Richtlijnen vragen integratie en raakvlakken

Nr.	Vraag	Uitleg of doel
18	Kunt u één of meerdere aannemers aansprakelijk stellen voor een stuk integratie of een specifiek raakvlak?	Begrijpen of en hoe verantwoordelijkheid juridisch kan worden toegewezen.
19	Kunt u in een contract opnemen hoe moet worden omgegaan met verschillende opvattingen over een raakvlak en uiteenlopende belangen?	Inzicht in omgaan met conflicterende belangen rond raakvlakken.
20	In hoeverre kunt u het gebruik van programma's zoals BIM contractueel verplichten?	Begrijpen of gebruik van BIM juridisch af te dwingen is.

Communicatie en informatiedeling

Deze vragen richten zich op het formaliseren van communicatieverplichtingen binnen contracten. Het doel is om te begrijpen hoe overleg, documentatie en gedragsverwachtingen juridisch kunnen worden vastgelegd.

Table 19: Richtlijnen vragen communicatie en informatiedeling

Nr.	Vraag	Uitleg of doel
21	Kunt u in het contract vaste overlegmomenten opnemen, inclusief wie daarbij aanwezig moet zijn?	Begrijpen hoe overlegstructuren juridisch te borgen zijn.
22	Hoe kunt u documentatieverplichtingen en communicatieafspraken juridisch vastleggen?	Inzicht krijgen in juridische mogelijkheden voor informatieverplichtingen.
23	Kunt u contractueel eisen stellen aan de houding of het samenwerkingsgedrag van een partij, zoals inlevingsvermogen of proactief handelen?	Onderzoeken of gedragsnormen juridisch vast te leggen zijn.

Incentives

Deze sectie behandelt hoe financiële prikkels zoals boetes en bonussen juridisch kunnen worden opgenomen in samenwerkingsovereenkomsten, en hoe collectieve afspraken daarbij vastgelegd kunnen worden.

Table 20: Richtlijnen vragen incentives

Nr.	Vraag	Uitleg of doel
24	Moet u boetes specifiek opnemen in de overeenkomst, of zijn de boetebepalingen uit UAV en UAV-GC daarvoor al voldoende?	Nagaan of extra contractuele boeteregelingen noodzakelijk zijn.

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Nr.	Vraag	Uitleg of doel
25	Kunt u bonussen nog later toevoegen? Is dat juridisch mogelijk? Hoe implementeert u dit?	Begrijpen of en hoe bonussen flexibel in te richten zijn.
26	Hoe legt u juridisch een gezamenlijk potje vast voor overige risico's voor alle aannemers? En werkt dit?	Inzicht verkrijgen in gezamenlijke bonusstructuren en hun juridische houdbaarheid.

Bijlagen

Deze vragen hebben betrekking op welke documenten u kunt opnemen als bijlagen bij een coördinatie- of samenwerkingsovereenkomst, en in hoeverre deze juridisch bindend zijn.

Table 21: Richtlijnen vragen bijlagen

Nr.	Vraag	Uitleg of doel
27	Kunt u een escalatiemodel als bijlage toevoegen?	Inzicht krijgen in juridische houdbaarheid van conflict-procedures als bijlage.
28	Kunt u een gezamenlijke planning als bijlage toevoegen?	Nagaan of een planning als annex juridisch leidend kan zijn.
29	Kunt u een overlegstructuur en overlegplanning als bijlage opnemen?	Begrijpen of overlegverplichtingen in bijlagen rechtsgeldig zijn.
30	Kunt u een lijst met nevenopdrachtnemers als bijlage opnemen?	Onderzoeken of transparantie over nevenpartijen juridisch kan worden vastgelegd.
31	Kunt u een raakvlakkennota of raakvlakkenmatrix opnemen, bijvoorbeeld met het RASKI-model?	Begrijpen hoe technische raakvlakken te documenteren.
32	Kunt u een mijlpalenoverzicht als bijlage opnemen?	Inzicht in het formaliseren van deadlines en beslismomenten.

Samenhang tot andere documenten

In deze sectie wordt besproken of u in de overeenkomst moet opnemen hoe deze zich verhoudt tot andere juridische documenten zoals UAV(-GC) en MBO.

Table 22: Richtlijnen vragen samenhang tot andere documenten

Nr.	Vraag	Uitleg of doel
33	Moet worden vastgelegd hoe deze overeenkomst zich verhoudt tot andere juridische documenten en contracten, zoals het MBO, de UAV of UAV-GC?	Zorgdragen voor eenduidigheid tussen contract-documenten.

