The discussion on the level of detail

Developing a framework to detect the difficulties in the determination of the level of detail in integrated contracts of large infrastructure projects

By
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Colophon

PROJECT DETAILS

Research project	A research into the difficulties in the determination of the level of detail of the tender specification based on UAV-GC 2005

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Preface

This Master thesis is the final report to conclude the Master Construction Management and Engineering at the University of Technology in Delft, the Netherlands. The research is executed within the company Witteveen+Bos in The Hague, the Netherlands, using their resources and case studies. With great pleasure I am finalizing my academic adventure at the TU Delft, while exploring new fields of interests and getting the opportunity to get a glimpse of what the engineering life holds for me in the future.

This research has been subjected to many transformations to become what it is. From the engineering company Witteveen + Bos there was a need to gain more insight on the decision-making process of the client together with the design process of the consultant. The engineering company felt that the dialogues between the client and the consultant were not going smoothly and observed an area of tension in this phase. However W+B could not pinpoint the exact problem. Due to the abstract demand, I considered myself being a detective in order to unravel the issue(s). In my first attempt I was looking for the solution, but the solution to what? Once I asked myself what I wanted to solve, it became clear to me, that finding the problem in itself will gradually lead to a solution. Therefore I devoted my research to allocate issues (areas of difficulty), while being inspired by the following quotes:

"If I had an hour to solve a problem I would spend 55 minutes thinking about the problem and 5 minutes thinking about the solutions". – Albert Einstein

"A problem well-defined is a problem half solved" – John Dewey

This research was of course not possible without the help of many people, which I would like to thank. Herewith I would like to thank my graduation committee. The chairman of my committee, Marcel Hertogh, thank you for your insights and sharp guidance. I would also like to thank my first supervisor from the TU Delft, Sander van Nederveen, for taking time to help me better my research and provide feedback throughout my research. Another person I would like to thank is my second supervisor from TU Delft, Martijn Leijten, for his extensive knowledge on, inter alia, process management and giving me advice and introducing me to valuable literature. I would also like to thank Ingrid Bolier, my supervisor from the engineering firm W+B. Her enthusiasm and ambitions were contagious and motivated me a lot during my process. Her passion for engineering reflected in her substantive guidance towards me, making the graduation process not only educational but also enjoyable.

Next to my graduation committee I also want to thank the 18 people I have interviewed for my pilot study and analysis not only from the engineering firm W+B, but also RWS, the municipality of Amsterdam and Utrecht. Nonetheless I would also like to thank the W+B colleagues in The Hague and Amsterdam, whom were always available to help out a grad student despite of their busy schedules. I experienced W+B as an open and knowledgeable company where personal development is highly valued and cheered on. Thank you for the pleasant experience.

Last but not least I would like to thank my family and friends for supporting me the last couple of months. My father's words always came across my mind when my motivation was lower than low. He once said to me "If there are 100 steps to walk, no one will remember the 99 steps you took if you quit at 99, the 100th step will make the 99 steps worthwhile".

Iet Fon
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Executive summary

The graduation research focuses on the difficulty in the determination of the level of detail (LoD) of tender specifications under UAV-GC 2005. The development towards a smaller and more efficient government had consequences for public organisations such as Rijkswaterstaat (RWS), the executive agency of the Ministry of Infrastructure and Environment (I&E). Public organisations dealt with lower budget, leading to a decrease in manpower and expertise while challenges became increasingly complex. A new way of procuring and commissioning was introduced in order to give answer to the changing needs. Resulting in the growing use of integrated contracts based on the UAV-GC 2005. Parties such as RWS and ProRail adopted this as a standard for their projects in the civil engineering sector.

Although the integrated contracts may offer more autonomy (within the frameworks of the tender specification), the client wants to know if the market can handle the autonomy. In order to keep control, one introduced the Systems Engineering (SE) method. SE is a design methodology, which was launched on the Dutch market for integrated contracts several years ago by RWS and ProRail. SE offers the contractor and the principal management/control capability, but it must be used and applied properly. In practice, parties appear to have great difficulty in the application of it. UAV-GC in combination with SE requires a different way of designing and cooperation. Initially, with the RAW systematic (UAV 2012) market parties were handed the technical specifications. Nowadays the market is confronted with functional specifications defined by public organisations, and therefore gaining more freedom in the technical approach. Subsequently this also gave room for discussions.

Pilot study
Principals such as RWS consult an engineering firm in the plan development in order to, inter alia, set up a tender specification, which will eventually form part of the tender documents towards the market in the procurement process. In the plan development phase, *somewhere* between the design process of the engineers and the decision-making process of the client, the engineering firm Witteveen+Bos noticed an area of tension but could not exactly pinpoint the exact issue. Therefore an empirical pilot study was conducted in that process to allocate the tension. According to Yin (2010, p. 37) the information from a pilot study can range from logistical topics (e.g. learning about the field time needed to cover certain procedures) to more substantive ones (e.g. refining a study's research questions). By means of the pilot study, the area of tension was unveiled and research questions could be established.

From an explorative pilot study on UAV-GC projects where the SE approach was used, it became apparent that the discussion on the level of detail (LoD) of the specification is where the area of tension of the project teams in the plan development phase appears. The pilot study revealed that the determination of the LoD is experienced difficult in the UAV-GC projects. Project teams are dealing with questions such as: How explicitly must the principal prescribe the specifications to the market? What is the appropriate amount of level of detail, or does that even exist? Can an appropriate amount be described in any way possible? However little knowledge was available on the implications on the determination of the LoD in practice and in addition there was no framework to guide a decision-maker in the determination as well.

Knowledge gap
It seems to be unclear why the determination of the LoD is difficult to determine in the aforementioned UAV-GC 2005 case studies. Insights in the causes for the current course of events have not been researched yet; neither does literature provide a framework for the determination of a suiting level of detail for infrastructure projects. It is mainly focused on the choice regarding the building organisation form (traditional, integrated or life-cycle). Although the building organisation form is indeed related to the level of detail, but how explicitly one should determine the specifications stands apart from the building organisation form. There can be considerable differences between one D&C contract and the other. In addition, which considerations should be taken into account in the determination of the LoD in the specification seems to be absent. By focussing on the determination of the LoD of the tender specification a method can be devised which may be applicable for other infrastructure projects that face similar decisions.

Objective
The objective of this research responds to the challenge of designing a framework that can help to determine the level of detail, but more importantly it should also reveal the areas of difficulty when a certain LoD has already been chosen, as is the case with the aforementioned UAV-GC case studies. The revelation of the areas of difficulty is important information for the principal in order to become aware of his risks in the plan development phase. In addition, by means of the framework awareness on deviations can be created in an early phase, and therefore form a part of the dialogue between the client and the consultant. This can help parties to foresee, prevent, eliminate or anticipate on the obstacles, so in turn project teams can focus on their core activities.

Research question
To be able to achieve the objectives and to investigate the difficulties in the case studies the following main research question has been established:

What are the causes of the difficulties in the determination of the level of detail of the specification in integrated contracts of large infrastructure projects?

A literature and theory study has been conducted to find the synergy between the level of detail in Systems Engineering and the building organisation form. Nonetheless the determination of the LoD is also subjected to policy guidelines. Therefore the statements on the LoD regarding public organizations have also been investigated.

Theoretical framework
In order to answer the research question, sub questions were formulated funnelling towards the causes of current events, i.e. causes on why the determination of the LoD is difficult in the UAV-GC 2005 cases. The first part of the theoretical framework focused on the current available literature and theories regarding the level of detail. Herewith it became apparent that the specification is one of the necessary constituent elements of the contract. The specifications will be utilized by a rather diverse group of participants. In fact the specification is the communication tool between the principal and the market.

In the literature study on the UAV-GC 2005, it became clear that Article 5 of the Basic Agreement describes the options in which the contracting authority can determine its influence on the design. However Article 5 gives no substance to the desired level of detail regarding functional or technical specification. PIANOo (2016f) stated that if a contracting party opts for an integrated structure, the contracting party must approach the market on a high abstraction level. In practice, many models on how one can choose between building organisation forms (traditional, integrated and life-cycle) were available but not on determining the LoD. While the latter is the essence in which project teams want guidance on in practice as observed in the pilot study. Literature on Systems Engineering showed that different systematic levels portray the explicitness of a tender specification. The systematic levels of Perrow (1984) have been used, in which the high abstraction level is linked to system and subsystem, and the low abstraction to unit and part. The literature study showed that although there is no framework to determine the level of detail, the contracting authority can be largely guided by the same considerations as with choosing the building organisation form as stated by Jansen (2006) and PIANOo (2016b).

Putting the literature study on the building organisation forms next to SE, it became apparent that no substance was given on what high and low abstraction level entails. While literature on the LoD in public organizations revealed that RWS and ProRail have a policy to outsource their works by means of integrated contracts, thus on high abstraction level. Resulting in the following hypothesis:

Projects based on the UAV-GC 2005 fit the characteristics of high level of abstraction

Building the framework
To fill the gap of knowledge, the elements contributing to the determination of the LoD have been investigated. By means of 14 literature and theory sources a list has been made on the determinants of

the LoD. Herewith it became apparent that the client, project and market aspects were the main aspects to take into consideration. In turn 9 dimensions and 31 indicators under those aspects have been detected and defined. In addition, to fill the gap on the concept of high and low abstraction level, the indicators have been matched to its relevant systematic level, by means of the linked keywords found in literature, see table 1.

Systematic level	Specification	Involvement market	Collaboration form	Design freedom	Abstraction level
System	Functional	Early	Integrated/life-cycle	Freedom	High
Subsystem					
Unit	Technical	Late	Traditional	No freedom	Low
Part					

Table 1 Systematic levels and the relevant characteristics

The framework should portray in one glance the policy of the public organisations (high abstraction level). Resulting in the conceptual framework, see table 2.

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction Unit to part
Client aspects			
Type of client	1. Professional or incidental client	Incidental	Professional
	2. Public or private client	Private	Public
	3. Knowledge & experience	Low	High
	4. Knowledge & experience regarding functional specification	High	Low
Client's ambition	5. Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	6. Sustainability	Important	Not important
	7. Innovation	Important	Not important
Client's influence	8. Translation to functional requirement	Many	Low
	9. Willingness to let go regarding setting requirements	Willing	Not willing
	10. High abstraction of the level of detail	High abstraction	Low abstraction
	11. The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	12. Newness of technology	Many new	No new
	13. Experience with the technology	Low	High
	14. Requirement of special equipment/technology	Needed	Not needed
	15. Technical risk	High	Low
Organizational complexity	16. Experience with parties involved	High	Low
	17. Organizational fragmentation	Low	High
	18. Organizational risk	Low	High
Environmental complexity	19. Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	20. Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	21. Environmental risk	Low	High
Cost complexity	22. Funding	Private	Public
	23. Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	24. Low management costs	Important	Not important
	25. Price/quality ratio	Important	Not important
Time complexity	26. Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	27. Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Market aspects			
Type of market and trust in market	28. Knowledge and experience	High	Low
	29. Knowledge and experience regarding functional specification	High	Low
	30. Readiness for long-term contract	Willing	Not willing
	31. Trust in the market	High	Low

Table 2 Conceptual framework

Method

The conceptual framework was part of the method to test the stated hypothesis. In order to test the hypothesis, the framework was supplemented with questions accompanying the indicators. Because the framework portrays in one glance the division between high and low abstraction level, deviations could be made visible. Two single case studies based on the UAV-GC 2005, namely project A9 Amstelveen Badhoevedorp – Holendrecht and project ZuidasDok, were investigated to challenge the hypothesis. The aspects that fall in the characteristics of the low abstraction level are considered not to fit the policy, i.e.

deviations. This is the gap between the desired and the existing situation, in other words the problem. Furthermore, a counter case study, namely Utrecht CU2030 HOV-viaduct, based on the traditional approach (UAV 2012) was conducted to verify the usability of the framework.

Analysis and synthesis
To determine the causes of the difficulties in the determination of the LoD, the two single-cases were conducted. Interviews have been held by means of the conceptual framework with project team members both from the client and the consultant side Witteveen+Bos. During the interviews questions were asked about the client, project and market aspects. Testing the hypothesis was done by means of only looking at the deviations that occurred in both case studies. The indicators that did not fit a high abstraction level were investigated in order to reveal the causes of the difficulties in the determination of the LoD.

Project Utrecht CU2030 HOV-viaduct was examined as a counter case study to verify the usability of the framework. In this additional case study no difficulties regarding the determination of the LoD was detected in the pilot study. The framework has been applied to this case study and was put next to the policy in order to detect possible deviations. This counter case study must fit a low abstraction level as it is procured under the UAV 2012. The synthesis proved that the client and project aspects fit a low level of abstraction, but the market aspects showed deviations. This is also the only junction where this project does not fit RAW, due to the present market's technical expertise.

Results and conclusions
The synthesis revealed the causes for the course of events in the mismatch between the policy (desired situation) and the practical (existing situation) by means of the deviations. Deviations on the client and project aspects were perceived in both cases. In addition, the ZuidasDok also showed deviations in the market aspects. Projects similar to the A9 Amstelveen Badhoevedorp – Holendrecht and ZuidasDok can be subjected to the difficulty in the determination of the LoD due to:

1. Privatization of governmental tasks towards the market (A9 Amstelveen)
2. Different intra-organizational objectives on the abstraction level (A9 Amstelveen)
3. The stated ambitions translated in the EPVE and the policy procedures (A9 Amstelveen)
4. The variety of principals (ZuidasDok)
5. Different inter-organizational objectives on the abstraction level (ZuidasDok)
6. The organizational and environmental complexity challenge of the project (ZuidasDok)
[7.] Distrust between the principal and the market (ZuidasDok)

In the following paragraphs, these causes are explained for the case studies.

A9 Amstelveen Badhoevedorp - Holendrecht
Privatization brings in external experts with technical enthusiasm, i.e. the ability and desire to specify into much detail, however their objective to specify into much detail does not correspond with the high abstraction level objective of RWS. In addition, privatization disrupts the traceability in the crystallization of the system, because it makes organizational and communication lines longer as the line under the core team is substituted rapidly. Occurrence of rapid substitutions and *project brain drain* in a project requires working explicitly to support clear communication in the chain cooperation. However the policy of RWS is to specify on high abstraction level.

Different objectives on the abstraction level disrupt the policy of specifying on a high abstraction level. This was perceived within the IPM teams. Teams that are more engaged with risks and costs (budget) want a high level of abstraction in order to tame the risks and costs of the project. Teams that are more engaged with technical, environmental and political matters are unwilling to let go control and desire a low abstraction level. This brings friction in the determination of the LoD.

Last but not least the policy of the principal dictates a high level of abstraction. While the stated vision (EPVE document), late entry point and the desire for accurate budget estimations in this case study implicate a low level of abstraction. The EPVE was used to engage with the stakeholders, the document is presented into much detail and steers the expectation of the project. Promises made regarding the

presented details are expected to be included in the contract. However this is in conflict with the stated policy. This makes the determination of the LoD difficult, as the desire of high abstraction is not reflected in the outcome due to regulations and wishes. The more one delves into the specification process the more one incorporates rules/requirements to safeguard their expectations on the project.

ZuidasDok

The variety of principals brings different ambitions, knowledge (working methods), projects areas and the related type of environment, making the determination of the LoD difficult. As in the elaboration of the objects, choices can be made that can be more favourable for one party but not for the other. Making specification degree hard to predict. In addition, the working methods of the principals were not aligned in this project. RWS and ProRail both have their own specification method, however RWS's was chosen. Subsequently, the municipality, which is used to the RAW systematic, and ProRail had to adjust their working method. This took quite some effort, making the determination of the LoD difficult.

Different inter-organizational objectives on the abstraction level occurred making the determination of the LoD difficult. In this case ProRail was unwilling to let go of specifying due to its technical knowledge and wanting to communicate by means of detailed drawings. Given that the municipality has the inhabitants and the economic activity to consider, and the municipality and ProRail both want to anticipate on the maintenance of the project. RWS specified on a higher abstraction level than the other two parties. Aligning the three principals into one direction was experienced as quite a hassle. Although the policy prescribed a high level of abstraction, the overall project had all kinds of abstraction levels eventually. The design process was continuously accompanied by laborious and slow decision-making due to many parties with a variety of interests, making the LoD difficult to determine.

The ZuidasDok project is subjected to high organizational and environmental complexity. A clear specification of policy goals or products is hard to make because of institutional fragmentation and strategic and knowledge uncertainty. The tender specification is in its core focused on the system rather than the handling of the environment. The difficulty of the determination of the LoD arises here on how one can incorporate requirements that take into account both technical as environmental matters. Taking into consideration that the market's core business lies in its technical skills.

Last but not least the assumption remains that distrust between the principal and the market can also contribute to the difficulty. In this case study it was found that although much has been stated into detail the market did not mind it due to the environmental complexity and limited time given for the project. The distrust between the market and the client has reshaped the demand of the project due to lessons learned from the MaVa A15 project. Nonetheless it can be assumed that in others projects where environmental and organizational complexity and lead-time are not perceived as explicitly important, the market would still want design freedom, i.e. a high abstraction level. The findings on the distrust did not provide a unanimous answer whether distrust led to the difficulty in determining the LoD, more research is needed on this subject.

The area of difficulty that occurred in both cases is the different objectives on the abstraction level in the organization. Every infrastructure project is subjected to a diversity of disciplines that have to take into account their own sphere of influence and interests. Therefore it is not unthinkable that different objectives on the abstraction level will occur. However in the case of A9 Amstelveen, there was only one principal. The focus lied on one organization and therefore the privatization of governmental tasks towards the market showed its consequences explicitly. The ZuidasDok on the other hand, deals with three principals, shifting the focus from intra to inter-organizational (between two or more separate organizations) cooperation. This explains why the outcome of the different objectives on the abstraction level within the organization in the A9 Amstelveen case was more into detail.

Another aspect that emerged from the empirical study is that both projects were perceived not that difficult technical wise according to the respondents. The environmental complexity had the upper hand, even more explicitly in the ZuidasDok case. The ZuidasDok deals with different sub projects into one contract, while the A9 Amstelveen project is one project part in one contract. The deal breaker in the ZuidasDok case to go for an UAV-GC is because the desire is to execute the project in an integrated

manner. This is also the reason why the challenge of the environmental and organizational complexity stood out and forms one of the difficulties for the ZuidasDok case. Regardless the magnitude of the project, the market is trusted more with its technical skills than with its ability to cope with the environment in both cases.

According to the framework (based on literature/theory), for both cases a low level of abstraction suits the observed deviations in the client and project aspects, and for the ZuidasDok also the market aspects. The question arises: does the policy needs to change? The answer is that it depends on the greater purpose. The shift to a smaller and more efficient government will only develop further. Both the government as the market need the experience to become familiar with the new way of working. The sector needs the incremental process to finally get to the point where the government wants it to be now. The policy does not need to change, but the areas of difficulty should be taken into account.

Recommendations

Recommendations have been set up to support the specification process between the client and the consultant. The following four recommendations have been established:

1. **Awareness on the problems occurring in the determination of the LoD**
   From the pilot study to the in-depth case studies, problems in the determination of the LoD arose. Giving recognition to the areas of difficulty that can jeopardize the specification process, consultants of the principal can anticipate and modify their specification process to the needs of the project. As perceived in both cases the different objectives on the abstraction level can form a difficulty in the determination of the LoD. In order to align the objectives of the abstraction level in the organization the principal must become aware what he brings into the organisation and make sure their competencies have room to flourish. Currently, in the A9 Amstelveen case the different teams only communicate through the IPM management lines. Just like the dialogue phase that the client has with the market, a dialogue phase should be incorporated in the specification process with the teams that are engaged with the technical, budget, risk and environmental matters. Herewith the different teams should present their line of reasoning regarding their objective on the LoD to each other and discuss openly about it. This will also clarify each other's role in the specification process. The line of reasoning on the LoD was also the missing link for the teams to understand the specification process in the A9 Amstelveen case (disrupting the traceability in the crystallization of the system).

2. **Anticipate on the environmental and political influence the project is subjected to**
   The case studies showed that both projects are technically less of a challenge, and the greater challenge lies in the market's organizational approach in the environmental complexity as perceived explicitly in the ZuidasDok case. Public and private organizations should give recognition to the environmental and political influence the project is subjected to. Herewith the focus on technical specifications consultants are dealing with should shift in thinking along with the client on an environmental strategy. The core focus of contracts lies now in the system as a technical challenge. Questions such as 'How are we going to incorporate environmental incentives in the procurement phase to the market' should be asked in the client-consultant engagement. By means of the EMVI, in which the client assesses the market on how to deal with the environment, nothing has been laid down formally and uncertainty remains for the execution phase. W+B can think of an award system every time the winning contractor shows its engagement with the environment in the execution phase or a way to specify environmental engagement into the functional specifications.

3. **Awareness on the added value of the market**
   Due to the developments in the industry, it is not unthinkable that the core business of the market has to shift. As the public organizations are downsizing, their control capacity will be less. Currently public organizations have a tendency to outsource everything. Even in the case study of the RAW this was detected. The development requires a contractor that is no longer only technically skilled but also organizational. Awareness on the added value of the market should be created and supported by the principal or consultants of the principal where gaps still occur. Public organizations should therefore also take the wishes of the market into consideration. It is a

misperception that the market always wants design freedom. Public and private organizations should define the right reason(s) why they want to bring the market on board. Is this technical or organizational, or both? Strengths and weaknesses of the market and the public organisation itself should be defined. It can be assumed that the strength of the public organisation lies in the handling of the environmental complexity (political, stakeholders, permits) and that of the contractor lies in dealing with technical complexity. By defining the strength and weaknesses of the project parties, one can complement each other to increase the effectiveness of their roles. As learned from the ZuidasDok it has been detected that the hired experts are more than capable of doing the standard design and the market should only focus on optimization challenges, therefore the market requested the reference design.

4. **Think along with the client**

   The core of the aforementioned recommendations is to advice engineering firms to think along with its client. The client respondents mentioned that it is important for any engineering firm to consider the greater picture and they expect a critical attitude from them. Engineering firms should make their clients aware that a stated policy can effect the determination of the LoD. As perceived in the A9 Amstelveen case it is of importance to be critical on the handed assignment and question 'what the greater purpose is of the assignment and if the outcome will add value to the overall process'. Think outside the own assignment (specifying the system) by also anticipating on the effects of the specification towards the market and the environment.

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List of abbreviations

CE	Civil Engineering
DNR 2011	De Nieuwe Regeling 2011
FS	Functional Specification
INCOSE	International Council of Systems Engineering
LoD	Level of detail
Ministry of I&E	Ministry of Infrastructure & Environment
RWS	Rijkswaterstaat
SE	Systems Engineering
UAC 2012	Uniform Administrative Conditions 2012
UAC-IC 2005	Uniform Administrative Conditions for Integrated Contracts 2005
UAV 2012	Uniforme administratieve voorwaarden 2012
UAV-GC 2005	Uniforme administratieve voorwaarden voor geïntegreerde contractvormen 2005

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Reading guide

1. Introduction
In this chapter the research context will be introduced, providing the reader the first confrontation with the problem derived from a brief literature and practical study. The introduction sets the foundation for further research on the problem. Nonetheless an overview regarding the research set up will be given. This chapter is important because it will clarify the purpose of the research by means of the research questions.

2. Theoretical framework
Chapter 2 investigates the literature and theories regarding the level of detail of the specification in the Systems Engineering, building organisation forms and the public organizations. The relevant concepts and their interrelations are herewith explored to form a starting point for the theoretical framework regarding the determination of the level of detail. At the end of the chapter a **hypothesis** will be formulated.

3. Building the framework
Because this research is in search of the problem area a deeper analysis on the level of detail will be conducted in section 3.1, where the determinants (input) are analysed, setting the foundation for the theoretical framework. The framework will be used to challenge the projects in practice. The aim of this framework is to make the discrepancy between the desired LoD (based on literature) and the perceived LoD (based on practical studies) explicit. Once the problem area is detected an intervention can be developed. This can result in recommendations or strategies.

4. Methodology
Chapter 4 provides the reader, the methodology that will be conducted in order to determine the areas of difficulty in practice by means of the framework as presented in chapter 3. This chapter will elaborate on how the analysis will be conducted following the structure of the framework (client, project and market aspects) and how the hypothesis will be tested. In addition, the projects for the single case studies will be introduced. The methodology chapter will clarify the path towards the results.

5. Analysis
The analysis follows the structure of the framework (client, project and market aspects). In this chapter the analysis regarding the projects A9 Amstelveen Badhoevedorp – Holendrecht and ZuidasDok will be explored and also how the theoretical framework perceives the aspects in relation to the abstraction levels.

6. Synthesis
Chapter 6 investigates the analysis further by conducting a synthesis, putting the policy (desired situation) and practice (existing situation) next to each other. Herewith the hypothesis was tested and revealed the deviations. The deviations have been investigated and uncovered the causes of the difficulties in the determination of the LoD. Next to that, an additional counter case study on Utrecht CU2030 HOV-viaduct has been conducted in order to investigate the framework on a RAW project.

7. Reflection on the framework
Chapter 7 presents a reflection on the framework and evaluates on the framework results as perceived by the respondents. In conclusion, the framework improvement points will be presented.

8. Conclusions and recommendations
The final chapter concludes this research and presents the final results derived from literature, theory and the single case study. In addition, recommendations will be given regarding the projects and further research.

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1 Introduction

In the Netherlands, the government is responsible for the development and maintenance of the road infrastructure network. At national level, the executive agency of the Ministry of Infrastructure and the Environment (I&E), Rijkswaterstaat (RWS), is responsible for the national network of highways, main waterways and water systems (Van Valkenburg, Lenferink, Nijsten, & Arts, 2008). To align infrastructure and the spatial development, collaboration in the form of a public-private partnership (PPP) plays an important role. The State, province and municipalities must work well together to achieve comprehensive development (Netwerk, 2015). However public organisations are dealing with lower budget leading to a decrease in manpower and expertise while challenges are becoming increasingly complex. Therefore private parties are involved for their extensive knowledge in design, construction, management and for co-financing (Netwerk, 2014). Next to the contractor often a third party is involved within a PPP, which is the consultant (engineering firm). The consultant either works for the client (employer) or the contractor. Often the consultant is consulted during the development/design phase (de Ridder, 2009, p. 27).

Traditionally, the public organisation as client has the supervisory role and determines in detail what is going to be built; this is also known as technical specification. The contractor executes the works devised by the client, at the lowest offer price. The traditional approach forces contractors not to think along with the client and taking responsibility. This approach is usually procured on the basis of the Uniform Administrative Conditions 2012 (Dutch: Uniforme Administratieve Voorwaarden) or RAW-systematic. This works well when the client wants to keep project control, has in-house expertise to create designs and specifications, knows and controls the risks and has the capacity to monitor the contractor (PIANOo, 2016f).

Rijkswaterstaat started from a technocratic system, which was reflected in the hierarchical and semi-military organisational structure and its project management tradition. The technocracy discourse dominated the way in which RWS engineers conceptualised the world. However the tide changed. Debates arose on the perceived technocratic management of large infrastructure projects and, more generally, its contribution to the modernisation of the Dutch government (van den Brink, 2009, pp. 78-81). As a consequence, Rijkswaterstaat found itself on the horns of a dilemma. On the one hand, it needed its renowned expert status to fulfil its public responsibilities. On the other hand, it also needed to distance itself from this expert status to be able to meet the increasing social and political imperative of developing into a more responsive and efficient public organisation as stated by van den Brink (2009).

The development of a smaller and more efficient government, next to infrastructure projects being larger, more multidisciplinary and complex led to a different infrastructure development approach. The Ministry of I&E aims for earlier involvement of contractors to achieve added value for society in other words best value for taxpayer's money. This added value being, inter alia, innovative solutions for mobility-related problems, better project control and savings on time and money. In order to achieve this the Ministry implemented integrated and life-cycle contracts, such as design and construct (D&C) and design, build, finance, maintenance, operation (DBFMO) (Van Valkenburg et al., 2008, pp. 323-324).

With an approach based on UAC-IC (Dutch: UAV-GC), the request towards the market also changes. Instead of detailed specifications, higher abstracted specifications are put on the market. A method to do this is with *functional specification*, which aims for a solution-free specification, and describes on every level of detail (LoD) the functions that must be realised and which requirements it must meet. The market shows its creativity by offering the technical solutions to the functional specification. This method is based on the Systems Engineering (SE) approach. RWS and ProRail BV, responsible for the Dutch railway infrastructure, explicitly use the SE method in order to formulate their tender specification (PIANOo, 2016f). The shift from traditional to integrated procurement and the request for supporting design tools, subsequently means that the market is involved earlier in the project process. This development gives room for discussions regarding how explicitly one should put out the tender specification, this will be further elaborated in the next paragraph and also forms the research context.

1.1 Research context

Principals are increasingly outsourcing infrastructural works on the basis of a tender specification in which the desired system is described functional. The development of these specifications and associated reference design can be outsourced to an engineering firm such as Witteveen+Bos. This takes place in the plan development phase in which the consultant is deployed to guide the client often through the draft Route decision (Dutch: ontwerptracébesluit) and/or the Route decision[1] (Dutch: tracébesluit) nowadays often by means of the SE method.

1.1.1 Observation

W+B helps translating stakeholders' and client's wishes and needs into functional requirements to be put on the market as the tender specification (Dutch: vraagspecificatie), which forms a part of the total tender document (Dutch: aanbestedingsdocument). Within this process the engineering firm noticed an area of tension but could not exactly pinpoint the issue. Therefore an explorative empirical pilot study was conducted in that process to allocate the tension. This is a project management research following an inductive approach to start with. Unlike the deductive approach, which has a theoretical starting point, the starting point of the inductive approach is observation. From specific observations, patterns are searched for and preliminary hypotheses are formulated, leading to the development of new theory.

[1] The Route decision follows a statutory process and is legally binding in public law. Moreover the Route decision is a detailed document specifying the infrastructure and the objects that go with them (lighting, sound barriers) due to the necessary legal certainty to the stakeholders. These are laid down in map displays and regulations (Verhees, 2013).

In the Wheel of Science from Wallace (1971), the phases of inductive and deductive research are naturally following each other, see figure 1.

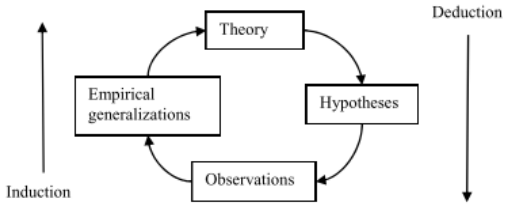

Figure 1 The Wheel of Science (Wallace, 1971)

For example, in this research it is unclear what and where the area of tension is, no theory is available. One can start with observations, which via empirical generalisations can lead to new theory (induction). From this newly developed theory hypotheses are formulated which are then tested by, again, observations (deduction). Although there is no single, unified theory on project management, different disciplines in project management do have a firm theoretical basis from which hypotheses can be formulated. Subsequently, these hypotheses are tested based on observations, which is at the deductive side of the deductive/inductive spectrum (Bosch-Rekveldt, 2015, pp. 317-318).

The observation will be conducted by means of explorative case studies. According to Yin (2003) explorative case studies are often done in the initial phases of the research in a certain area, having the most inductive character of the different types of case studies. Nonetheless case studies can still be useful in both deductive and inductive approaches as "the case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone" (Flyvbjerg, 2011). In section 1.1.2 the most important relevant findings from the pilot study for this research will be presented. In **Appendix A,** the pilot study has been further elaborated.

1.1.2 Pilot study

Three cases based on UAV-GC 2005 were investigated; nonetheless one RAW project was intentionally researched as well as a counterpart. The most relevant finding in relation to the plan development phase and in the client-consultant engagement was the issue regarding *the discussion on the level of detail (LoD)*. The discussion on the LoD was not detected in the RAW case study, because in the light of RAW, one specifies in detail and outsources the works to the market. This will leave no room for discussion on the LoD.

The level of detail of the specification was experienced difficult to determine in practice. Reasons by the respondents had to do with complying with the stakeholder's wishes and requirements, conflict of interest, the risks of the client and giving design freedom to the market. In other words, the issue entails a discrepancy between what the public client wants, what it prescribes and what it is obliged to do. To start with, the UAV-GC is appealing to the public client due to the shift of *risks* to the market party and for the public client being more relinquished from the project (de Koning, 2014). With this being said, the client formulates the specifications functional. Meaning no longer in terms of solutions but as a problem description (de Koning, 2015). However relinquishing from the project appears to be difficult in practice (de Koning, 2014). Stakeholders, especially network operators such as ProRail, NS, cables and pipes operators, want to stay involved and make sure that their detailed wishes are implemented. Next to that residents would also like to see detailed information on their future neighbourhood regarding the social security. The public client needs to comply with their wishes due to *legal certainty*. However more involvement and detailed specifications also means taking back the risks. Nevertheless it reduces the *design freedom* of the market. In a sense a new kind of triple constraint can be detected regarding the risks, design freedom and legal certainty, see figure 2. The first two graphs in the figure represent the pure reality. The third graph in figure 2 represents the desired situation for the client, however this cannot be reached due to responsibilities and risks being interwoven.

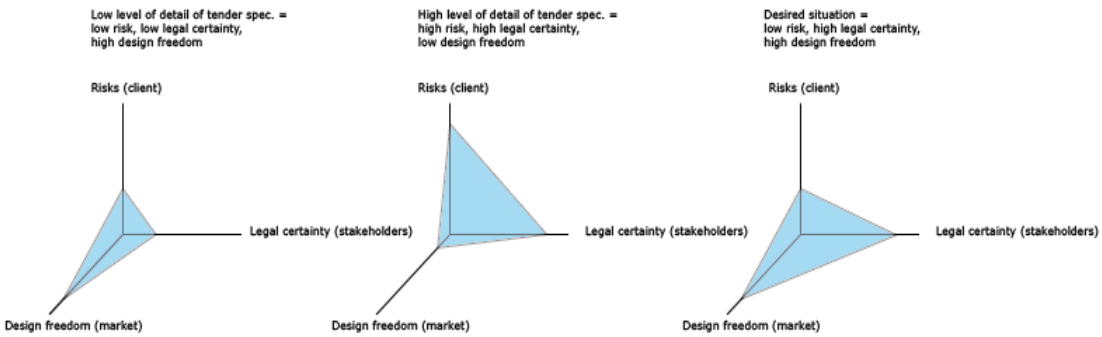

Figure 2 The triple constraint of the level of detail for a tender specification (own ill.)

Public organisations and the market are facing challenges in finding the balance between the appropriate level of detail of tender specifications to restrain the risks of the public client on the one hand, but on the other hand also to offer legal certainty to its stakeholders and design freedom to the market.

The aforementioned reasons by the respondents from the pilot study were investigated, but have been perceived as the outcome for the choice of a certain level of detail of the specification. First of all the risk allocation is *not* or *should not be* determined by the building contract model or LoD. According to de Ridder (2009, p. 54) the risk distribution depends on a certain reimbursement system. The link between risk allocation and the choice for a certain LoD or building contract model should not be mixed, as the risk allocation is an outcome of a certain reimbursement system. Second of all the legal certainty of the stakeholders and the design freedom of the market are interrelated. More design freedom, does not necessarily have to mean a decrease of legal certainty. Because by deploying the market in an early phase the design and execution can/will be more integrated, hence increasing the legal certainty (Jansen, 2009, pp. 77, 91, 105). In other words, these are not the fundamental considerations for a LoD. However it can be assumed that the respondents mentioned these because it is easier to communicate with these concrete terms.

As spotted in the three UAV-GC cases the determination of the level of detail in itself seems to be the struggle of the project teams, and that is the only assurance that can be given from the pilot study. Project teams are dealing with questions such as: How explicitly must the principal prescribe the specifications to the market? What is the appropriate amount of the level of detail, or does that even exist? Can an appropriate amount be described in any way possible? There is no grip such as a framework to determine the LoD by any means. It can be stated that there is a gap of knowledge on how the level of detail of the specification is determined for UAV-GC projects in the civil engineering. In this perspective more knowledge is needed on what the LoD entails, how it is obtained and why and where the struggles seem to appear.

1.2 Problem analysis

The pilot study revealed an area of tension in the determination of the LoD in the specification in the plan development phase of the three UAV-GC cases, many questions and discussions seem to appear in the light of this subject. Project teams, both from the client as from the consultant side, find it difficult to determine the appropriate LoD of the tender specification. The term *level of detail* used in this research, describes to what extent and what scale level a system (for example an infrastructure network) must be worked out or examined. In different literature sources one also uses the term *specification detail*. The specification detail should not be confused with the complexity of language. In the construction industry it refers to the magnitude of specified information relative to the *scope* and the *complexity* of the project (Kalin, Weygant, Rosen, & Regener, 2010). In this research the term 'level of detail' will be used.

It seems to be unclear why the determination of the LoD is difficult to determine in the aforementioned UAV-GC case studies. Insights in the causes for the current course of events have not been researched yet; neither does literature provide a framework for the determination of a suiting LoD for infrastructure projects. It is mainly focused on the choice regarding the building organisation form (traditional,

integrated or life-cycle). Although the building organisation form is indeed related to the LoD, how explicitly one should determine the specifications stands apart from the building organisation form. There can be considerable differences between one D&C contract and the other. In addition, which considerations should be taken into account in the determination of the LoD seems to be absent. By focussing on the determination of the LoD, a method can be devised which may be applicable for other infrastructure projects that face similar decisions.

This research focuses on the determination of the LoD in the tender specification and the implications that are currently perceived within it. The LoD occurs in the context of the building organisation form and Systems Engineering and is also subjected to a certain organization.

1.3 Research objective

The academic relevance of the research is primarily the assessment of literature in the field of the level of detail in the civil engineering. It has become a vital aspect since the introduction of UAV-GC 2005 in combination with the SE method.

The objective of this research responds to the challenge of designing a framework that can help to determine the LoD, but more importantly it should also reveal the areas of difficulty when a certain LoD has already been chosen, as is the case with the aforementioned UAV-GC case studies. In this research the A9 Amstelveen Badhoevedorp – Holendrecht and ZuidasDok will be investigated. The revelation of the causes on why the LoD is difficult to determine is important information for the principal in order to become aware of his risks in the plan development phase. In addition, by means of the framework awareness on deviations can be created in an early phase, and therefore form a part of the dialogue between the client and the consultant. This can help parties to foresee, prevent, eliminate or anticipate on the obstacles, so in turn project teams can focus on their core activities.

1.4 Research question

The objective as mentioned in previous section leads to the main question of this research:

What are the causes of the difficulties in the determination of the level of detail of the specification in integrated contracts of large infrastructure projects?

By dividing the main research question into relevant sub questions, the research process can be structured. The mentioned case studies A9A (B-H) and ZuidasDok will be used as case studies and the following sub questions are formulated:

Sub question 1
What insight(s) are needed in order to determine the level of detail of the specification according to literature/theory?

To comprehend the current literature/theory about how the LoD is defined, where it occurs and what still needs to be investigated. This has an explorative objective.

Sub question 2
What elements of the project do contribute to the determination of the level of detail of the specification according to literature/theory?

To comprehend the elements that determines the LoD of the specification. This also has an explorative objective.

Sub question 3
What insights are needed to construct a theoretical framework in order to determine the level of detail and to detect the areas of difficulty?

A theoretical framework in order to determine the LoD of the specification is required to structurally investigate the areas of difficulty. This question has an explorative and designing character. The answer to this question is embedded in the methodology chapter, as it will form a part of the method to investigate the research problem.

Sub question 4
What are the causes of the difficulties in the determination of the level of detail in the case studies A9 Amstelveen (Badhoevedorp-Holendrecht) and ZuidasDok?

The final question deals with the area of tension as occurred in the pilot study.

1.5 Scope

Although the LoD is the center of discussions in practice, still little literature or theories have been devoted to this specific topic. In most cases the LoD of the specification has only been addressed as an embedded topic within the *building organisation form* and the *Systems Engineering* approach. Yet this is not really strange as the consideration of whether a specification is worked out sufficiently or not is often done in consultation with the contract management (which deals with the building organisation form) and the technical management (which deals with Systems Engineering). In addition, the internal policy guidelines within an organization may prohibit a particular level of detail of the requirements of the tender specification or even mandate a certain level of detail (PSI 112). Therefore the perspective of the organization on the level of detail must also be investigated. All in all this research considers the context of three fields, their intersect will be the scope of this research (figure 3):

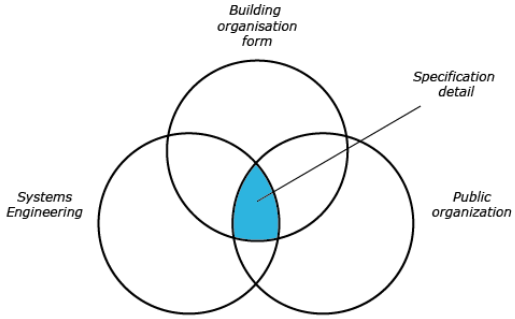

Figure 3 Scope of the research (own ill.)

- **Building organisation form** describes the division of tasks amongst participants in the building process. This can be done by means of the traditional, integrated and life-cycle model. The focus of this research limits to the integrated and life-cycle model.
- **Systems Engineering** is in essence a structured specification and design method. The focus will be on specifying the requirements and the level of detail that goes with it.
- **Policy guidelines of an organization** will be described regarding the following public organisations: Rijkswaterstaat, ProRail and municipalities.

2 Theoretical framework

In previous chapter the research context has been established. In this chapter the relevant concepts and their interrelations are further explored. This chapter focuses on the theoretical perspective on the LoD. The chapter starts with an introduction of what the level of detail of the specification entails (2.1). The term level of detail occurs both in the building organisation form (2.2) as in the System Engineering approach (2.3) in the civil engineering. The objective of this chapter is to find the synergy between these two aspects in order to make a framework for the determination of the LoD eventually. Nonetheless the internal policies of an organization as mentioned in section 1.5 also plays a crucial role in the determination of the LoD, therefore special attention is given to the matter in which public organisations deal with the LoD (2.4).

This chapter will give answer to sub question 1:
What insight(s) are needed in order to determine the level of detail of the specification according to literature/theory?