Effectiviteit

Hier wordt onderzocht of coördinatie- of samenwerkingsovereenkomsten daadwerkelijk juridische waarde hebben, en hoe u dat doelgericht kunt verwoorden.

Table 23: Richtlijnen vragen effectiviteit

Nr.	Vraag	Uitleg of doel
34	Heeft zo'n type overeenkomst ook juridische werking, of blijft het beperkt tot een inspanningsverplichting?	Begrijpen wat de juridische status van de overeenkomst is.
35	Moet het doel van de overeenkomst worden toegevoegd? Of is dit meer een informele uitleg?	Nagaan of het opnemen van doelstelling juridische waarde toevoegt.

Fasering van ontwerp en uitvoering

Deze vragen behandelen hoe fasering binnen het project (parallel of sequentieel) invloed heeft op de juridische invulling van samenwerking en coördinatie in een overeenkomst.

Table 24: Richtlijnen vragen fasering van ontwerp en uitvoering

Nr.	Vraag	Uitleg of doel
36	Heeft de overeenkomst een andere opzet nodig bij parallelle uitvoering van ontwerp en/of uitvoering in vergelijking met sequentiële uitvoering? Welke juridische aspecten veranderen dan?	Achterhalen of fasering invloed heeft op contractstructuur.
37	Zijn er specifieke risico's of juridische knelpunten die ontstaan bij parallelle uitvoering tussen meerdere aannemers die tegelijkertijd actief zijn binnen hetzelfde projectgebied?	Inzicht verkrijgen in bijkomende risico's bij gelijktijdige uitvoering.
38	Moet er in de overeenkomst een onderscheid worden gemaakt tussen samenwerking en coördinatie tijdens de ontwerpfase en tijdens de uitvoeringsfase? En hoe legt u dit juridisch vast?	Begrijpen of fasering expliciet geadresseerd moet worden.
39	Maakt u onderscheid tussen ontwerp en uitvoering in het contract?	Vaststellen of functionele fases apart benoemd dienen te worden.
40	Maakt u onderscheid in de verantwoordelijkheden in die twee fases?	Onderzoeken of rolverdeling per fase noodzakelijk is.
41	Detailniveau bij raakvlakken blijkt in de praktijk belangrijk. Dient u dit expliciet toe te voegen? Hoe?	Begrijpen hoe detailafspraken vastgelegd kunnen worden.
42	Wat voegt u toe wanneer u wel weet dat er een raakvlak is, maar nog niet weet hoe dit eruit komt te zien?	Nagaan hoe u onduidelijke raakvlakken juridisch kunt adresseren.

Overige vragen

Tot slot wordt ruimte geboden voor aanvullingen. Hiermee wordt gecontroleerd of belangrijke elementen ontbreken of extra aandacht verdienen in een coördinatie- of samenwerkingsovereenkomst.

Table 25: Richtlijnen vragen andere vragen

Nr.	Vraag	Uitleg of doel
43	Heeft u nog aanvullingen op deze lijst? Moet er iets anders nog in ieder geval in de overeenkomst naar voren komen?	Mogelijkheid om ontbrekende aandachtspunten aan te vullen.

D.3 Respondenten interviews

In tabel 26 staan de respondenten vermeld die zijn geïnterviewd op basis van hun expertise bij een specifiek project. Per respondent is vermeld wat het project is waar ze bij betrokken zijn, wat hun functie is en met welke organisatie zij betrokken zijn bij het project.

Table 26: Respondenten interviews project-specifieke experts

Interview nummer	Project	Functie
E1	Uithoornlijn	Projectmanager nevencontracten
E2	Uithoornlijn	Projectmanager nevencontracten
E3	Uithoornlijn	Projectmanager
E4	Uithoornlijn	Contractmanager
E5	Schiphol bagagekelder	Projectmanager
E6	Schiphol bagagekelder	Contractmanager
E7	AWZI Zwanenburg	Projectmanager
E8	AWZI Zwanenburg	Contractmanager
E9	Amsterdam CS	Bouwmanager
	Amsterdam CS	Bouwmanager
E10	Amsterdam CS	Manager Projectbeheersing
	Amsterdam CS	Technisch projectleider

In tabel 27 staan de respondenten vermeld bij de interviews met advocaten. Per respondent is vermeld wat de functie is en bij welke organisatie de respondent werkzaam is.

Table 27: Respondenten interviews advocaten

Interview nummer	Functie	Opdrachtgever of opdrachtnemer
F1	Bouwadvocaat	Opdrachtnemer
F2	Bouwadvocaat	Opdrachtgever
F3	Bouwadvocaat	Opdrachtgever