2.1 Level of detail of the specification

There are many definitions of *specification* available in literature (Encyclo, 2016; Merriam-Webster, 2016; Rosen, 1974; vanDale, 2016). Despite small differences in these definitions, specification generally refers to a detailed description of work to be done or materials to be used in a project: an instruction that says exactly how to do or make something (Merriam-Webster, 2016). In the definition one can detect the word *detailed*, how detailed the description should be, will be referred to as the level of detail. The term level of detail in this research is based on the description of Kalin et al. (2010),which has also been mentioned in the introduction:

The level of detail describes to which extent and what scale level a system (for example an infrastructure network) must be worked out or examined. In different literature sources one also uses the term *specification detail* (in short: spec detail). The specification detail should not be confused with the complexity of language. In the construction industry it refers to the magnitude of specified information relative to the *scope* and the *complexity* of the project. In the overall research the term level of detail or in short LoD will be used.

According to the American Institute of Architects the specifications is one of the necessary constituent elements of the contract. As one of the major contract documents, it is imperative that practicing architects and engineers have a very good working knowledge of the role that specifications play. The specifications will be utilized by a rather diverse group of participants. Rosen (1974, pp. 5-6) distinguishes the following roles of specifications:

Participants using the specifications	**How they will use it**
Contractor	Telling him how to construct, manage and direct the construction
Estimator in the contractor's office	To prepare the estimate based on the specifications
Purchasing agent in the contractor's office	Procuring the materials and equipment described in the specifications
Resident project representative or inspector	To aid him in inspecting and controlling the work
Owner	To know what he is buying and what he is entitled to receive
Subcontractors	To readily discern the scope of his subcontract
Manufacturers of building materials and equipment	So that the grade and type are clearly defined with respect to many variations they may manufacture

Table 3 The role of specification

The LoD occurs in the context of the building organisation form and Systems Engineering and is also subjected to a certain organization. Respectively, these topics will now be elaborated in the next sections to find out what insight(s) are needed in order to determine the LoD according to literature/theory.

2.2 Level of detail in the building organisation form

The building organisation form/building contract model (Dutch: bouworganisatievorm) and the contract form are two different terms often used interchangeably. However PIANOo[2] and Regieraad Bouw[3] made a clear distinction in the two terms. The building organisation form is the manner in which the tasks are divided amongst the participants in the building process. Nonetheless the choice for a building organisation form is not the same as choosing a contract form. The contract concerns the legal establishment of the contractual agreements made between the participants (PIANOo, 2016e).

2.2.1 Different types of building organisation forms

The choice for a building organisation form answers the questions who is going to perform which tasks, regarding:

- The design of the project (design or engineering)
- Execution of the project (build or construct)
- Acquisition project finances (finance)
- Provision long-term maintenance and management of the actual construction process (maintain)
- Exploitation of the actual construction process (operate)

In most cases the market always conducts the execution. There are three common building organisation forms in the Netherlands; these have been further elaborated in **Appendix B**:

- The traditional building contract model
- The integrated building contract model
- The life-cycle building contract model

The focus of this research is on the integrated and the life-cycle building contract models. These models are based on the UAV-GC 2005 (Dutch: Uniforme Algemene Voorwaarden voor geïntegreerde contractvormen 2005). Whenever an architect/engineer is commissioned by a client to design a structure there are three documents that need to be developed, which a third party, the contractor must utilize in order to build the structure. These three basic documents are the drawings, the conditions of a contract and the specifications; together with the agreement they constitute the contract documents (Rosen, 1974, p. 5). These documents have a coherent system and a fixed hierarchy: in case of discrepancies, the upper documents in figure 4 will prevail.

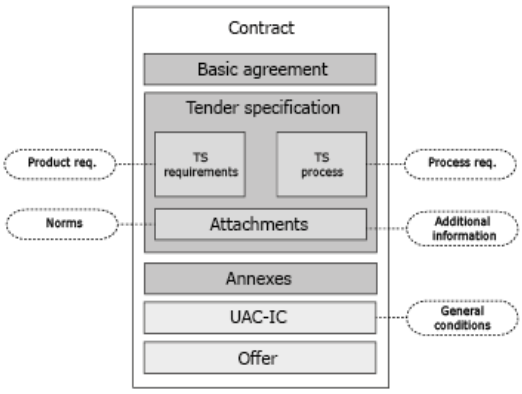

Figure 4 Structure of an UAV-GC 2005 (Moonen, 2016, p.181)

Important components of the basic agreement are the determination of the contract price and the moment of completion. The tender specification describes the core of the contract: what needs to be realised in part 1 (in the tender specification requirements) and what the requirements are for the work to be performed in part 2 (in the tender specification process). The tender specification also contains many attachments, which the contract refers to. For example information notices (Dutch: nota's van inlichtingen). The annexes contain partly administrative matters, but also substantive aspects

[2] PIANOo, Procurement Expertise of the Ministry of Economic Affairs, provides information, advice, tools and practical advice to anyone who engages in the procurement in the public sector and procurement of works, supplies and services.
[3] Regieraad Bouw, Innovation platform for clients and contractors in the regional construction industry. The strength of the Management Council is the representation of municipalities, county, Rijkswaterstaat, boards and corporations, which work together with the market and education at a high level of innovation and change in the construction industry.

such as planning and information on request of licenses for the contractor. Deviations and additions on the UAV-GC are also included. The annexes also contain a list of documents what the contractor must take into account. Such as licenses, research data, information on land acquisition et cetera. Subsequently the annexes can also contain information with consequences on the division of responsibilities and risks. Eleven annexes are part of the standard framework. In addition, the client is free to add annexes himself. The UAV-GC is a set of general conditions applicable to the contract, unless deviated. These conditions contain important rules regarding the (standard) risk allocation in the contract. Additionally, they also include administrative provisions and processes on how to deal with deviations (Projectburo, 2015).

As mentioned the UAV-GC 2005 consists of several parts, inter alia, the Basic Agreement. The UAV-GC gives the client a few choices in order to determine his influence on the design to determine their degree of influence on the design itself. This is most reflected in the ability for the client to work out his LoD to different levels. In Article 5 of the Basic Agreement, the client can choose from the following options from which the tender specification may include:

1. The program of requirements (Dutch: PVE)
2. The program of requirements and the preliminary design (Dutch: PVE + VO)
3. The program of requirements, the preliminary design and the final design (Dutch: PVE, VO + DO)

The LoD determines the influence of the client on the design. As mentioned the LoD is described in the tender specification in the product requirements. However the product requirements and the process requirement are intertwined with each other. Product requirements can demand a certain process requirement, especially when it comes to unique products requiring special tools and certain procedure in order to implement it.

The abovementioned options as described in Article 5 give no substance to the desired level of detail regarding functional or technical specification. According to PIANOo (2016f) if a contracting party opts for a Design & Construct contract form or any other integrated structure, there are certain consequences bound to it. He must approach the market on a high abstraction level or functional level, and the project management should focus more on the quality assurance.

2.2.2 Considerations regarding the building contract models

A contracting authority is legally free to decide at what level of detail the requirements of the tender specification will be. However internal policy guidelines within an organization may prohibit a particular LoD of the requirements of the tender specification or even mandate a certain LoD. The question then arises, to what level of detail must the contracting authority specify the requirements from a standpoint of efficiency prior the market approach. This question can be rephrased to: what degree of solution/design freedom does the contracting authority wants to offer ultimately? In answering that question, Jansen (2009) and PIANOo (2016b) state that the contracting authority can be largely guided by the same considerations as with choosing the building organisation form. This is because the choice of the building model and the degree of solution freedom that is offered to the market by means of the tender specification are not only in line with each other but are also strongly intertwined with each other. Meaning that in order to understand the establishment of the level of detail, the determinants of the building organization (traditional, integrated or life cycle) must additionally be identified.

The choice of a building organisation form must be done as early as possible, preferably in the definition phase of a project where the client defines the requirements, expressed as a program of requirements. Because the choice for a building contract model determines how the design- and construct process will be established, this choice must be done timely. Boot et al. (2012, pp. 31-36) make a distinction in non-juridical aspects and juridical aspects regarding the determination of the building contract model:

2.2.2.1 Non-juridical aspects:

Influence

With a traditional model the client has a lot of influence and saying, and in turn will therefore have the related responsibilities. In case of the integrated contract, the client will give more tasks and thus more design and execution freedom to the contractor compared to a traditional model. With the lifecycle model the client relinquishes even more from the project. The client even lets go a large part of the psychical requirements and bases his questions on the performance requirements.

Tender specification
The tender specification is the method the client uses to establish his demand to the market. In a traditional model it is common to specify the requirements into details. Specifying into detail has the following benefits:

- The client knows exactly what he will get at the end of the realisation phase.
- The client has influence on the design
- The contractor knows exactly what he must construct
- The contractor is able to make an accurate cost estimate
- The contractor is not responsible for the design

With integrated contract the client no longer specifies into detail. Depending on the desired degree of detail a functional specification is written instead. The most important characteristic of functional specification as mentioned earlier is that one strives to describe the problem, and not the solution. Making a proper functional specification requires knowledge and effort. Last but not least the tender specification of a life-cycle model is similar to that of an integrated contract, whereby also the performance of the exploitation phase is added. In most cases the specifications are even more general leaving more room for the contractor to give substance to.

Selection
The process-related consequences are as follows. With a traditional contract model there are two moments the client will search for market parties. The client must select advisors (architects) that will work out the design. Once that is completed the search for the contractor will take place. With an integrated or lifecycle contract there are also two moments of selection. However the second moment (the selection of the contractor) will take place earlier in the process. After all a part of the design process is for the contractor. In theory one can imagine that there is only one selection moment because the client will not perform design activities, but will only do the tender specification. In practice, with integrated models, the client is often assisted regarding the formulation of his inquiry to the market.

2.2.2.2 Juridical aspects

Contractual relation
In short the contractual relation with a traditional model is based on a DNR 2011 in the design phase, for the execution phase one uses the UAV 2012 in most cases. The DNR 2011 sets the relation between the consult and the client. The UAV 2012 forms the basis between the contactor and the client.

With the integrated models one chooses the UAV-GC 2005, which suits projects where only one party is responsible for (a part of) the design and the realisation of a project.

In principle the UAV-GC 2005 also suits lifecycle contracts, yet with these projects it always involve tailor-made contracts. The reason for this is the size of the project and the financial part of the contract.

Contract enforcement
A contract must also be adhered to. The contract enforcement describes how that will be monitored. With the traditional model this will be done by means of the UAV 2012. Hereby, there is management and supervision, meaning control will be conducted intensive, and on technical substance if the works are in accordance with the program of requirements.

With an integrated model or a life cycle contract, the work is divided differently and along the risk allocation is different, leading to different contract enforcement than with a traditional model. There is external quality assurance, which the contractor is responsible for. When the UAV-GC is applied one will make use of the testing and acceptance procedure.

2.2.2.3 Assessment models in practice

Next to the previous mentioned considerations, different parties have developed assessment models in order to choose between one of these models or contracts:

Public parties

- Partly commissioned by the Regieraad Bouw, CROW developed the Decision Support System (DSS). The *Leidraad Aanbesteden* is a tool for clients regarding their questions on the organisation of their building project. The DSS is an online-based tool in order to assess a building contract model, a procurement strategy and award criterion. The result is a judgement in the most suitable building contract model.
- Rijkswaterstaat in association with Twynstra Gudde made an assessment model the POG 21e eeuw. POG stands for Professional client ship (Dutch: Professioneel Opdrachtgeverschap). This model works by means of a series of workshops, where people directly involved with the project will identify and assess the risks.
- Another assessment model is the Public Private Comparator (PPC). This instrument is developed by the Ministry of Finances and provides a financial comparison between a traditional building contract model and a DBFM(O) model. It shows which one will offer financial benefit. However it does not give insight in the financial consequences of other kinds of building contract models.

Private parties

- The engineering company Royal Haskoning has developed the "Ballenbak" tool. By means of a software program (CD) one answers different questions in order to come to the most suitable building contract model.
- The engineering- and consultancy firm Witteveen+Bos developed the decision model "Socrates". Within a day session the relevant parties will go through a number of statements. The data will be put into a program, which gives an indication on the most appropriate building contract model.
- Consultancy firm APPM also developed an assessment model, specifically meant for spatial planning projects. By means of a number of sessions with relevant parties an analysis of the most determining factors on the choice of a building contract model are made.

The functioning of all these models is similar in the core. In their approach almost all models include themes on the following three aspects (A.A. Boot, Bruggeman, Chao-Duivis, & Haantjes, 2014, p. 37):

- The client
- The project and the environment
- The contractor

2.3 Level of detail in the Systems Engineering approach

Systems Engineering stems from systems thinking. According to Nicholas and Steyn (2012, p. 47) systems thinking means being able to perceive the 'system' in a seemingly confused, chaotic situation and perceive some degree of order or harmony in it. As such, it is a useful way for dealing with complex phenomena, especially human-created systems and endeavours such as large projects. The philosophy of system thinking underlines a SE thought process based on the belief that the study of the whole should come before that of the parts, recognizing that there are system level behaviours, interactions, and structural attributes that are not present when the system is decomposed into its elements. As stated by Parnell, Driscoll, and Henderson (2011, p. 11) systems thinking combined with engineering principles focuses on creating value for stakeholders is a modern world view embedded in Systems Engineering capable of addressing many of the challenges posed by the growing complexity of systems (see **Appendix C** for further elaboration on systems theory and SE).

SE as we know today in the civil engineering is a method adopted from the telecommunication. From there on it has been tweaked for all different kinds of fields such as military, aerospace engineering, automotive engineering, industrial engineering and more. SE is in essence a structured specification and design method. Below the definition of the International Council on Systems Engineering (INCOSE), the professional society of SE, is given:

> *"An interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then preceding with design synthesis and system validation while considering the complete problem: operations, cost and schedule, performance, training and support, test, manufacturing and disposal. Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs" (INCOSE, 2004).*

The goal of SE is to give structure and provide insight in the complexity of the object (Rijkswaterstaat, ProRail, Nederland, NLingenieurs, & Waterbouwers, 2007, p. 29). Over the recent years SE has been considered an important method to improve the infrastructure industry. However SE in the civil engineering is still considerably in development (Rijkswaterstaat et al., 2007, p. 5).

2.3.1 Definition of system

There are many definitions on the word *system*. The Webster Online Dictionary defines a system as "*a regularly interacting or interdependent group of items [elements] forming a unified whole*". INCOSE defines a system as "*an integrated set of elements that accomplishes a defined objective. These elements include products (hardware, software, firmware), processes (policies, laws, procedures), people (managers, analysts, skilled workers), information (data, reports, media), techniques (algorithms, inspections, maintenance), facilities (hospitals, manufacturing plants, mail distribution centres), services (evacuation, telecommunications, quality assurance), and other support elements.*" All in all the definitions are similar in their core which can be expressed by the definition of Nicholas & Steyn (2012) *"a system is an organized or complex whole; an assemblage of things or parts interacting in a coordinated way".* According to Nicholas & Steyn a system can be just about anything and has 4 features:

1. *It is an assemblage of parts*
   Any system can be broken down into parts, and the combination form the "assemblage of parts" constitutes the system. A system can be broken down into subsystems, which is a part of the system having its own system.

2. *Parts of the system affect the system and are affected by it*
   In systems, the whole is more than the sum of the parts. This is also the central idea to systems thinking.

3. *The assemblage of parts does something; it serves a purpose or goal*
   This implies that systems are dynamic and they exhibit some kind of behaviour; they *do* something. The parts of a system interact and their behaviour depends upon the particular kind of system. This can be either observed in the output of the system or the way the system converts inputs to outputs.

4. *The assemblage is of particular interest*
   This means that systems are conceived by the people looking at them. The conception of a system can be altered to suit one's purpose.

Systems, subsystems, and elements have distinguishing characteristics called *attributes*. These attributes describe the conditions of systems, subsystems and elements in qualitative or quantitative terms. Often, the attributes of a human-made system are designed into the system because they are necessary for the system to perform as required. Universal attributes of most elements in a project are for instance time and costs (Nicholas & Steyn, 2012, pp. 47-49).

2.3.2 Systematic levels

As mentioned, a system is an assemblage of parts. In the SE approach the decomposition of a system into parts can have various names tied to its specific decomposition level. Both Nicholas and Steyn (2012) and Parnell et al. (2011), have made a division in system, subsystem and elements. Where the whole of the elements forms a subsystem, and in turn the whole of the subsystems forms the entire system. In addition Parnell et al. introduces two perspectives on how to perceive the levels, depending on the focus, see figure 5.

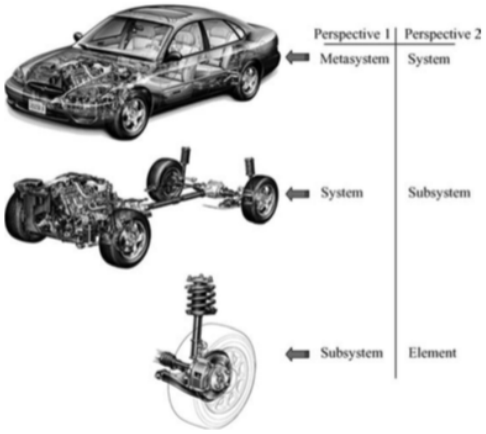

Figure 5 Three hierarchy levels of system spatial placement (Parnell et al., p57)

In perspective 1, the system would reside within the metasystem of the entire automobile and have as one of its subsystems the left rear brake drum and shock absorbing subsystem. If we were instead focusing on the entire automobile as our system of concern, then Perspective 2 would be appropriate. The complete suspension system would be a subsystem and the left rear brake drum and shock-absorbing object would be an element of this subsystem. Parnell et al. states that at higher levels of a hierarchy a more abstract, encompassing view of the whole system emerges without attention to the details of the elements or parts. At lower levels, where subsystems and individual elements are evident, a multitude of interacting parts can typically be observed but without understanding how there are organized to form a whole.

Perrow proposes a division of the system into four levels of increasing aggregation: units, parts, subsystems, and system (the four levels of complexity), see table 4 below. What extends beyond the overall system belongs to a possible fifth level, the system environment (Change, 2013, pp. 170-171). Depending upon the systematic level, the specific degree of complexity entails a variety of risks. In **Appendix D** the background on the establishment of Perrow's systematic levels has been elaborated.

Aggregation level: identifies the level of the event according to the system involved

Levels	
Part	Is considered as the smallest component of a system, for example a valve
Unit	Is a functionally related collection of parts, for example those parts constituting a steam generator
Subsystem	Is an array of units, for example the union of a steam generator and the water system
System	When different subsystems come together, then we have a system, like a nuclear power plant

Table 4 Aggregation levels defined by Perrow

The level of detail is reflected in the systematic level in the SE approach. In literature one will gradually find out that different authors and even system specifiers in practice use different systematic levels. The systematic level portrays the explicitness of a tender specification.

2.3.3 Systems Engineering

Designing a building, infrastructure project or technical installation using Systems Engineering includes the method of functional or solution free specifying however it entails more than that. What characterises Systems Engineering is working from global to detail. It is based on a top-down approach and starts with a general question in which the project policy of the client is established. This is the so-called top specification. Subsequently the system – for example the desired housing – is being *decomposed* into even smaller functional units, such as the organizational units to which the housing must accommodate. This can continue until at workplace level. The functional units are again linked requirements at the various decomposition levels, which (also) always have their origin in the demands made at the higher levels. This results in a requirements tree (Dutch: eisenboom) (Rijkswaterstaat, 2005, pp. 11-45). In Systems Engineering, the development of requirements and designing the solutions cannot be separated from each other. The preparation of the requirements goes hand in hand with its impact on design solutions. In addition to the development of the requirements tree, a solution tree or object tree (Dutch: objectenboom) is therefore developed simultaneously. The top of the requirements tree embodies the top specification. Based on that top specification, a solution is designed on the same decomposition level of the object tree. Partly based on the chosen solution the requirement tree will be elaborated a level deeper. Subsequently, the object tree based on the requirements of the solution concept will be worked out at a comparable level, and so on. The functional specification is thus developed at an increasingly detailed level, interacting with the evolving design. The specification is therefore a repeating and iterative design, working from global to detail. The added value of this process lies in making the process manageable, by decomposing the system explicit and traceable in addition to relate it to the life cycle (Spekkink, 2006, pp. 25-27).

The activity *specifying* within Systems Engineering is thus performed continuously in relation to the design process and is not a separate phase. The principles of Systems Engineering in relation to specifying the demand as used, in practice currently, can be described as follows: The contracting authority describes, when aiming for a solution free specification, what a building, infrastructure work or installation must *do* to meet the functional use that is intended for the object. *How* the object must be realised will not be described according to this method. The contracting party describes only *which functions/features* must be met and to which requirements it must comply with. The method *how* it must be done – the solution – will be left to the market.

In order to make design decisions, market parties must not only possess insight regarding the prescribed functions and requirements. Moreover, the realisation of a construction project means that successful resolution of these requirements will depend heavily on how these requirements are mutually aligned to each other. In addition, solving the tender specification adequately requires the availability of sufficient information regarding the requirements and the chosen solution, and the risky environmental factors. This explains why tender specifications in the building practice not only consist of requirements in principle, but often also contain data. These data can be used by the market in making choices - again, within the requirements - regarding *what* is being built and *how* it will happen.

The desired level of specification however is difficult to determine in advance. This is determined by two contradictory requirements of the contracting authority: on the one hand giving as much as possible

solution freedom and the related design responsibilities to the private party and on the other hand the desire itself – either alone or through consultant (architect/consulting engineer) – to take design decisions in order to exclude or limit risks and failures. Jansen (2009) states that only by following a structured and systematic specification process one will figure out during the process till what level of detail a requirement must be elaborated. The systematic approach meant here is *decomposition*. Parnell et al. (2011) describe decomposition as follows: *"Decomposition is an activity that focuses on individual system element characteristics. It uses these individual characteristics to logically group or arrange elements so that the extent of shared characteristics becomes evident, thereby providing insights into how a more efficient or effective systems structure might be realized (by combining elements) or how a systems analysis might be more simply performed (because the analytical results associated with one element might apply to other elements possessing a high degree of shared characteristics with it)" (Parnell et al., 2011, p. 30).* In practical sense one divides the project into smaller and smaller parts. The overall project and each element are described separately in a specification. Parnell et al. however stresses that this is dangerous because focusing on individual system elements tends to miss crucial interactions.

Nonetheless if the systematic approach is completed according to the principles of Systems Engineering (using decomposition), one might gradually find out that there are serious reasons (mostly risk considerations) to work out the system into further detail and subsequently base it on the traditional UAC. If the contracting authority decides to tender it on traditional basis, then he describes in detail *how* and *what* must be build or applied. This type of specification is in nature not solution free considering the technical solution – the *how* – is inherently described in the technical specs.

If the contracting authority draws up a technical specification, it can only do so on the basis of a certain vision of *what* needs to be realized. Defining *how* something must be technically build or applied, implies that a certain view/image exists with regard to what needs to be achieved in functional matters. In fact, functional specifications constitute the first step of the design process, while the technical specifications - also called "ready implementation design" - can be seen as the final step of that process. The use of the principles of Systems Engineering during the specification is thus independent of the contract choice.

2.3.4 Systems Engineering and functional specification in the Netherlands

In the Netherlands RWS, the executive agency of the ministry of I&E has set up a guideline on functional specification (Rijkswaterstaat, 2005). This guideline describes that in order to engineer a step further one must partition the system by means of decomposition. A system is being decomposed into diverse subsystems. For each subsystem a different specification, variant and design will be defined. When necessary these subsystems will be decomposed further. From the network approach of RWS, the following levels have been defined: policy level, top level, system level and subsystem level. The Route decision is taken at system level. In the event that the project is put as a D&C on the market, RWS will define and decompose the system to subsystem level after the Route decision. After the Route decision, the design will be unravelled in parts, also called decomposition. For instance a road infrastructure project can be decomposed into the objects: road, objects (Dutch: kunstwerken), service area, transport management and environment. This decomposition only happens if the system and the relations with the environment are too complex to manage it as a whole. This is determined by means of risks. The decomposition of the public client will be further set out by the contractor. This transition is known as the serrated edge (Dutch: kartelrand). The most difficult aspect of functional specification, as mentioned earlier, is determining whether a specification is worked out sufficiently or not. This consideration/assessment is often done in consultation with the technical management and contract management. There are several documents of RWS in order to specify functionally. However the most important two will be elaborated below:

1. *Manual Functional Specification (Dutch: Handreiking Functioneel Specificeren)*
   To ensure an unambiguous way on handling functional specification within RWS, common knowledge has been combined within this manual. In this way standardization of projects at RWS is fostered. This manual outlines the theoretical framework of functional specification, but also answers *how to conduct functional specification in practice.* For example, it explains how one can formulate

and structure the functional requirements of a project. This handbook thus does not give guidance on how to set requirements for the final contract, decision process or certain decision documents.

In this manual distinction has been made on 4 types of requirements:

1. Functional requirements; what is the function of the system or object?
2. Internal and external interface requirements; how does the system fit into the environment and in each other?
3. Conditions; external imposed
4. Aspect requirements; what must be taken into account?

2. Basic standard specifications

In addition to the manual there are also some basic standard specification for various objects such as roads, bridges, viaducts and developed locks. As the name suggests, this can form the basis for the specification of a given product demand. The basic specifications include elements and requirements that are standard for such products. A good start for the preparation of a tender specification may therefore be completing and possibly modify its basic specification by the project teams. Hereby project specific requirements must be added in order to draw up a complete tender specification of the project. If necessary, one can use several basic specs within one project.

In conclusion the systematic architecture described in Systems Engineering are guidelines for the user on how to decompose. The description of RWS however gives some substance to the levels considering it is linked to policy and regulations.

2.4 Level of detail in public organizations

As stated in §2.2.2 the policy guidelines within an organization may prohibit a particular level of detail of the requirements of the tender specification or even mandate a certain level of detail. In this section the most important public clients namely, Rijkswaterstaat (RWS), ProRail and municipalities, will be elaborated regarding their policy that influences the level of detail.

2.4.1 Rijkswaterstaat

The executive Ministry of I&M has the policy to tender on the basis of the UAV-GC 2005. RWS follows 'the market unless..' rule regarding the execution of works. The UAV 2012 does not fit well anymore with the current process of RWS. Their aim is to specify on system or subsystem (in case of D&C) level. Nevertheless in the maintenance sector the contract is still based on the UAV 2012 (Rijkswaterstaat, 2016). Integrated contracts demand a different way of collaboration between the market and the government. This contributes to the achievement of objectives in the field of sustainability and innovation, with a different risk management and assurance of expenditures.

The policy of RWS to implement integrated contract is due to the following reasons:

- Smaller and more efficient governments, leading to more outsourcing hence earlier involvement of contractors to achieve added value for society in other words *best value for taxpayer's money.*
- Integrated contract allow more room to achieve a more balanced and optimal allocation of risks and responsibilities, by laying the risks and responsibilities at the party that can bear and manage it the best. By doing this, and leaving room for the contractor to bring in specialized knowledge and experience in designing and developing solution, a *better price-quality ratio* should arise.
- With an approach based on UAV-GC 2005, the request towards the market also changes. Instead of detailed specifications, higher abstracted specifications are put on the market. A method to do this is with functional specification, which aims for a solution-free specification. Functional specification encourages *design freedom of the contractor.*

When the UAV-GC 2005 forms the basis, the choice of the specific contract form depends mainly on the size and characteristics of the project. When choosing a type of contract there are different variations to determine which contract form yields the most added value (time, money, quality etc.) for the project. It must be noted that there can be considerable differences between one D&C contract and the other. Here the engineering firm is consulted for making up the tender specification when a contract form already has been determined (Rijkswaterstaat, 2007).

2.4.2 ProRail

ProRail, the railway infrastructure administrator in the Netherlands has a 'make-or-buy'-policy. ProRail has positioned itself as the 'director'. Basically, ProRail is the party with the problem and indicates within which conditions the solutions are possible. ProRail works according to the SE method in combination with the integrated contract form D&C (in most cases). The reduction to the appropriate level of uncertainty (detail) has become a guiding theme; it is of importance within the decision-making, communication and the contracting. However, eliminating uncertainties is not an end in itself, the premise is that a sufficient degree of freedom remains to keep the possibility of optimization to the market. Therefore the contract formation requires a functional as possible tender specification by means of SE (ProRail, 2013).

2.4.3 Municipalities

Municipalities follow different rules. In fact, municipalities are more freely in choosing their procurement strategy. Often they consult an engineering firm to decide on the most suiting procurement strategy for a specific project. Therefore it is safe to assume, that a lack of procurement policy leads to a more appropriate consideration for a certain procurement strategy for a specific project.

2.5 Interim conclusion

In this final paragraph of the theoretical framework, sub question 1 will be answered. The insights on the theory will form the inspiration for further research.

Answering sub question 1:
What insight(s) are needed in order to determine the level of detail of the specification according to literature/theory?

Section 2.2
The mentioned option as described in Article 5 give no substance to the desired level of detail regarding functional or technical specification. According to PIANOo (2016f) if a contracting party opts for a Design & Construct contract form or any other integrated structure, there are certain consequences bound to it. He must approach the market on a high abstraction level or functional level, and the project management should focus more on the quality assurance.

The literature study revealed that although there is no framework to determine the level of detail, the contracting authority can be largely guided by the same considerations as with choosing the building organisation form as stated by Jansen (2009) and PIANOo (2016b). Various models have been made by both public as private parties. In their core the considerations all include the following aspects:

- The client
- The project and the environment
- The contractor

Section 2.3
The specification process however is conducted by means of the SE approach. The use of the principles of Systems Engineering during the specification is independent of the contract choice. The determination of the specification takes place prior to the contract choice in the plan development phase.

The LoD is reflected in the systematic level in the SE approach. In literature one will gradually find out that different authors and even system specifiers in practice use different systematic levels. The systematic level portrays the explicitness of a tender specification.

Section 2.4
The policy guidelines within an organization may prohibit a particular level of detail of the requirements of the tender specification or even mandate a certain level of detail. RWS and ProRail are bound to their policy. For the non-maintenance sector, RWS procures on the basis of the UAV-GC 2005 in most cases the contract form is the D&C where they strive to specify on system or subsystem level. ProRail also works according to the SE method in combination with the D&C form. Municipalities on the other hand are more freely in choosing their procurement strategy.

Hypothesis
Based on the findings in the theoretical framework, a hypothesis has been drawn up for the two UAV-GC case studies. In case of A9 Amstelveen the principal is RWS. RWS has the policy to procure on the basis of the UAV-GC 2005 implying an integrated approach. It has already been stipulated that the A9 Amstelveen will be procured on the basis of the life cycle model, under a DBFM contract. In case of the ZuidasDok there are several principals, namely: RWS, ProRail and the municipality of Amsterdam. The ZuidasDok is procured on the basis of integrated model, under a D&C contract. As concluded from section 2.2, in case of an integrated contract the client must approach the market on a high abstraction level or functional level. The assumption that holds for both cases is: **projects based on the UAV-GC 2005 fit the characteristics of high level of abstraction**

Nonetheless the articles bound to the UAV-GC 2005 give no substance to what a high or low abstraction is. In the next paragraph the researcher will give meaning to the abstraction levels.

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3 Building the framework

Inspired by Jansen (2009) and PIANOo (2016b) (see quote below) a framework will be drawn up. In order to understand the establishment of the specification degree, the determinants of the building organization (traditional, integrated or life cycle) must additionally be identified.

"What degree of solution/design freedom does the contracting authority wants to offer ultimately? In answering that question, Jansen (2009) and PIANOo (2016b) state that the contracting authority can be largely guided by the same considerations as with choosing the building organisation form."

In the light of this research the characteristics must relate to the elements where decision-makers base their decision on. It is assumed that the decision-makers look at, inter alia, the project characteristics of a certain project in order to determine what level of detail/building organization form the project needs. However different authors consider different key elements in the determination of the LoD/building organization. In order to achieve a more general view on the elements a literature survey will be conducted to shed light on the key elements. From there on the conceptual framework can be further designed.

This chapter gives answer to sub question 2:
What elements of the project do contribute to the determination of the level of detail of the specification according to literature/theory?

3.1 Determining the key elements of the level of detail by gathering elements from literature

Fourteen literature sources were investigated to identify the elements that contribute to the determination of the level of detail from a literature perspective. Literature databases were first searched for relevant articles with the keyword 'level of detail'. However due to the specific subject and specific aim of knowledge, it can be assumed that a more common/broader keyword must be considered as well. Because the determination of the level of detail is inextricably linked to the selection of the building organization/procurement strategy (after all the LoD is embedded within the tender specifications), keywords on the determining elements of the 'building organization' and 'procurement strategy' were also examined. Elements contributing to the determination of the LoD/procurement strategy were listed and rephrased in order to cluster it. The list below covers the most recurring elements in total. In **Appendix E** the entire list is shown.

Elements	Occurrence in literature		Total occurrence in literature	Author / source
	Keyword Level of detail / specification detail	**Keyword** Building organization form / procurement strategy		
1. Project complexity	3	6	9	(Antoniou, Aretoulis, Konstantinidis, & Kalfakakou, 2013; BIS, 2010a; Davis, 2009; Group, 2011; Jansen, 2009; Kalin et al., 2010; Love, Davis, Baccarini, Wilson, & Lopez, 2008; PIANOo, 2016b; Roelofs, 2005)
2. PM aspects (quality, organization, risk, costs, time)	2	5	7	(BIS, 2010b; Davis, 2009; Jansen, 2009; Love et al., 2008; Ojo & Gbadebo, 2012; Roelofs, 2005; Wiegers, 2006)
3. Client's ambition	4	3	7	(AIA, 2000; Group, 2011; Hagemann, van Stijn, Hartmann, Buis, & van Kinderen, 2002; Kalin et al., 2010; Love et al., 2008; PIANOo, 2016b; Roelofs, 2005)
4. Client's characteristics	2	5	7	(AIA, 2000; Antoniou et al., 2013; Davis, 2009; Jansen, 2009; Love et al., 2008; Roelofs, 2005; Wiegers, 2006)
5. Market aspects	1	4	5	(Bemelmans, 1998; Hagemann et al., 2002; Jansen, 2009; Love et al., 2008; Roelofs, 2005; Wiegers, 2006)
6. Environmental aspects	0	5	5	(Davis, 2009; Hagemann et al., 2002; Jansen, 2009; Love et al., 2008; Ojo & Gbadebo, 2012)
7. Stakeholders	2	2	4	(BIS, 2010b; Love et al., 2008; Roelofs, 2005; Wiegers, 2006)

Table 5 The seven elements derived from literature

In table 5, 7 elements have been identified from a literature survey on fourteen sources. They are listed from most frequently found to less. Some elements, although found in literature, were not included in this final literature table. However, some elements have not been explicitly added nevertheless they are implicitly covered.

As can be seen some elements came by more often due to the choice of keywords. The elements found with the keywords *level of detail* or *specification detail* were less extensive than the elements found with the keywords on *building organization form/procurement strategy* (see **Appendix E**). All the elements have been mentioned at least once in literature, except the *environmental aspect*, which has been only mentioned with the keywords *building organization form/procurement strategy.* Nevertheless this aspect could be embedded within the *project complexity,* because the investigated sources only mentioned complexity as a factor, but did not describe what it entails. In 9 of the 14 literature sources, *project complexity* was mentioned as one of the influencing elements in the determination of the level of detail and building organization form. What is meant with project complexity? The dictionary simply defines complexity as having a large number of interacting parts. Baccarini (1996, pp. 201-203) proposes the following definition on project complexity *"'consisting of many varied interrelated parts' and can be operationalized in terms of differentiation and interdependency".* According to Baccarini when referring to project complexity it is important to state clearly the type of complexity being dealt with because it can be applied to any project dimension. The most common types of project complexity are organizational and technological complexity. Where a complex organizational structure is defined "*as one containing differentiated parts so that the greater the differentiation the more complex the organization".* The technological complexity is defined as follows *"the transformation processes which convert inputs*

into outputs. This transformation process involves the utilization of material means, techniques, knowledge and skills".

In the TOE framework of Bosch-Rekveldt (2011) the technological and organizational complexity are also distinguished adding a third one, the environmental complexity. Bosch-Rekveldt characterized project complexity of large infrastructure projects in the front-end development. She distinguished three dimensions of complexity; technical complexity (T), organizational complexity (O) and environmental complexity (E), which in turn consist of several indicators, see table 6 below:

Technical	Organizational	Environment
Goals	Size	Stakeholder
Scope	Resources	Location
Tasks	Project team	Market conditions
Experience	Trust	Risk
Risk	Risk	

Table 6 Subcategories of the TOE framework (Bosch-Rekveldt, 2011, p. 87)

The framework can be used to assess the complexity of an engineering project. It enables the identification of the complexity areas in a specific project. As stated by Bosch-Rekveldt *"knowing these complexity areas, attention could be paid to the management of these" (Bosch-Rekveldt, Jongkind, Mooi, Bakker, & Verbraeck, 2011, pp. 728-739).*

In the research of Hertogh & Westerveld (2010), six dimensions of complexities in large infrastructure projects have been detected: technical, social, financial, organisational, legal and time. By means of examples of projects, the six complexities were made explicit.

Complexities	What makes the element complex according to Hertogh & Westerveld (2010)?
Technical	Unproven technology Technical uncertainty
Social	Conflict of interest Different meanings and perceptions Large impact
Financial	The cost and benefits, which are difficult to calculate and are not equally divided The perception of cost developments, which can differ from calculations Different perceptions about definitions and agreements Strategic misinterpretation, optimism bias and pessimism bias Cascade of distortion
Legal	Changing, non existent and conflicting laws Extensive legislation and rules, have an important influence on content and processes People involved need space to operate
Organizational	To find and to keep motivated people appropriate to the challenge Many decision with no clear 'best solution' The project organisations has numerous processes that interfere with each other Consultants, contractors and suppliers require numerous contract to be arranged
Time	Long time frame with continuous developments No sequential process of implementation

Table 7 Framework complexities Hertogh & Westerveld (2010)

It can be assumed that environmental aspects are interrelated to the social complexity in the framework of Hertogh & Westerveld (2010). For the completeness of the framework all of the 7 found elements will be included, if not explicitly than implicitly. Both frameworks on complexity will be taken into consideration when determining the project complexity for the framework of this research.

The second most common element, the project management aspects, relate most to the functions of project management as described by Turner (2008, pp. 7-10), in figure 6 five core functions have been illustrated.

- The scope entails work, and that scope of work must be managed
- The resources are assembled into a temporary organisation which must be managed
- In order to deliver the desired benefit a required level of performance, or quality must be managed
- Cost needs to be managed, in order for the project to be of value to both the client as the contractor, therefore it must cost less than the value of the benefit
- Time needs to be managed in order for the work of the project to take place effectively and efficiently, and because the time value is associated to the benefit of the asset
- The uniqueness, novelty and transience of the work of the project creates risks

- There are a wide variety of stakeholders to a project, all with differing objectives. The commitment of these stakeholders to the project needs managing.

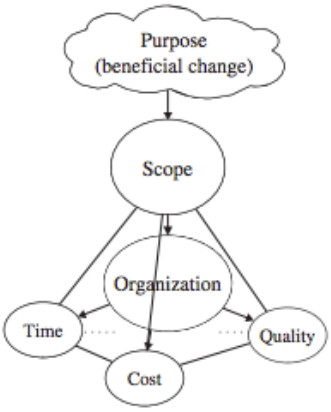

Figure 6 Iron Triangle (Turner, 2008, p.7)

Time, cost and quality also form the classic Iron Triangle. In different definitions on project management the three aforementioned criteria have been frequently mentioned, for example by:

1. The British Standard for project management BS60794 (1996) defined project management as: *The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance (Lester, 2013, p. 7).*
2. The UK Association of Project Management (APM) have produced a UK Body of Knowledge UK (BoK) which also provides a definition for project management as: *The planning, organisation, monitoring and control of all aspects of a project and the motivation of all involved to achieve the project objectives safely and within agreed time, cost and performance criteria (Basu, 2016).*

Nonetheless according to Basu (2016) the latest versions of PMBOK and PRINCE2 (2009) have added even more variables. The reason for this is that a project has many more constraints to be observed beyond the scope, schedule, and budget or costs, time and quality. In PRINCE2 six variables have been suggested namely: costs, timescales, quality, scope, risk and benefits. These relate to the functions of project management by Turner. In PRINCE2 the role of quality appears to be in the specification and functionality of the deliverables, and overlaps with scope and benefits.

Quality is an ambiguous term and different people interpret quality differently. Rezaian (2011, p. 219) defines quality as follows *"its ability to fulfil the customer's needs and expectations"*. Quality cannot be objectively measured. Bosch-Rekveldt state that it is still commonly accepted to limit the measures of project success (cost, schedule and quality) towards the traditional three that can be objectively measured: meeting time, budget and (technical) specifications. In this research the quality will be housed implicitly under the client's ambition, because the translation of a client's ambition is linked to the specifications, which in turn describes the client's wishes (this also corresponds to Jansen's framework and PRINCE2). In next section choices will be made regarding the elements and their indicators to fit the aim of this research.

3.2 Structuring the elements

The 7 elements from table 5 will now be structured in order to come to a clear-cut classification, which will be used eventually to characterize the systematic levels. Thereafter the elements will also be defined and analysed regarding their relation to their level of detail.

It is noticeable that the detected elements show similarities with the elements and indicators of the TOE framework. Especially regarding the environmental (E) aspects in the TOE framework, which are the stakeholders and the environmental aspects itself (politics, society and location). However the classification of the TOE framework cannot be adopted one-on-one, due to the difference in purposes. The aim of the conceptual framework for this research is to categorize a project (by means of the 7 elements) in order to reveal the desired level of detail (aggregation level of Perrow). In order to do so, there is more to take into account than the project complexity. For instance, the client's characteristics are not explicitly considered in the TOE framework (this will be elaborated in section 3.3.2). However this is an important factor in the determination of the specification degree, because the client's expertise and knowledge influences, inter alia, the level of detail and the division of works.

In the framework of Hertogh & Westerveld (2010) six complexities were determined for what complexity might be in large infrastructure projects by taking an insider's view based on practice. The determinants of each complexity were therefore also specific because it was derived from projects. From the study it came to conclusion that the legal complexity was less important, while the social and organizational complexity were considered very important. The social and organizational complexity has also been included within the TOE framework, under organizational and environmental. The costs and time aspects are also considered in both frameworks, but not categorized explicitly in the TOE. Next to that the substance differs, the complexities of Hertogh & Westerveld (2010) elaborate more on these topics.

Within the investigated sources regarding the choice for a certain building organization form, the determinants as stated by Jansen (2009) were also analysed. According to Jansen, when a contractor has to make decisions regarding the alignment between the building organization form, tender specification, contract form and procurement strategy, the contractor will do this within a threefold context, namely: the internal, external and project. This also relates to the core aspects of the assessment models as analysed by *Boot et al.* (2014) in section 2.2.2, namely: the client, the project and the environment and the contractor. The classification of Jansen (2009) also suits the aim for the conceptual framework the most, due to the fact that the purposes are intertwined, in **Appendix F** the elements and indicators of Jansen (2009) have been visualized.

All in all an own classification will be created for a better fit to its aim. The elements will be clustered again but now according to their context inspired by the investigated models. Table 8 below shows the final clustering:

1. Client aspects (section 3.3.1)	**2. Project aspects** (section 3.3.2)	**3. Market aspects** (section 3.3.3)
• Type of client • Client's ambition • Client's influence	• Technical complexity • Organizational complexity • Environmental complexity • Cost complexity • Time complexity	• Market characteristics • Readiness for long-term contract • Trust in the market

Table 8 The final clustering of elements

3.3 Defining the elements and their indicators

The elements are determinants when considering a certain level of detail. However certain indicators guide them. Now the classification is finalised, the elements and their indicators in the sphere of the level of detail will be defined and elaborated in this section.

3.3.1 Client aspects

3.3.1.1 Client type

In literature both by *Boot, Bruggeman, Chao-Duivis & Haantjes and Pries (2014) as Keizer, Kuypers & Mooiman-Salvini (2006)* have a view on the different types of client.

- *Literature on type of client by Boot, Bruggeman, Chao-Duivis & Haantjes (2014)*
  An incidental client is often unfamiliar with the building process. To him it is essential that he will have good support in an organizational sense: who guides him in the choices he has to make. Even before a building (contract) model is selected, the client will have to consider whether he wants to contract with a consultant (under DNR 2011). If it is a professional client, a client with more knowledge and experience regarding project and the building processes, than the question arises what kind of professional client is it? Boot et al. (2014) make a distinction in 5 types of client:
  - *The private accommodation provider*
    Here one can think of a bank that needs a lot of buildings or stores. For these types of clients the building needs to have a certain constant appearance and functionality. It is imaginable that the first project will set the tone for the rest of the buildings. The client will have major involvement with the first project, and later on less due to repetitive projects in the future.
  - *The investor*
    For this type of client it is evident that the building will generate enough financial profits. For them the cost management and the appearance of the building (if that contributes to the value) are of importance.
  - *The social residential construction company*
    This type is focused on the end-user. On the one hand the rent cannot exceed, on the other hand these types of residents must comply with certain sustainability rules. The input of the contractor might be important in this case.
  - *The project developer*
    In certain sense the project developer is similar to the investor. Nonetheless the project developers want security on the costs and time above all. Appearance plays a role when it contributes to the marketability. Finally the actual building process cannot take too much time. Therefore an integrated contract is suitable.
  - ***The infrastructural client***
    In general the infrastructural client will have little interest in the aesthetics of the design. Next to that, timely project delivery, within budget and good usability play an important role. Here the integrated approach is most suitable.

- *Literature on type of client by Pries, Keizer, Kuypers & Mooiman-Salvini (2006)*
  Pries et al. (2006) make a distinction in types of client regarding the following aspects: the degree of professionalism, incidental versus regular building client, government versus private and collectivity versus delegated commissioning and steering versus buying. Pries et al. developed a matrix and distinguishes on the basis of the mentioned aspect, 6 profiles on types of clients:

	Professional	**Incidental**
Private	Project developer [4] Companies (own use) [5]	Companies [1] Private parties [2]
Public and non-profit	Provinces [6] Municipalities Water boards	Education [3] Health cares

Table 9 Types of client by Pries et al. (2006)

- *Profile 1 The company: incidental, private, companies*
  This profile falls under the companies that construct for their own use. In general this type of client has little knowledge of the building process and will therefore conduct few tasks. One is committed to good work conditions, low running costs, public opinion and if the project is timely finished. In general one values the environment less. Within this type of organisation one has a delegated client from the organization. The decision-making procedure has a low degree of complexity.
- *Profile 2 The residential consumer: incidental and private*
  This profile regards the builders of their own resident (for own use). In general they have little knowledge of the building process and rarely perform the tasks. It is important for the client that the building is functional and within budget. Next to that it is important that the design and expectations of the resident comply with the client's wishes. The decision-making procedures are simple; nonetheless one finds it difficult to see the consequences of certain choices.
- ***Profile 3 The collective client: incidental, public, organisation or institution***
  This type of client has specific building projects such as schools, health care institutions and governments. This type of client builds for its own use. In general there is little knowledge on the building procedure and tasks are outsourced. During the preparation- and implementation phase one often uses external advisors. The most important role is the functionality of the building. Next to that the realization within budget and the efficiency and legitimacy are also important. Boards mostly do the decision-making.
- *Profile 4 Constructor of the market: professional, private*
  This regard project developers, builders at their own risk, housing corporations and institutional investors. This type of client does not built for its own use but for the market. They rarely work with an external construction manager, but works often with a cost specialist (potentially external). The preparation phase is often done by the client self. This type of client values investment return, a favourable selling price, satisfied customers and creating good work- and living conditions. More than any other client, this type of client values the architecture and the positive contribution to the staging.
- *Profile 5 Constructing for own use: professional and private*
  This profile concerns the large companies such as banks and retailers. Here own builds for its own use. This type of client rarely uses an external construction manager and will execute the preparation phase itself. The building is an asset for this client and should primarily be suitable for this position. In addition, the following aspects are important: a satisfied customer, a good indoor climate and good working conditions, realization within budget and a smooth process (without the 'hassle'). This type of client usually works with a delegation from the client organization.
- ***Profile 6 The collective sector: professional, public***
  This profile regards all governments, government agencies and semi government. One builds for its own use or to rent out. This type of client often has its own construction department. It often performs the preparation of the project itself and monitors or carries out the project management of the construction project. Aspects that are important: the realization within budget, functionality, low operating costs, good working conditions and a smooth construction process. Often complex, collective decision-making procedures are involved with this type of client. This should be taken into account in the construction process, because taking decisions sometimes proceeds via long lines.

The types of client that will be considered in this research are the public clients conducting infrastructural projects and the following distinction has been made:

Professional client	**Incidental client**
Rijkswaterstaat (profile 6 of Pries et al.)	(Small) municipalities (profile 3 of Pries et al.)
Provinces	
ProRail	
Large municipalities (profile 6 of Pries et al.)	

Table 10 Professional and incidental client

Pries et al. (2006) state two different types, which the government could fall under, namely: profile 3 and profile 6. In profile 3 the client has little knowledge of the building procedure and outsource most of it works. Profile 6, which the government falls under as well, states that the client has its own construction department. Rijkswaterstaat fits the most to profile 6. Although Pries et al. (2006) have characterized municipalities under professional client, according to Boot et al. (2014) this could fall under an incidental client, because not all municipalities are familiar with the building process. Looking at the profiling of Pries et al. (2006) municipalities could be either profile 3 or 6, depending on the regularity of projects they conduct. ProRail on the other hand can be seen as a semi-public professional client and conducts governmental works.

According to Pries et al. (2006) an incidental client delegates most of its works due to the lack of knowledge and experience. RWS, ProRail, Provinces are considered as professional clients, and are familiar with the construction process in contrast to municipalities. However some large municipalities can be considered as professional clients as well, due to the regularity of projects they conduct. Nonetheless it must also be noted that many tasks are outsourced by RWS, due to a smaller and more efficient government.

Compared to small municipalities and other incidental clients, RWS will be considered in this research as a professional client being familiar with the construction process and having knowledge because they do have their own construction department. Small municipalities will, or any incidental client for that matter, must be guided by external consultants in the specification process. These are based on the literature of Pries et al. (2006).

Building the framework
The first dimension of the client aspect is the type of client in the framework. Its indicators have been shown below, in table 11. A professional client is herewith perceived as a client with knowledge and able to specify in detail (low level of abstraction) compared to an incidental client. The incidental client is here considered to be a client not having much knowledge and experience (and therefore not able to specify into much detail) and will therefore delegate its works. Due to the responsibilities of a public client towards its stakeholders, it is more likely that he needs to be transparent and provide detailed information. If the knowledge and experience is low regarding the building process, as with small municipalities, the principal will be more eager to specify its demand on higher level of abstraction and outsource the remaining process to the market. Nonetheless if the knowledge and experience regarding the functional specification is high, the principal is assumed to be able to properly specify on a high level of abstraction.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low

Table 11 Dimension type of client

3.3.1.2 Client's ambition

In general sense *ambition* means striving for a certain goal (Harper, 2010). According to a study by Jonny Klakegg & Haavaldsen (2011) the level of ambition expresses the degree to which the project organization has to stretch – the expected level of achievement. Correlating to the project definition, the definition of objectives based on society and users' needs and also to the project design, the means to achieve the objectives. Gardner considers large-scale ambition for a project to a project which has never been conducted before in a certain country, which can implicate innovation (Gardner, 2015, p. 31). The model of Jansen (2009) links ambition to quality, which in turn is linked to quality guarantee, the architectural and spatial quality and the need for maintenance. In this research ambition is linked to the desired aesthetics and spatial integration, sustainability and innovation (linked to maintenance) for a project.

Aesthetic is defined by dictionary as the study of beauty. The term 'aesthetics' has historically been associated with the fine arts – painting, sculpture, architecture, and music (Swartz & Iacobucci, 1999, p. 69). It is a common notion that architecture carries a certain aesthetic value. However in general the infrastructural client will have little interest in the aesthetics of the design (Beheshti & Adams, 1999; A.A. Boot et al., 2014). In the main case, the design of infrastructure needs to be functional; nonetheless infrastructure itself has a relation to its environment. Their aesthetic design can greatly influence living activities in public spaces and local identities, and they are determined in response to social needs. The infrastructural aesthetic is thus more reflected in its **spatial integration** (Sasaki, pp. 1-2). A good example of an infrastructure project with high aesthetic value concerning the spatial integration is for example the 'Erasmusbrug' (Erasmus bridge) in Rotterdam. Architects employed by the Municipality of Rotterdam made a number of designs, but none of these designs have made the cut. Eventually the Amsterdam architect Ben van Berkel was commissioned. The reason for this choice was the high-quality appearance of the design, which met the high level of ambition that the Kop van Zuid had to radiate. In this case the aesthetics prevailed the functionality (Rotterdam, 2016).

Another form of ambition is the degree of **sustainability** the client strives for. What is sustainability? Sustainability as a policy concept has its origin in the Brundtland Report of 1987. The original meaning of sustainability concerns *"the well-being of future generations and in particular with irreplaceable natural resources—as opposed to the gratification of present needs which we call well-being"*. In the course of time, the concept has been re-interpreted as encompassing three dimensions, namely social, economic and environmental. This idea stems from the Triple Bottom Line concept conceived by Elkington. Elkington intended it as a way to operationalize corporate social responsibility. To the conventional bottom line (profit) should be added care for the environment (the planet) as well as being good to people, for instance by providing facilities for the handicapped and hiring minorities (the social dimension). According to Kuhlman & Farrington sustainability covers largely the environmental dimension. They redefine sustainability loosely as a state of affairs where the sum of natural and man-made resources remains at least constant for the foreseeable future, in order that the well-being of future generations does not decline (Kuhlman & Farrington, 2010). When looking at infrastructure and the practical application and formulation of sustainability, there is not one answer to the question what sustainable infrastructure is. According to RWS (2015) sometimes the sustainability entails CO2 reduction and other times it is more about the life-cycle costs and benefits of environmental quality. It is up to each project in order to develop the maximum achievable durability interpretation.

The final form of ambition, which will be taken into account for this research, is **innovation**. Innovation is often viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. The term 'innovation' can be defined as something new with high-level of originality, that breaks into society and the market (Frankelius, 2009). Nonetheless innovation processes are also associated with risks by definition. On the one hand it is impossible to assess all necessary information on the consequences of innovative actions such that risks are avoided completely. On the other hand, innovations harbour an enormous development potential. According to Change (2013, p. 267) innovation can contribute to all three dimensions of sustainability (social, economic and environmental). An example where innovation is actually required is with the realization of drilled tunnels. For these kinds of projects, one does not use traditional models anymore in the Netherlands because no standard designs exist with the innovative drilling techniques. Note that this can also fall under *technical complexity* (Jansen, 2009, p. 107). Based on a study on 31 PPP projects in Norway, it came to conclusion if innovation is desired than a less detailed specification is an important factor (Solheim-Kile, Laedre, Lohne, & Meland, 2014). Van Valkenburg et al. (2008) also stresses on the traditional procedure for infrastructure, which does not start until the public decision-making procedure, leaving little room for innovation. The consequence of the traditional approach is that the contractors have very little room for flexibility to deviate from the solution as laid down in the Route Decision. As a result, innovative ideas from the contractors may have become impossible to implement. Room for innovation therefore also relates to the entry point of the market. In order to achieve innovation, an early start in the planning procedure of contractor involvement is essential. According to van Valkenburg et al. (2008) the freedom can be given if the participants are involved early in the process of giving planning consent – the so-

called route determination/EIA-procedure (EIA = environmental impact assessment)[4]. Only in this way the contractors may have an active developing role, which can be enhanced by adopting a broad project scope – an integrated area oriented scope instead of just a scope on building line- infrastructure.

Based on literature the following assumptions will be used for the conceptual framework. High ambition is defined by the degree of spatial integration, innovation and sustainability statements the client defines for the project. In case of high expectations on sustainability the client should also consider to outsource the maintenance (Jansen, 2009, p. 105). If innovation is desired than less detailed specifications are an important factor contributing to that aim. An integrated approach may also be required when there is a need for innovation in order to reuse the lessons learned for further innovative endeavours. When it comes to aesthetics, it is up to the client if he already has a certain vision on it. If the vision is present and it is stated by the client, then low level of specification is in order, because then the outcome will live up to his expectation.

From a study it came to conclusion that in general with a high level of ambition clients were more satisfied with the completed project when he had more influence on the design. In those cases the project lived up to the client's expectations (van der Spek, 2012). According to the study this has to do with the cognitive dissonance theory: "*People are more likely to be satisfied with something when they had an influence on it. People are inclined to justify the choices they make.*"

Building the framework
The client's ambition is the second dimension of the client aspects. The indicators as described have been schematized in table 12. If the aesthetic/spatial integration is important, the principal will document it. in most cases in the form of an aesthetic program of requirement. Nonetheless this will leave little design room for the market. The aesthetic has been added after the empirical study, as the respondent mentioned that if the principal already has a clear vision on it, he should specify into detail. If sustainability and/or innovation are considered important, the principal should leave room to the market to come up with sustainable/innovative solutions because this is the markets core business (based on van Valkenburg et al. & Jansen).

Dimension	Indicator	High level of abstraction	Low level of abstraction
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + stated
	Sustainability	Important	Not important
	Innovation	Important	Not important

Table 12 Dimension client's ambition

3.3.1.3 Client's influence

Another element, which has been added, is the *client's influence*. This element has also been mentioned as the first non-juridical aspect in the consideration of a certain building contract model by Boot et al. (2014) in section 2.2.2. For the completeness of the framework, this dimension has been added. The client's influence will have the following indicators; the ability of translating the expectations and wishes to functional requirements by the client, the willingness to let go of specifying, if the level of detail is of a high abstraction level and last but not least the need to monitor in order to realise the desired ambition/concept/policy.

The ability of translating the expectations and wishes to **functional requirements** by the client is an important indicator to go or not go for an integrated approach whereby the client can procure on a high level of abstraction (Boot et al., 2014). If the client is not able to do this, it could in turn indicate that 1) the project can only be specified in technical terms and functional specification is not relevant or 2) the client does not have the knowledge and experience to specify it in a functional manner, which is coupled to the *type of client* dimension as well or 3) it could also implicate that the wishes/ambitions are not realistic or feasible.

[4] The route determination/EIA-procedure is an extensive procedure whereby the Minister of Transport has to carry out a broad assessment of environmental and other impacts, and in which there is intensive consultation with regional and local authorities and other parties. Because of the direct environmental consequences, only marginal deviations from the Route Decision are allowed during the construction (Van Valkenburg et al., 2008, p. 325).

Willingness to let go regarding setting requirements relates to how much control the client wants to keep. If he is willing to let go of specifying, he will specify on a higher abstraction level. If it is not the case he will specify on a low level of abstraction, thus in much detail (PIANOo, 2016f & Boot et al. 2014).

If there is a lot of **need to monitor** in order to realise the desired ambition/concept/policy the client would usually go for the traditional way of procuring, thus more into detail. As the traditional model offers good checking possibilities (de Ridder, 2009, p. 50).

Building the framework
The last dimension of the client aspects is the client's influence. The indicators and their impact on the level of abstraction also known as the degree of the level of detail have been schematized in table 13. Depending on the stage of the specification, one could state if the LoD is already on high or low abstraction level.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required

Table 13 Dimension client's influence

3.3.2 Project aspects

As mentioned project complexity does not stand on one factor; moreover it is about the composition of several aspects combined making a project complex. Nicholas & Steyn (2012, p. 354) define complexity as *"how many steps, elements or components there are in the product or process and how tightly interrelated they are. An end-item or process with numerous, interrelated steps or components is riskier than one with few steps and simple relationships*". Bosch-Rekveldt (2011, p. 35) also noted that one must make a distinction between complex projects and project complexity (also referred to as the complexity of a project. Complex projects refer to a specific class of projects (namely the complex ones) and the project complexity focuses on what aspects make a project complex. This section is based on the project complexity. The eventual entire project profile can determine if a project is indeed considered to be complex or not.

A combination of the tripartite division of Bosch-Rekveldt (2011) and the six complexities of Hertogh & Westerveld (2010) will be used to detect the project complexity of a certain project. It must be noted that the TOE framework does fit more with the considerations for the level of detail, because these complexities were investigated and defined for the front-end development, which is also the focal area of this research. Risk will be embedded within each element because the degree of complexity contributes to risk.

In the division of Bosch-Rekveldt (2011) the system perspective is recognized in the technical dimensions, and the actor perspective in the organizational and environmental (external organizational) dimensions. In the TOE framework the client characteristics have not been directly related to the elements, although the client was mentioned most often in her research. Bosch-Rekveldt chose not to explicitly mention the client as the most complex element because that will suggest an "it is not our fault" attitude: the client is considered to be the party outside one's control cycle, and therefore easy to blame. In the TOE framework the client characteristic is covered under the element *lack of experience with parties involved* (Bosch-Rekveldt, 2011, p. 127). However in this research the contracting party has been categorized separately and explicitly. Not only because it has been detected 7 out of 14 times in the examined literature and considered to be too important to house it under an element, but also to make the influence of the client characteristics explicit in the results. IF there is a need to analyse the results without the client characteristic it can be left out easily due to its separate categorization.

3.3.2.1 Technical complexity

Under **technical complexity** the following indicators are defined: newness of technology (world-wide), experience with technology, technical risks and requirement of special equipment/technology. The first three indicators are derived from Bosch-Rekveldt (2011) based on both literature and empirical data. The newness of technology in this research refers where there is a change in an input, the addition of a new product or client that is more likely to trigger the need to hire specialties. As mentioned in the element *ambition* under *innovation* an example is the drilled tunnels where one uses special technique/equipment (Jansen, 2009). There is a tight correlation with innovation and the use of new techniques. However in this research the following distinction will be made. Innovation will be referred to the action or process of innovating, which could be a new method, idea, product etc. being ground breaking. **Newness of technology** will be referred to as the application of scientific knowledge for practical purposes, such as the development of machinery and devices. **The experience with technology** refers to the experience of the project team regarding the to be used technology, concerning the procedures and management of it as well. And last but not least **the requirement of special technology**. If a project such as the drilled tunnel requires a specific technology, than this must be taken into account. Because it will also require a special kind of knowledge and in most cases it will be outsourced. If new machineries, equipment or special technology is required it is better to leave it up to the market, as the technical aspect is their core business.

For the **technical risk**, the following statement of Bosch-Rekveldt (2011, p. 274) is used: "*higher technical risks coincide with higher quality requirements, more uncertainties in methods, application of new technology, lack of experience with technology, interface problems, higher organizational risks and occurrence of interference with the existing site".*

Building the framework
The first dimension of the project aspects has the following four indicators, see table 14. The indicators all refer back to the necessity of involving the market for their technical skills.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low

Table 14 Dimension technical complexity

3.3.2.2 Organizational complexity

Berggren, Soderlund & Anderson (2001) distinguishes two different organizational structures. There is the permanent organization, which is represented on the organizational chart. Next to that there are the temporary organizations: the various projects with their focus on one specific goal. Often the temporary organizations only include a minority of the company's personnel. Contractors outsource activities while clients trim their own organization. Berggren et al. (2001) and Baccarini (1996) state that due to **organizational fragmentation** the complexity of project increase. Organizational fragmentation here is meant that tasks are divided amongst different organizations, different disciplines and operating from different locations. The composition of the project teams influences the decision-making. With more project team members from the parent company, the communication lines will be shorter and less feedback loops can be encountered. For this research the organizational complexity will be characterized by the experience with parties involved, organizational fragmentation and organizational risk. If the size of the project team is large and composition varies than it can be assumed that communications lines will extend and therefore it is more logical to specify into more detail (Wiegers, 2006). However if there is experience with the involved parties it will make it easier to understand each others working method. The **organizational risk** entails the planning, coordination, and procedural uncertainties within an organization.

Building the framework

Three indicators have been set up for the organizational complexity dimension, see table 15. The indicators refer to the statement of Wiegers (2006). If experience is low, organizational fragmentation is high and the organizational risks are high it is more logical to specify into more detail in order to reduce misinterpretations.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High

Table 15 Dimension organizational complexity

3.3.2.3 Environmental complexity

Bosch-Rekveldt defined the environmental dimension as the influence from the environment (external organization), which entails the number of stakeholders, the variety of stakeholders' perspectives but also political influence, weather conditions and more. Remington (2016) stresses upon the importance of political upheaval, giving an example on how a major rail extension project was cancelled in Sydney, Australia, due to a change in Premier and Cabinet and a crisis in confidence. Jansen (2009) also considered the politics and society in his framework under the external aspects. In this research the following indicators will be taken into account for the **environmental complexity**: the political influence, the societal influence and the environmental risk. The **environmental risk** meant here has to do with the environmental (stakeholders/political) upheaval that can emerge and their influence to disturb the project.

There is also an interconnection between the technical, organizational and environmental complexity on how they influence each other. According to Wood & Gidado (2008, p. 10) the organisational aspects contribute more to the complexity of the project than the technical aspect. Technical complexity is a definite factor and is considered easier to deal with than complex relationships and organisations. If we take this statement to its extension, in other words, involving the environmental complexity as well. It can be assumed that the overall complexity is also related to the degree of control. Resulting in the following: technical complexity is easier to deal with than organisational complexity, the organisational complexity is in turn easier to deal with than the environmental complexity. When the technical complexity is high Sebastian & van Gelderen (2007) state the client should let go of the preliminary design solutions and trust the contractors. Nonetheless if the organisational complexity is high than a traditional approach might fit better. Last but not least if the environmental complexity is high than both extremes of specifications (high abstraction and low abstraction) can be considered depending on what the project needs. For example if **stakeholder's and political influence** were high (high complex environment) then one would logically choose to specify into detail in order to inform the stakeholders and politics. This also depends on whether the principal is able to specify into detail in an early phase or not. If the principal is able to do so, then he can integrate the design and the expectations to correspond his ideas with the ideas of the stakeholders and politics. However, it can also be the other way around. If there are a lot of stakeholders involved, and public support is needed than it is better to specify on a higher abstraction level in order to involve the market to do both the design and execution. In this way the design will correspond more to the outcome i.e. expectations of the stakeholders.

Figure 7, summarizes the complexities with its relevant degree of control and abstraction level which are based on the statements of Wood & Gidado (2008) and Sebastian & van Gelderen (2007).

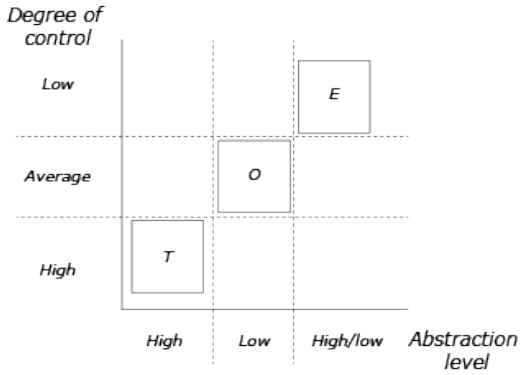

Figure 7 Complexities, degree of control and the abstraction level (own ill.)

Building the framework

Three indicators have been set up for the environmental complexity dimension, see table 16. Regarding public infrastructural projects, the influence of stakeholders and politics are perceived in any case high, due to public funding as well. The option between a high or low level of abstraction will therefore depend on the matching strategy in the line of reasoning as explained in this sub section.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Environmental complexity	Stakeholder's influence	High (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Political influence	High (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Environmental risk	Low	High

Table 16 Dimension environmental complexity

3.3.2.3 Cost complexity

In this research the costs and finance has been put under the same umbrella. In this case it refers to the way of funding, price certainty, low management costs and price/quality ratio. Which are based on the indicators of Kalin et al. (2010) and Jansen (2009).

The way of **funding** influences the level of detail. Projects can be either privately or publicly funded. The definition of public funds is *"money that is generated by the government to provide goods and services to the general public" (Dictionary, 2016).* Private funds are defined as *"funds available in the private sector without government involvement, support or guarantee" (Investorwords, 2016).* In case of private funding and what the architect specifies is what must be provided by the contractor, without alternate manufactures or substitutions and without substantial descriptions of the installation and quality control provisions, then the level of detail may be low (high abstraction level). If the project is publicly funded or will be competitively bid, then greater detail will be necessary (Kalin et al., 2010, p. 165). This is due to the fact that public funding needs to be justified and therefore more transparency is also required.

Another aspect is the **price certainty**. When a contracting entity has a tight budget then price certainty will become a central aspect, other than a contracting entity with sufficient budget and wants to exert influence on the realization of extra quality. When the client determines the specification more into detail, he will get more influence on the building process and therefore also on the outcome and the price. However if the client specifies in less detail, and involves the market with the design process than more price certainty can also be achieved. Because the uncertainty risk will decrease, and therefore price certainty will increase (Jansen, 2009).

When the **low management costs** are taking into consideration by the client, then he should consider outsourcing the long-term maintenance and optionally also the exploitation. Because by making the designing contractor responsible for long-term maintenance and optionally the exploitation, he will be stimulated to keep the life cycle costs as low as possible (Jansen 2009).

The desired **price/quality ratio** can lead to different choices regarding the building contract model. According to theory outsourcing integrated tasks to one market party should lead to a better price/quality ratio. Nonetheless Jansen (2009) stresses that this principle is not absolute. Because the choice of a building contract model depends on many circumstances.

Building the framework
Four indicators have been set up for the cost complexity dimension, see table 17. Concerning the price certainty, it assumed that this would be considered important at all time for the client. Nonetheless it depends on the moment of market involvement or if the client wants to keep his influence on the building process.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price / quality ratio	Important	Not important

Table 17 Dimension cost complexity

3.3.2.4 Time complexity

In the study of Hertogh & Westerveld (2010) time complexity was considered to be more abstract to participants than to the other types of complexity. A main issue derived from the study on time complexity related to the long time frame with continuous developments, which also relates to the time considerations as defined by Jansen (2009), the phasing of the project, the desired lead-time of the project till completion, desired time certainty and the desired contract duration.

The **certainty on the lead-time** of the project relates to the price certainty as mentioned previously. There is something to say for both models. The traditional model would be a logical consideration if certainty on lead-time is desired, in other words, specifying into more detail. Nonetheless this also correlates to the knowledge and experience of the client. In case of an incidental client, he will not be able to specify into more detail leading to inaccurate estimates and uncertainty on the lead-time. In such case, it is more logical to go for an integrated approach, where the market is early involved, thus the client specifies on a higher abstraction level. By shifting that responsibility, the market has more incentive to accurately estimate the lead-time. In turn one must also look at the phase in which the project is in. If the project is already in an advanced stage than an integrated approach is the less obvious choice. This also relates to little design freedom for the market.

Another point that must be emphasized is the mentioned **long time frame with continuous developments**. This indicator has interfaces with other mentioned complexities as well. According to the study of Hertogh & Westerveld (2010, pp. 169-171) the long duration of planning and construction means that citizens will have difficulties realising which impact a project will have on their living circumstances. This was made explicit in the case of Canton Uri. Due to the extended timescale, people tend to think the project will not mature and are surprised when the project is executed and impacts heavily on their environment. With a long time frame/lead time the project must be flexible due to the changing context and the project delivery organisation itself. In this case an integrated approach would suit more. Within a changing context, the design approach should also be flexible, leaving the technological choices (which also changes over the course of time) to the market. Because the technical aspect is the core business of the market and the technical developments manifests in their sphere.

Building the framework
The dimension *time complexity* is built up of two indicators, see table 18. Concerning the certainty on the lead time, it assumed that this would be considered important at all time for the client. Here the researcher will look at the reasoning regarding if the expertise of the market is needed or not.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)

Table 18 Dimension time complexity

3.3.3 Market aspects

The market aspects regard the knowledge and experience of the market, trust in the market and the readiness for long-term contract from the market's perspective. The first two are based on Jansen's model (2009), the latter one is based on Boot et al. (2014).

An important indication to go for an integrated approach is when the market has a lot of **knowledge and experience** regarding the relevant project. On the other hand when stimulating the innovation in the market is an important aspect, than the client must consider allowing the market to develop the knowledge (in case of insufficient knowledge and experience) (Jansen, 2009).

Another important indicator that will be taken into account is the **readiness for long-term contract by the market**. Here it regards if the market is willing and able to take on a long-term contract. This also relates to the capacity of the market (Jansen, 2009).

The final indicator is **trust**, which is important within each form of collaboration. When it comes to outsourcing the maintenance and the exploitation (life cycle) meaning that the solution freedom will also increase than it is important that the client trusts the contractor that he will bring the project to a good end in compliance with the client's interests. The trust will be less if the contractor thinks and acts from a culture that corresponds more to the traditional form. In that case, it is more suiting not to give the market too much freedom. However it can also be the case that if the client does not have sufficient trust in the market, but the market does has the knowledge, experience and capacity to realise the project than the client can consider going for an alliance collaboration form. Entailing to conduct certain tasks collectively, the client creates the opportunity to increase his trust in the market without giving away full design freedom (Jansen, 2009, p. 95). This form is often applied in combination with the integrated form and when risks are hard to oversee and neither party benefits to bear those risks themselves, nor to merely submit the risks to the other party (PIANOo, 2016a).

According to Kadefors, Gerle, and Nyberg (2001), distrust between client and contractor leads to the adoption of highly specified contracts and close control. Contractors have tried to persuade clients to make design-build contracts less specified so that the contractors may participate in the initial phases of a project. Contractors argue that their knowledge of construction technology and the current market prices of alternative building materials may bring significant value to the process. They complain that it is dissatisfying to always be suspected and not being allowed to contribute their knowledge. However the study of Kadefors et al. (2001) revealed that client preferred specified design-build contracts. The main reason is that the project execution will be smoother with less fuss about minor issues. The client and their stakeholders also required price certainty. There were different opinions on bringing in the contractor earlier. Some considered it valuable, others experienced that it did not contribute much when they were invited to participate (Kadefors et al., 2001, pp. 1-6).

Building the framework

The dimension regards the type of market and the trust in the market and has four indicators, see table 19. This is a special aspect, considering it is about the perception of the principal on the market.

Dimension	Indicator	High level of abstraction	Low level of abstraction
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 19 Dimension type of market and trust in market

See **Appendix G** for a summary of all dimensions and its indicators based on findings in literature and theory.

3.4 Determining the systematic levels

In order to answer how the elements relate to the degree of specification, the degree of specification will be first defined. Thereafter the accompanying attributes per abstraction level will be clarified. In the next chapter, the conceptual framework will be revealed.

The systematic levels of Perrow (1984) as described in 2.3.2 will be used in this research to set up systematic levels for the framework. The concept of system and part are mutually dependent. Each helps to define the other. A technical object can be considered as a system in one analysis but could also be considered as a part in another. The decomposition very much depends on the viewpoint of the one who will decompose the system into parts. In terms of what is functional and technical specification, CROW defines the system and subsystem levels as functional specifying, while everything that falls under the subsystem level such as component (in terms of systematic levels as described by Perrow (1984) this would be the unit level) is technical specification. According to ter Huerne & Veenvliet the design process on system level involves other objectives, parties and an other context than on component or element level (ter Huerne & Veenvliet, 2006, p. 5).

In this study, the following explanations will be used:

1. System
A system can be considered as an infrastructure network of the government. This is the highest abstraction level. In most cases the public client defines this level in a functional manner. Involving third parties on this level relates to an integrated or life cycle approach. Nonetheless the entire infrastructure network is not outsourced in the Netherlands.

2. Subsystem
A subsystem can be considered as the interstate highways, state highways, public space and rural road. In this research it can also mean 'a connection between A and B' (road section). Specifications on this level are considered functional.

The system and subsystem levels are considered functional, also high-level requirements (Negele, 2000, pp. 32-33).

3. Unit
The unit can be considered as the functionally related collection of parts. This can be considered as a bridge, lock, pavement, bank etc. Specifications on this level are technical.

4. Part
This is considered as the smallest component of a system, for example a layer of asphalt, bridge deck, materials etc. Specifications on this level are technical.

The client defines the system himself. The further decompositions here can be considered as the works that are going to be outsourced by the client. In order to design the framework the elements and their indicators need to be linked to their abstraction level. In section 3.3 the indicators have been identified in the sphere of the level of detail. As observed from literature, one does not speak often explicitly about the systematic levels. Therefore different keywords are linked to its relevant systematic levels, see table 20. This has been derived from chapter 2 and 3.

Systematic level	Specification	Involvement market	Collaboration form	Design freedom	Abstraction level
System	Functional	Early	Integrated / life-cycle	Freedom	High
Subsystem					
Unit	Technical	Late	Traditional	No freedom	Low
Part					

Table 20 Systematic levels and the relevant characteristics

3.5 The conceptual framework

The tables below represent the conceptual framework by means of a theoretical and literature research, in addition these aspects and indicators answer sub question 2.

Answering sub question 2:
What elements of the project do contribute to the determination of the level of detail of the specification according to literature/theory?

Client aspects

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction Unit to part
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of the level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required

Table 21 Conceptual framework: client aspects

Project aspects

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price / quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)

Table 22 Conceptual framework: project aspects

Market aspects

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 23 Conceptual framework: market aspects

This conceptual framework is the first step towards understanding the difficulty in the determination of the level of detail. Nonetheless also understanding the establishment and the discussion concerning the LoD. There might be more indicators influencing the LoD, however the line was drawn when no new information concerning the dimensions were found in literature. The dimensions and its indicators here give a broad overview on what needs to be taken into account in the determination of the LoD.

4 Methodology

In this chapter, the research methodology is described. This chapter starts with the research strategy (4.1), herewith the case study strategy will be explained. Thereafter the research design (4.2) will be described, in which application of the conceptual framework will be explained and the data collection and analysis. Finally, section 4.3 describes the case selection and gives a short introduction to the cases that will be explored and analysed.

This chapter gives answer to sub question 3:
What insights are needed to construct a theoretical framework in order to determine the level of detail and to detect the areas of difficulty?

A theoretical framework in order to determine the level of detail is required to structurally investigate the areas of difficulty. This question has an explorative and designing character. The answer to this question is embedded in the methodology chapter (4.2.1), as it will form a part of the method to investigate the research problem.

4.1 Research strategy

The start of this research was conducted by means of an inductive quality study as mentioned in paragraph 1.1. Wester, Smaling & Mulder (2000) have defined three characteristics of qualitative research:

1. The use of data, which is nominal and not intended to represent points or intervals of a continuum. Thus the emphasis is more on the production of data.
2. The role of analytical framework, where the absence of a specific knowledge or method is central. The empirical elaboration in this specific research field.
3. Relative open research design. With qualitative research the research design is not according to a fixed structure of successive research activities as with quantitative research. The formulating character requires a continuous confrontation in preliminary insights based on categories with accompanying data, where changes of insights require new data.

The starting point of an inductive approach is the observation, the empirical study. This was chosen due to the nature of the graduation assignment where the issue was not exactly located. By means of the empirical study the context of the issue decreased.

The conceptual framework has been established in chapter 3, by means of a deductive quality research. A deductive quality research is based on theories concerning the subject. Whereby the researcher firstly investigated existing theories on the subject. This study enables a first version of the conceptual model. Subsequently the theories give insight into all kinds of definitions of the key concepts of the search and help to distinguish different dimensions and aspects from each key concept. On the basis of this comprehensive study the researcher is able to better decide what to investigate precisely. The researcher can also derive assumptions or expectations from the theory. Thereafter one can see, by means of empirical research, whether or not the assumptions are supported in reality (Doorewaard, Kil, & Ven, 2015, p. 16).

In order to investigate further, a research strategy will be stipulated. One can think of different research strategies when conducting research, such as experiment, survey, archival analysis, histories or case studies. Yin (2009, pp. 26-30) suggests that the following three conditions could determine the type of research program indicated. The first condition regard the type of research question, such as the ‘how’, ‘why’, ‘what’, ‘where’ questions. If research questions focus mainly on ‘what’ questions, either of two possibilities arises. Some types of ‘what’ questions are exploratory, such as “what can be learned from a study of a start-up business?”. This type of question is a justifiable rationale for conducting an exploratory study, the goal being to develop pertinent hypotheses and propositions for further inquiry. The second type of ‘what’ question is actually a form of a ‘how many’ or ‘how much’ line of inquiry. Identifying such ways is more likely to favour survey or archival methods than others. For example, a survey can be readily designed to enumerate the ‘what,’ whereas a case study would not be an advantageous method in this situation. ‘How' and 'why' questions are more explanatory by nature, and are likely to lead to the use of experiments, histories and case studies. These questions tend to deal with operational links, which occur during a span of time, rather than the incidents or phenomena, which occur at intervals over time.

The main research question described in chapter 1 is: ‘***What are the causes of the difficulties in the determination of the level of detail in integrated contracts of large infrastructure projects?’***

This questions starts out with the ‘what’ question, implying an exploratory research. According to Yin (2009) with an exploratory study, any of the five research methods can be used: experiment, survey, archival analysis, histories or case studies. Nonetheless this question could be rephrased to ‘how come’, implying an explanatory research, and here one can choose between: histories, experiment or case studies.

This research is actually a combination of exploratory and explanatory research. Where the exploratory research had the overhand at the start of the research, and the explanatory parts takes it over after the

conceptual framework. The exploratory character of this research is that the researcher has an idea or has observed something and seeks to understand more about it. Exploratory research can come in two forms: either a new topic or a new angle. A new topic is often unexpected and startling in its findings. The explanatory character of this research lies in the attempt to connect ideas to understand cause and effect, meaning researchers want to explain what is going on. Explanatory research looks at how things come together and interact.

The second and third condition of Yin (2009), regards respectively, the extent of control an investigator has over actual behavioural events, and the degree of focus on contemporary as opposed to historical events. The distinctive contribution of the historical method is in dealing with the "dead" past—that is, when no relevant persons are alive to report, even retrospectively, what occurred and when an investigator must rely on primary documents, secondary documents, and cultural and physical artefacts as the main sources of evidence. The case study is preferred in examining contemporary events, but when the relevant behaviours cannot be manipulated. The case study relies on many of the same techniques as a history, but it adds two sources of evidence not usually included in the historian's repertoire: direct observation of the events being studied and interviews of the persons involved in the events. Finally, experiments are done when an investigator can manipulate behaviour directly, precisely, and systematically. This can occur in a laboratory setting.

In summary, when historical events are subject of investigation, a history research strategy can be applied. If contemporary events are subject of investigation, an experiment or a case study research strategy is preferred. This research focuses on the determination of the LoD in infrastructure projects based on UAV-GC 2005 in current practice, therefore excluding the history research strategy. Regarding the third condition, no control over behaviour events is required. Therefore, a case study strategy is chosen. The pilot study started out with case studies, and the question itself refers to figuring out the difficulties regarding relevant cases. Therefore the choice for the case strategy is a logic subsequent step.

4.2 Research design

As stated by Yin (2009) the case study is a separate research method that has its own research designs. A complete research design requires the development of a theoretical framework for the case study that is to be conducted. The use of theory, in doing case studies, is an immense aid in defining the appropriate research design and data collection. In this research this was done in chapter 2 and 3 leading to the conceptual framework based on theories.

Because a research design is supposed to represent a logical set of statements, you also can judge the quality of any given design according to certain logical tests. Yin (2009) mentioned four tests: construct validity, internal validity, external validity and reliability. Construct validity relates to identifying correct operational measures for the concepts being studied. Internal validity (for explanatory or causal studies only and not for descriptive or exploratory studies) seeks to establish a causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships. External validity relates to defining the domain to which a study's findings can be generalized. Finally reliability relates to demonstrating that the operations of a study—such as the data collection procedures—can be repeated, with the same results.

Case study research can achieve construct validity by developing its constructs through a literature review, use of multiple sources of evidence, establishing a chain of evidence, and having key external informants review draft case study reports (Christie, Rowe, Perry, & Chamard, 2000, pp. 16-20). According to Yin (1993), in case study research, internal validity/credibility can be established by the use of case analysis, cross case analysis, pattern matching, assurance of internal coherence of findings, expert peer review, and the development of diagrams, illustration and data matrices to demonstrate the internal consistency of the information collected. Further activities to demonstrate internal validity include precisely distinguishing the unit of analysis, linking of the analysis to prior theory identified in a literature review, and presentation and analysis of pilot case studies (Yin 1993). For this research construct validity is established by literature review. Internal validity is established by the use of case analysis, assurance of internal coherence of findings (by means of the conceptual framework), unit of

analysis (client, project and market aspects) linking prior theory identified in a literature review. The external validity and reliability is established by means of the interview protocols that will be used. The further findings will not be generalized; because the cases are too specific to generalize nevertheless the findings are qualitative and based on respondents perspectives as well.

Yin makes a distinction in four case study strategies: single-case (holistic) design, single-case (embedded) designs, multiple case (holistic) designs and multiple-case (embedded) designs. These are based on two discreet dimensions: the single- multiple-case designs and holistic versus embedded case studies. A single case study is often used when it comes to a critical, or to an extreme or unique case. Conversely, a single case can be used because this is characteristic or makes it possible to observe a phenomenon and to analyse, where only few researches have paid attention. Yin gives the following five rationales when single cases are appropriate: when it represents the critical case in testing a well-formulated theory, where the case represents an extreme case or a unique case, the representative or typical case, the revelatory case and last but not least the longitudinal case. Nonetheless there is also the distinction between holistic and embedded. The same single-case study may involve more than one unit of analysis. A holistic case study focuses on for example the company as a whole. If there are for example, departments in a company to be analyses, then there is more than one unit of analysis. Regardless of how one chooses these subunits, this is called an embedded case study.

This research is comprised of several units of analysis; it is chosen to observe the case studies as an embedded single-case. Two cases have been chosen to be investigated, yet will not be used for cross-case study. These cases will be not be compared due to the uniqueness of the cases, and due to limited research on the level of detail. The conclusions on the single-cases can provide stimulating insights for the study of the phenomenon on a broader scale and generate hypotheses for further research. Whether the results are truly generalizable to the investigated case to other cases, remains an open question that can be answered only by additional case studies or through a more extensive approach. The focus is primarily aimed at describing and explaining developments and associations in each case.

4.1.1 Conceptual framework

The theoretical framework for a complete research design has been bundled within a conceptual framework as presented in section 3.5. The framework can be seen as guidance throughout the analysis ensuring a structured content. Relevant information had been derived from literature and theories and schematized in a sheet. The elements have been derived and generalized through an extensive literature search. The dimensions and its indicators were found by a more in-depth analysis on the elements with additional literature sources.

4.2.1 Application of the framework

The conceptual framework will be applied to the designated case studies. The framework forms a bridge between the client aspects, project aspects and market aspects and the proposed systematic levels from literature. These will in turn be analysed to detect the **areas of difficulty** in the determination of the LoD. A way to do this is by comparing the prescribed systematic level by means of the organisation's policy, in the case of RWS and ProRail the UAV-GC 2005: specifying on a high abstraction level (system to subsystem). The stated hypothesis in section 2.5 will now be rephrased to:

The client, project and market aspects of projects based on the UAV-GC 2005 fit the characteristics of high level of abstraction.

The difference between the outcome of the framework and the hypothesis (policy), the **deviations**, will be investigated. The aspects that fall in the characteristics of the low abstraction level are considered not to fit the policy, i.e. deviations. This is the gap between the desired and the existing situation, in other words the problem. Questions such as 'why does the practice differ from what literature states for this case study' (if there is any) will be answered. The discrepancy will be evaluated to verify with the interviewees if the theoretical approach would indeed be a better fit or that there are other reasons to

consider the applied LoD. Nonetheless missing elements/dimensions/indicators may come to light as well, therefore the framework might be adapted after the practical study once again.

The conceptual framework will be used in the interviews in the case studies to find out the areas of difficulty. The choice between high level of abstraction and low are illustrated in extremes (for example high or low). The term 'extreme' here is used to describe the range or expanse of responses to a particular question. As stated by (Leslie, 2015), some interview questions may not have such direct and easily placed extreme answers. Nonetheless it is often helpful to examine unusual responses, the ones that are insufficient, obscure, or in some other way incomplete. Each and every response is a piece of data and cannot be thrown out. They might be very useful to address the research question. For every project at least 2 respondents will be interviewed, therefore there is a chance that the interviewees will answer differently due to their project role or perception on the project. If there ought to be differences in answering, the reasoning will be evaluated in order to check the right box. The results of the framework will therefore be evaluated at the end of the survey by the researcher in order to reach the most relevant or suitable answer.

In order to use the conceptual framework in practice, questions have been set up in the framework linked to their answers and to their level of detail. The framework that will be presented to the respondents will be slightly different from what has been presented in 3.5. First of all the choice in answers is more extensive in the one that will be presented to the respondents. Not every question can be answered in extremes in practice; in addition the reasoning of respondents will be investigated. The framework that will be used in the interviews is illustrated in **Appendix H**.

4.2.2 Results of the framework

The framework has been divided into three main elements, namely: the client aspects, the project aspects and the market aspects. The hypothesis will be tested. The outcome of the cases illustrates where the areas of difficulty in determining the LoD are situated, for example these could lie in the client aspects or even in a combination of aspects. **Assumptions** can arise on what causes the difficulty in the determination of the LoD, which will be supported again by means of the empirical study and literature/theory review.

Allocating the areas of difficulty gives an idea where improvements can be made (or implemented). Herewith one can propose solutions or interventions. These areas can also contribute in signalizing threats or opportunities.

4.2.3 Verification of the framework

The framework will be verified by means of a counter case study based on the traditional approach (RAW systematic) by means of UAV 2012. According to Ramdhani and Ramdhani (2014, p. 6) a logical framework of research can be accepted as a good framework if the framework successfully passes the verification process. The concept of verification process is generally measured by: the level of usefulness, usability, the ability to represent the state of problem, as well as other important variables. The verification round must show that a UAV 2012 case will not fit the characteristics of a project according to high abstraction level objective.

4.1.2 Data collection and analysis

This research is divided into five steps, see table 24 below. Herewith the steps and its accompanying input, question and chapter are described.

Step	Theoretical exploration I	Theoretical exploration II	Analysis	Synthesis	Conclusions and recommendations
Input	Literature	Literature + theories + methodology	Case 1 and 2	Results from analysis and theory	Results from synthesis
Question	SQ 1	SQ 2 + 3	SQ 4	SQ4	RQ
Chapter	Chapter 2	Chapter 3 + 4	Chapter 5	Chapter 6	Chapter 8

Table 24 Research framework

When conducting case studies different sources of evidence like documentation, archival records, interviews, direct observations, participant observation and physical artefacts can be used (Yin, 2003). In this research information has been derived from documents from both public as private organisations. In this case the documents of the private organisation are retrieved by the database of W+B (project documents) and online search.

For the two cases, semi-structures interviews will be held. The interviews will be conducted with project team members that also had a role in the selected case studies. The interviews will be conducted face-to-face. The interview consists of an introduction part, where the participant explains his/her role in the project and organization. Thereafter the core of the interview will be held, which consists of two parts. The first part is the closed questionnaire; designed through the conceptual framework, see **Appendix H**. The conceptual framework helps to categorize the answers automatically and the connections between them will also be described. The participant will fill in the conceptual framework, however the meaning of the answers will be hidden (the systematic levels) in order to avoid biased answers. Because the meaning of the answers could steer the answers of the participants, which must be avoided at all time. The second part of the interview consist open questions regarding the SE process. This questionnaire is needed to understand the process of getting to the level of detail. In addition also to conduct an internal validation round with the respondents whether the found elements in the framework should represent the choice for the determination of the level of detail and to find out missing elements regarding the framework.

The interviews will be recorded. According to Yin audiotapes certainly provide a more accurate rendition of any interview than any other method. However, it should not be used if inter alia the interviewee refuses permission or appears uncomfortable in its presence. Prior to every interview, permission will be asked to the interviewee and the researcher will safeguard his/her privacy by processing the information anonymous. The interview protocols are included in **Appendix I**.

4.3 Case selection and introduction

In this section the method on the empirical study will be elaborated. Case studies will be conducted to challenge the conceptual framework. A case study research strategy enables the researcher to gain a profound insight into one or several objects or processes that are restricted in time and space (Verschuren & Doorewaard, 2010, p. 163).

In order to be able to investigate the determination of the level of detail based on the UAV-GC 2005 procured by a public client the following hard criteria are set up for the selection of the case studies:

1. The project is a dry infrastructure project in the Netherlands
2. The project is initiated by one or more public clients
3. The project will be procured based on the UAV-GC 2005
4. Systems Engineering was used in the design process

The first criterion is set due to the different procedures the dry and wet infrastructure follows in the Netherlands. In order to be consistent and to decrease the scope, dry infrastructure projects have been chosen. The second criterion has to do with the procedure of determining the LoD and the building organisation form. Large public clients must follow certain policies regarding this aspect; therefore it is interesting to investigate whether or not the project matches its policy regarding the LoD or building contract model. The project must also be procured based on the UAV-GC 2005 because only in this contract form there is the discussion of specifying into more or less detail.

The cases have been selected within the portfolio of Witteveen+Bos. A9 Amstelveen (Badhoevedorp-Holendrecht) and ZuidasDok are the selected case studies for this research. In addition, a counter case study will be conducted to verify the conceptual framework. This case has also been selected within the portfolio of Witteveen+Bos. The Utrecht CU2030 HOV-viaduct is the selected counter case study. The information provided for the case studies are by means of project documents and interviews with project experts from both the engineering firm as the client (Rijkswaterstaat and municipality of Amsterdam).

4.3.1 Project A9 Amstelveen Badhoevedorp – Holendrecht

The A9 Amstelveen is part of the road expansion Schiphol-Amsterdam-Almere (SAA). The SAA is the largest road program of the upcoming 10 years according to RWS. The need for the program was due to the busy highways between Schiphol, Amsterdam and Almere where traffic jams have become a regular feature. In order to reduce congestion, the road network will be expanded. In this way, RWS, wants to improve the traffic flow and in addition also the accessibility of the northern Randstad region. At the same time, RWS, takes action against noise pollution. The program consists of five projects. In this research the focus will be on one of the five projects, which is the A9 Amstelveen, from Badhoevedorp till Holendrecht, see figure 8 below (brown ribbon).

Figure 8 Road expansion Schiphol-Amsterdam-Almere (project document)

The A9 Amstelveen is an important link in the total traffic network of SAA with connection to the A2 (node Holendrecht) and the A4 (node Aalsmeer) and it also functions as a detour for the A10 Zuid. A part of the A9 route goes right through the core of Amstelveen and forms a barrier in the Noord-Zuid connection in the underlying road network. Due to the urban location there are many stakeholders and interfaces. Between the nodes of Badhoevedorp and Holendrecht the A9 will get 4 instead of 3 lanes in each direction and also new noise barriers. The highway in Amstelveen will be deepened 1.3 kilometres.

This project is quite special due to the design change. The Ministery of I&E had established the Route Decision (Dutch: TB) for the A9 in March 2011 as part of the SAA road expansion. In the first place, a tunnel was to be realised according to this Route Decision. Initially the municipality of Amstelveen would help to pay for this tunnel, but due to the financial crisis this turned out not to be feasible. After consultation with different parties, the collaboration agreement was revised and an alternative solution was sought that also had to improve the accessibility and the quality of life in the area. This resulted in a deepened road, where the connection at the Keizer Karelweg remains intact and two canopies and new connections for cyclists and pedestrians will be realised.

	A9 Amstelveen Badhoevedorp - Holendrecht	
Project type	Infrastructure	
Principals	Rijkswaterstaat	
Phase	Plan development phase	
Procurement	To the consultant a BVP, and eventually to the market as a DBFM	
Engineering	Witteveen+Bos	
Financing	Public	
Project size	€150+ million	
Planning	**March 2016**	Revised OTB 2016 reviewed
	March 2016	Information meetings and the possibility to submitting an opinion (indienen van zienswijze)
	March 2017	Minister of I&E determines modified TB 2016
	Medio 2018	Verdict Council of State: TB irrevocable
	2017-2018	Start tendering process for contractors
	2018-2019	Awards contract to contractor
	End 2019	Groundbreaking
	2024-2026	Opening of the widening of the A9
Objectives	The purpose of the project is to strengthen the accessibility, taking into account the viability, by realising 2x4 lanes at the A9 between the nodes Holendrecht and Badhoevedorp with a deepened connection around Amstelveen. The following objectives were formulated: - Keeping stakeholders satisfied: the project must remain its connection with the environment - The execution must be future proof within the scope: on time, the desired quality for as little money as possible - Working in a powerful way: recognizable uniformity, practical and sober and daring	

Table 25 A9 Amstelveen Badhoevedorp - Holendrecht facts & figures

4.3.2 Project ZuidasDok

The ZuidasDok is a project of Rijkswaterstaat, ProRail and the municipality of Amsterdam in order to improve the accessibility of the Amsterdam south axis and the northern part of the Randstad, both by

public transport and by road. This will be achieved by expanding the Amsterdam Zuid station, including the integration of urban and regional public transport. The A10 Zuid will be widened between the nodes De Nieuwe Meer and Amstel from 2 x 6 lanes, which will be separated through transit traffic and local traffic. The nodes itself will be adjusted as well.

Extending the station and the widening of the highway is made possible by building two tunnels by the A10 Zuid at the height of the center of Zuidas. This will inter alia reduce the noise level around the center of the Zuidas. As a result the Zuidas can be further developed into a sustainable mixed urban center for living, working and facilities.

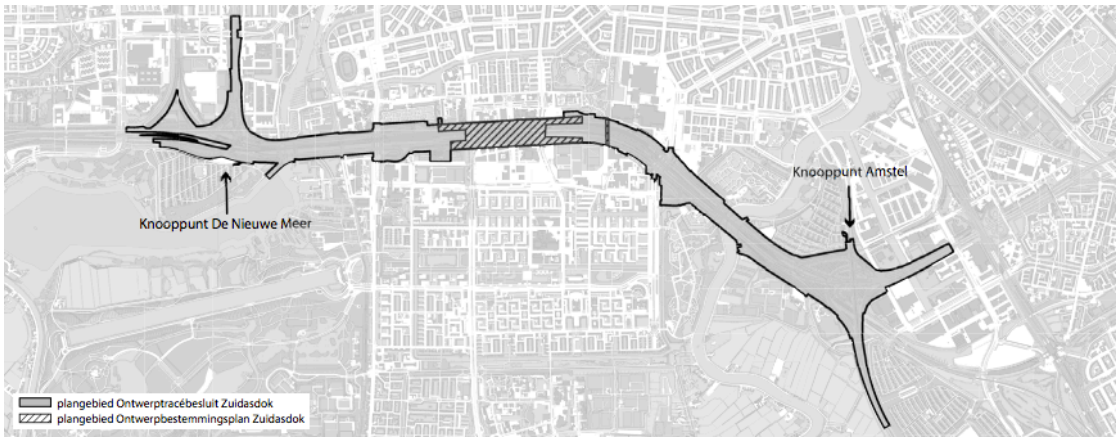

Figure 9 Project ZuidasDok (project document)

The ZuidasDok project involves the following:

1. Expansion of the Amsterdam Zuid station and incorporating municipal and regional public transport
2. Room reservation for future construction of a 5th and 6th train track with an additional platform
3. Widening the A10 Zuid and adjusting De Nieuwe Meer and Amstel nodes, whereby the A10 Zuid at the height of the center of the Zuidas a northern tunnel (circa 1.1km) and a southern tunnel (1 km) will be located
4. Designing the vacant public space above the tunnels
5. Constructing the railroad switches for domestic high-speed trains south of Diemen

	ZuidasDok	
Project type	Infrastructure and public space	
Principals	Rijkswaterstaat, Municipality of Amsterdam, ProRail	
Phase	Plan development phase	
Procurement	Design & Construct	
Engineering	IBZ (Arcadis, AT Osborne and Witteveen+Bos)	
Financing	Public	
Project size	€1.9 billion	
Planning	**2015-2016**	Preparatory work: Building bicycle parking and redevelopment Gustav Mahlerplein; Shift cables and pipes.
	2016	Determination TB and land-use plan ZuidasDok
	2017	Award of contract
	2017-2028	Building the ZuidasDok possible phases*: Widening of the embankment of the A10 Zuid for additional lanes; Construction of tunnels and viaducts for the A10 Zuid; Removing the Amstelveenboog (a new high quality tram connection with Amstelveen); Realization of a new passage under the station Amsterdam Zuid (Brittenpassage); Renovation of Amsterdam Zuid station (with widening the current Minervapassage); Commissioning of the A10 Zuid including tunnels; Removing the old A10 Zuid; Commissioning the 'new' Amsterdam Zuid station; Designing public spaces, including tram, bus and bicycle. * the contractor will ultimately determine the phases
Objective	- Further realization of an international location as an integral part of the region and the city of Amsterdam - An optimal functioning quality traffic and transport network; - A high quality public transport hub of international stature - Sustainable integration of the infrastructure to the barrier to reduce and to improve the quality of the environment.	

Table 26 ZuidasDok facts & figures

4.3.3 Project Utrecht CU2030 HOV-viaduct

The municipality of Utrecht is working with its partners on a new station area, which is called the program CU2030 ('See you too 030'). Together with the historic city center this will form the new city center of Utrecht in the future. The program includes a wide range of urban project in which new infrastructure and public space, real estate development and amenities will emerge. One of the investments of CU2030 is the construction of a HOV-lane (Dutch: hoogwaardig openbaar vervoer), between the station and the Jaarbeusplein (stop Centraal-Jaarbeusplein). The project 'Realization HOV-lane west including viaduct and HOV-lane Smakkerlaarsveld' will be a part of it. The purpose of this project is to create a high quality public transport link between the station and the stop Centraal Jaarbeursplein and the Smakkelaarsveld.

The project consists of a HOV-viaduct design and the redevelopment of the Van Slijpesteijnkade. The HOV viaduct is an object with a span of approximately 52 meters and driveways from Jaarbeursplein and Leidseveertunnel.

Figure 10 HOV-viaduct under construction (left) and the design (right) (Boekel, 2016)

	Utrecht CU2030 HOV-viaduct
Project type	Infrastructure and public transport
Principals	Gemeente Utrecht, Klepierre, ProRail, NS, Jaarbeurs
Contractor	Van Boekel Zeeland
Phase	Realisation
Procurement	RAW bestek
Engineering	Witteveen+Bos and design by Engineering firm Verhoeven & Leenders
Financing	Public
Project size	The contract does not mention the costs. It is part of a loop through the tram network to the Uithof, in which a total of €440 million is involved.
Planning	**Current status** Realisation and preparation **2018** Opening 2018
Objective	- Improving the quality of life and safety. - More room for culture, entertainment, improved accessibility and bringing the water back to the canal - Making the area more durable; efficient buildings, room for cyclists, pedestrians and public transport and solar cells on the new platform roofs.

Table 27 Utrecht CU2030 HOV-viaduct

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5 Analysis

In this chapter, the project A9 Amstelveen Badhoevedorp – Holendrecht (5.1) and project ZuidasDok (5.2) are explored. The interviews that were held with the respondents are elaborated. The findings are structured according to the division as presented in the framework: client aspects, project aspects and market aspects. Thereafter the interrelations (5.1.4 & 5.2.4), relation between the framework results and the abstraction level (5.1.5 & 5.2.5) and interim conclusions (5.1.6 & 5.2.6) will be presented regarding the cases. This analysis forms the input for the synthesis.

5.1 Project A9 Amstelveen Badhoevedorp – Holendrecht

For this case five respondents have been interviewed in which three of them have filled in the framework. Each respondent will be coded in order to present his or her perspective in the analysis. The respondents that did not fill in the framework also provided relevant information for this section, and therefore their answers will be incorporated as well.

Role	Principal/Consultant	Pilot study	Filled in framework	Code
Facilitator	Consultant W+B	No	Yes	AC1
Project control manager	Consultant W+B	No	Yes	AC2
Technical manager	Principal RWS	No	Yes	AP1
Plan study manager	Principal RWS	Yes	No	AP2
Project control manager	Principal RWS	Yes	No	AP3

Table 28 Respondents coded A9 Amstelveen (B-H)

The outcome of the questionnaire, filled in by the respondents of the consultant from W+B has been illustrated by means of the conceptual framework. In the following sub sections the interviews will be elaborated regarding the client aspects (5.1.1), projects aspects (5.1.2) and the market aspects (5.1.3). Nevertheless the interrelations (5.1.4), relation to the abstraction level (5.1.5) and interim conclusions (5.1.6) will also be presented.

5.1.1 Client aspects

In this framework the client aspects relate to the type of client, client's ambition and client's influence, in which they have their own indicators and associated questions. By filling in the table conclusions can be drawn on how the client aspect matches the level of abstraction.

Dimension	Indicator	Question	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Type of client	Professional or incidental client	1. Is the client of the relevant project a professional or an incidental client?	Incidental	Incidental	Professional	Professional
	Public or private client	2. Is the client of the relevant project a public or private client?	Private	Private	Public	Public
	Knowledge & experience	3. To which extent does the client has experience and knowledge with the relevant or similar project?	Low	Average	High average	High
	Knowledge & experience regarding functional specification	4. To which extent does the client has experience and knowledge with functional specification?	High	High average	Average	Low
Client's ambition	Aesthetic/spatial integration	5. To which extent is a vision on the aesthetic/spatial integration formulated in this project?	No vision + not stated	Vision + not entirely stated a lot of room	Vision + stated little room	Vision + stated
	Sustainability	6. To which extent is sustainability important in this project?	Highly Important	Important	Average important	Not important
	Innovation	7. To which extent is innovation important in this project?	Highly Important	Important	Average important	Not important
		8. To which extent is there room for innovation? (Using new methods, which have not been applied before)	Plenty	High Average	Average	Low
		8.1. At which stage will the contractor be involved in this project? 8.2. What is the scope of the contractor/market?	Exploratory phase Scope: area	Exploratory phase Scope: area	Draft Route Decision, OTB Scope: b/l	Route decision, TB Scope: b/l
Client's influence	Translation to functional requirement	9. To which extent can the ambitions be translated to functional requirements?	Many	High average	Average	Low
	Willingness to let go regarding setting requirements	10. To which extent is the client willing to let go of specifying the requirements?	Very willing	Willing	Not that willing	Not willing
	High abstraction of the level of detail	11. To which extent is the level of detail of the tender specification high/abstract?	High abstraction	High average abstraction	Average abstraction	Low abstraction
	The need to monitor	12. To which extent is influence needed of the principal to guard the ambitions, policy and concept?	No influence required	Low average influence required	Average influence required	Influence required

Table 29 Client aspects A9 Amstelveen Badhoevedorp - Holendrecht

5.1.1.1 Type of client

The principal of this project is the ministry of I&E and the executive agency RWS, which have been perceived as public professional clients by the respondents (AC1, AC2, AP1). As a public client, they are obliged to work transparently towards the public. The people working in the project organisation from the client side are considered to have average to much knowledge and experience regarding the relevant or a similar project. According to the respondents (AC1, AC2) it was actually a mix of very knowledgeable individuals from the client side, but there were also some who were conducting a project in general for the first time.

The answer on the degree of knowledge and experience with functional specification differed. The respondents from the consultant side considered the client having a lot to average knowledge and experience. However stated that this does not mean that the specification process runs smoothly. The respondent from the client side states that the knowledge and experience is present however it is also very diverse in his team. RWS has many faces, it does not consist of a fixed organisation but many of the team members are hired including him. Nevertheless the knowledge on FS is present, but due to the fact that RWS works with basis specification, people tend to show copy-paste behaviour.

Regarding the knowledge on functional specification by means of SE, the respondent mentioned that the technical team does not really use the systematic names as defined in literature. Because the perception of each specifier is different on what a system, subsystem, unit and part is. They find it too subjective and vague. The respondent mentioned that he intentionally calls everything a subsystem per definition, even if it is 10 layers deep. Because it gives people a certain perception that it is a component, and a component can be a complete object.

The overall knowledge and experience of the client has been perceived as high average by all the respondents (AC1, AC2, AP1). From other interviews this seems to clash with the procurement of the design, which is on the basis of a Best Value. The Best Value Procurement (BVP) implies that the engineering firm will make use of its expertise and experience, and therefore the client would in theory relinquish from the project and give the lead to W+B (PIANOo, 2016c). However from the interview with the client (AP1, AP2) it became apparent that the client wanted W+B to make use of the client's in-house knowledge and experience. The respondent stated that RWS also has consultants with knowledge about the subject matter. There is a tension noticeable here.

In addition, RWS also wanted to go more into detail with the design while W+B did not want that. A conflict of interest was detected here. As a public client, RWS has to justify its work towards the public. This was also mentioned as one of the reasons why the client wanted more detail in the OTB phase, because in their consultations with the environment, the people wanted to react on visuals and wanted to know everything into detail. However it was also mentioned that the client had to deal with a front and end test, which is not conducted by their own organisation group but by national operating teams, legal experts and advisors (external party). They are the ones deciding if the OTB is qualitative acceptable in order to present it to the Minister. The parties conducting the test expect that the client knows the content of the report, which will be send in in the front test. However due to BVP W+B was not obliged to let the client revise the report prior to the test. Whilst RWS had stated that they can give advice on their own initiative to W+B. There was a friction on *when* the client could inspect the report. Nonetheless feed back loops have been held throughout the process. By means of key performance indicators (KPI[5]) measurements the performances have been linked to the desired behaviour. Eventually a new session was conducted between RWS and W+B in order to revise the report prior to the front test.

PIANOo (2016c) states that the preconditions to apply BVP successfully are, inter alia: presence of competition in the market, complexity (sufficient principal risks for the to which companies can distinguish themselves) and the extent to which the project can be set up functionally. But most

[5] KPI are variables to analyse the performance of a company, brand or product. KPIs are used to measure the success of an organization in general, or the success of a given operation or campaign.

important, the *principal must be willing to let go* (minimizing scrutiny and proper attitude and behaviour). The contractor on the other hand must be prepared to show his skills and making its performance transparent.

It has been observed that although the BVP is a good method to incorporate external knowledge and experience for the OTB and the researches, the client is still hesitant in giving away control because the upper layers of the organisational field will not make a distinction whether the OTB is procured on the basis of a BV or not. As the respondent (AP2) stated, the Minister operates in a politically sensitive arena, and will not simply sign the OTB. It is essential for the Minister that the OTB goes through the front and end test. Nonetheless by introducing a verification round prior to the front test, engineering firms might not get inspired to perform optimal because they will be *checked* again and this does not fit with the BVP mind set.

5.1.1.2 Ambition of the client

The assignment entails an amended OTB and TB. Before, there was already an entire TB laid out with plans for the landscape, integration plans et cetera for the initial tunnel project. W+B is now converting that to fit into the deepened road project. Respondents (AC2, AP1) answered that there is some room for the market but not much. The respondent (AP1) explained that this is due to the fact that RWS had varies conversations and agreements with the stakeholders, those conversations in turn lead to requirements RWS has so comply with. The market has some design freedom within the boundaries of the frameworks. The design freedom lies within the building method for the market, it is actually the details and the choices regarding construction types the market has a say in. The client considers the aesthetics of the project highly important and it also has been specified in an external program of requirements, namely the aesthetics program of requirements (EPVE). Specially hired architects designed the EPVE. That document is now used by RWS to engage with stakeholders, as it is a book containing drawings and visuals. That kind of document is what people can relate to and it works quite well according to the respondent (AP1).

The client (AP1) stated that sustainability is an important aspect to encounter, as it is also one of the objectives of the project. According to the consultant respondent (AC1) the client did not actively steer on sustainability but was satisfied with what W+B had presented in terms of sustainability in the design.

Innovation was not considered important, this also links to the lack of room for innovation. According to (Van Valkenburg et al., 2008) the entry point of the market is considered to be too late in order to incorporate innovation for the market. Because it is *after* the TB, meaning a lot of procedures, regulations and requirements will encapsulate the design already leaving little room for innovation to the market. Next to that the scope of the market entails only the line infrastructure, in order to present the market enough room for innovation the scope must be broader. All in all the lack of ambition regarding innovation does match the entry point and scope towards the market. However it does not match the incentive of using the UAV-GC as presented by RWS itself “using integrated contracts to stimulate innovation”.

5.1.1.3 Client’s influence

All the respondents (AC1, AC2, AP1) agree that many of the ambitions can be translated to functional requirements. This is therefore in line with the use of functional specification leaving the technical specification to the market.

According to the respondents (AC1, AC2) the client is on the one hand not that willing to let go of specifying the requirements, but on the other hand the project will be procured based on DBFM and therefore the client will not specify into a lot of detail. The respondent from the client side (AP1) however explained that they are very willing to let go of specifying but there are strings attached to it. In extreme case, the project manager dares to procure without any requirements if and o*nly if* the reasoning behind it is crystal clear on how the project team came to a sketch or reference design. The

ambition is in fact to absolutely let go of specifying the requirements but it has to be based on the line of reasoning, the 'why'. The question than is, to what extent is the level of detail of the tender specification high/abstract? At the moment this subject is still under discussion between RWS and W+B. According to W+B this will probably be not abstract, thus in much detail. Stating that this also varies per part. For example where the pump station will go, will probably not be specified in much detail. But the construction of the highway, the guardrail, will be specified into a lot of detail. RWS has formulated basis specification regarding that subject. The client's perspective (AP1) on this is that the specification will be average abstract. Admitting that there are project specific specifications laid down. In fact it is a copy based on previous SAA projects, supplemented with components and basis specifications. What is still missing, are the risk-driven technical challenges/details. The client is still in debate whether or not to specify the seepage (Dutch: kwel) functional or technical to prevent a repeat of the A4 Delft Schiedam. The discussion on this subject will be taken upcoming fall.

In order to guard the ambitions, policy and concept of the project, influence of the client is needed as stated by all respondents (AC1, AC2, AP1). Not only must the client comply with the wishes in political spheres but also with its stakeholders. Therefore the client has conducted several gatherings with stakeholders to inform them. In those meetings the stakeholders mirrors their ambitions and wishes to what RWS presents. The influence of RWS is also needed when it comes to the ambition in the sense of maintaining support from the environment, because this will not be maintained by the contractor in the next phase. According to the consultant respondent (AC2) the contractor has other incentives, which has to do with doing their own job and generating revenue. In the case of stating 'maintaining support from the environment' in a collaboration agreement with the contractor, the environment will probably still address the issues to RWS because they are the face of the project as stated by the respondent from the consultant side (AC2). This will also become apparent in *the trust in the market* aspect. The answer to this question also referred back to the aforementioned BVP dilemma. The respondent (AC1) noticed that the client really wants to monitor, while the A9 project is according to BVP. The client showed difficulty in letting go control because they have to justify it towards the politics.

5.1.2 Project aspects

In this framework the project aspects relate to the following complexities: technical, organizational, environmental, cost and time. In which they have their own indicators and associated questions. By filling in the table conclusions can be drawn on how the project aspect matches the level of abstraction.

Dimension	Indicator	Question	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Technical complexity	Newness of technology	13. To which extent will one make use of new technologies regarding machinery/equipment in the execution phase?	Many new	High average new	Average new	No new
	Experience with the technology	14. To which extent does the project team has experience with the to-be-used technical applications?	None	Low	Average	High
	Requirement of special equipment/ technology	15. Does the project requires the use of special technique?	Needed	Needed	Not needed	Not needed
	Technical risk	16. Do you think that the project is subjected to high risk (number, probability and/or consequences of) regarding technical risks?	High	High average	Average	Low
Organizational complexity	Experience with parties involved	17. To which extent do the relevant parties have experience with each other?	High	Average	Low	None
	Organizational fragmentation	18. To which extent is the project organisation subjected to fragmentation?	None	Low	Average	High
		18.1. Are a lot of different organizations involved in this project? 18.2. Are a lot of different kinds of disciplines involved in the project team? 18.3. Are there a lot of different locations from which the project team operates?	No No No	2x No 1x Yes	2x Yes 1x No	Yes Yes Yes
	Organizational risk	19. Do you think that the project is subjected to high risk (number, probability and/or consequences of) regarding organizational risks?	Low	Average	High average	High
Environmental complexity	Stakeholder's influence	20. Which strategy fits in this case most to the extent of influence the stakeholders have?	High influence (if principal is not able to specify into detail himself, he should involve the market early)		High influence (if principal is able to specify into detail)	
	Political influence	21. Which strategy fits in this case most to the extent of influence the politics have?	High influence (if principal is not able to specify into detail himself, he should involve the market early)		High influence (if principal is able to specify into detail)	
	Environmental risk	22. Do you think that the project is subjected to high risk (number, probability and/or consequences of) regarding environmental risks?	Low	Average	High average	High
Cost complexity	Funding	23. Will this project be financed by means of private or public funds?	Private	Private	Public	Public
	Price certainty	24. To which extent is price certainty important?	Important early market involvement		Important more influence on building process by principal	
	Low management costs	25. To which extent are low maintenance costs important?	Highly Important	Important	Average important	Not important
	Price/quality ratio	26. To which extent is the price/quality ratio important to take into account?	Highly Important	Important	Average important	Not important
Time complexity	Certainty on the lead time	27. To which extent is there room in the schedule in the lead-time of the project?	Tight schedule expertise of the market needed		Tight schedule expertise of the market not needed	
	Continues developments	28. Is the project subjected to many changes/developments in the context and scope between the initial and exploitation phase?	Many (project flexibility is needed)	High average	Average	Low (straight-forward project)

Table 30 Project aspects A9 Amstelveen Badhoevedorp - Holendrecht

5.1.2.1 Technical complexity

The respondents (AC1, AP1) assume that this project will probably not involve new kinds of technology in the sense of equipment and machineries. Nonetheless the contractor that will be chosen in 2017 might use new kinds of technology. It is also not unthinkable that technical developments by then will be more

advanced and preferred by the contractor to apply if it is more cost-friendly. The respondents (AC1, AC2, AP1) answered that although from the outside the project might look general, it will still require special technique. It is not a standard project. Especially regarding the groundwater flow special technique may be necessary.

The technical team on the project at the moment are considered to have a lot of knowledge and experience with the technical applications that will be used (AC1, AP1). The respondent (AP1) states that the technical team from the client side actually involves many individuals with a contractor's background, therefore knowing a lot regarding the execution of works. However he questions if this in-house knowledge is necessary in a functional specification contract. On the other hand, it seems necessary or else one cannot properly specify. It is actually the chicken or the egg causality dilemma. This is also where the tension between the contract managers and the technical managers are perceived. They argue over different degrees of specifications, as the technical manager sees many risks and wants to specify into more detail. Yet the contract manager looks at 'what do we have to pay, and what is it worth'. They want to buy off the risk so that they do not have to investigate the issue technically.

The technical risk is considered to be high to average for many reasons as stated by the respondents (AC1, AC2, AP1). The deepened road is a geotechnical risk. Although it will not be a tunnel anymore, and therefore not bound to the Dutch tunnel law with all kinds of regulations on the installations, there is still a technical challenge in it according to the respondent (AP1). From another interview with the client respondent (AP2) it became apparent that the sound and safety aspects were highly important with the deepened road. The initial design was a tunnel, whereby the noise would be muted. Despite that, that decision was eventually off the table, the sound standards of the tunnel were adopted in the legislation. Therefore the project team still had to adhere to the low sound standards of the tunnel for the deepened road. This relates to the expectations of the environment. The same applies for the external safety. With a tunnel there is less risk with the transport of dangerous goods, but with a deepened road that risk will become higher.

The high technical risk fits a high abstraction level according to the framework. This is also the expertise of the market, and therefore their core business.

5.1.2.2 Organizational complexity

W+B is considered to have a lot to average experience with the involved parties and internally with each other in the project team as stated by the respondents from the consultant side (AC1, AC2). At the start of the project there was no experience with the municipality of Amstelveen, but by now there is. The IPM technical project team however from the side of RWS is considered to have little experience with each other according to the client respondent (AP1). This is due to the fact that a major part of the team is a freelancer; only 2 out of 10 in the technical team is from RWS. Next to that, there are many flexible employees. This is very difficult organisation wise, because everyone has a different background and is used to a different kind of working in an organisation. People need to get used to each other, understand each other; this requires a different way of working. The standard organisational struggles are applicable here. The respondent (AP1) mentioned he was spending more time on the soft skills of the project instead of diving into the substantive technical matters.

The fragmentation of the project organisation is observed as average. There are a lot of different organisations involved in the project team of the A9 Amstelveen Badhoevedorp – Holendrecht, such as W+B, RWS, freelancers within RWS, wUrck architects, Netmobile, landsadvocaat and visual engineers XKP. In addition the project team involves many different disciplines, from architects to contract managers, environmental manager, engineers etc. Although there are a lot of different organisations involved, only 2 locations were used where the project team meet up to work together. Therefore the location fragmentation is kept to a minimum.

Regarding the question on whether or not the organisation risk is high, the respondents from the consultancy side (AC1, AC2) answered *low* in contrast to the respondent from the client (AP1) side *high*. This is due to the fact that the relation between W+B and RWS is stabile and therefore the risk is low.

However according to the client respondent the organisation risk is high within RWS, there are many freelancers working in the project team on the client's behalf with different backgrounds. The hierarchical lines functions differently than what they were used to in a political organisation it works totally different. There are many decision-making procedures to go through in order to get something done in contrast to a construction company where decisions are taken rapidly and things are getting swiftly done. Respondents from the consultancy (AC1, AC2) also noticed that the organisation risk at the client is high, stating that RWS is struggling with low capacity of people, not necessarily with the core team but with everything that falls directly under them. That line is continuously and rapidly substituted. The core team is actually very stabile; there was only one substitution in the 2 years that has gone by. But even respondents from the consultant noticed that the line directly below the core team was unstable due to the short contracts they have.

5.1.2.3 Environmental complexity

In all cases with public projects the public support is needed because they can either positively or negatively influence the project. With the A9 Amstelveen this is no exception according to all the respondents (AC1, AC2, AP1). The key stakeholder is the municipality of Amstelveen, which also contributes financially to the project and that is also one of the reasons they have a lot of influence on the project. Therefore it was also chosen to involve the market early according to the respondent (AP1). However it must be noted that the technical team from the client side is actually able to specify into detail as perceived in section 5.1.2.1.

Next to that all the respondents (AC1, AC2, AP1) states that the politics also has a major influence on the project. The respondent (AP1) explains that the Minister has already pulled the plug on the project in the past. Whenever there are budget cuts coming from The Hague it will directly influence the project. Therefore this project is very political sensitive.

Overall the environmental risks are considered as follows: respondents from W+B (AC1, AC2) considered it average to high and the respondent from RWS (AP1) answered very high. The difference lies with the indirect/direct lines to the political spheres and the role of contact point RWS has towards the public. W+B will notice the political risks from a further distance than the project team of RWS. The environmental risk will probably remain high throughout the construction because the project goes right through the living area of Amstelveen. For the apartments close to the highway it is quite risky.

5.1.2.4 Cost complexity

The project will be publicly funded. In almost every project price certainty is actually an important aspect to consider according to the W+B respondent (AC1). However the intervention can differ. In this case price certainty is considered important and therefore the client wants to involve the market in an early stage, hence the use of an integrated contract (DBFM) and the dialogues that will be held next year with the market (AC1, AP1). Nonetheless RWS also wants to keep control, this manifests in the fact that in September RWS will conduct a budget estimation regarding the entire work from poles to asphalt (AP1). The choice to procure the maintenance in the DBFM also suggests the need for low management costs. In order to make the project manageable for RWS they will outsource the maintenance for approximately 25 to 30 years.

The price/quality ratio was also considered (AC1, AC2, AP1) as a very important aspect to take into account, because this will be expressed by means of the Economically Most Advantageous Tender, or shortly the EMAT (Dutch: Economisch Meest Voordelige Inschrijving (EMVI)). With this kind of tendering not only the price is taken into consideration but also other quality aspects are considered in the assessments of the tenders. EMAT is used to encourage bidders to offer more than what is required. In fact, the EMAT materialize the wishes of the contracting authority above the minimum requirements for a particular contract. The use of EMAT is a method to honour extra quality. The client evaluates the tender not only at the lowest price, but also on other criteria. Only in exceptional cases the lowest price criterion should be applied in accordance with the Public Procurement Act 2012 (Dutch:

Aanbestedingswet 2012). The motivation for this must be laid down in the tender documents (PIANOo, 2016d).

5.1.2.5 Time complexity

Although there is a tight schedule regarding the lead-time of the project, there is still some room in the schedule, especially prior to the contract award. Nonetheless the schedule is very much subjected to politics according to the client respondent (AP1).

Whether the scope or context of the project will change is difficult to say for this project according to the respondents (AC1, AC2, AP1). First of all, as mentioned the Minister had already pulled the plug on this project before, changing the scope or actually the solution of the project, from tunnel to deepened road. Existing researches were based on the situation of a tunnel and now everything has to be converted for a deepened road. The change in solution point creates a different expectation from the stakeholder's side especially the inhabitants. A tunnel, with all its requirements, can resist higher rates regarding air pollution and noise nuisance than a deepened road. In the perspective of the stakeholders this new solution is less pleasant. If the solution were to be a deepened road in the first place, there would be no comparison or *better* solution imprinted in the mind of the stakeholders. Second of all, the respondents (AC1, AC2, AP2) did answer that they expect the project not to change majorly in the future; perhaps only on small details such as the underlying road network (roundabouts and intersections) depending on the municipality's wishes and requirements. All in all this aspect depends heavily on politics.

5.1.3 Market aspects

In this framework the market aspects relate to type of market and the trust in market, in which they have their own indicators and associated questions. By filling in the table conclusions can be drawn on how the market aspect matches the level of abstraction.

Dimension	Indicator	Question	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Type of market and trust in market	Knowledge and experience	29. To which extent does the market has experience and knowledge with the relevant or similar project?	High	High average	Average	Low
	Knowledge and experience regarding functional specification	30. To which extent does the market has experience and knowledge with functional specification?	High	High average	Average	Low
	Readiness for long-term contract	31. To which extent is the market ready for a long-term contract?	Very willing	Willing	Not that willing	Not willing
	Trust in the market	32. To which extent is there trust that the market has the capacity to bring the project to a good end taking into account the interests of the client?	High	High average	Average	Low

Table 31 Market aspects A9 Amstelveen Badhoevedorp - Holendrecht

5.1.3.1 Knowledge and experience (of the market)

The knowledge and experience of the market regarding this or a similar project is perceived high, by all the respondents (AC1, AC2, AP2). This kind of project is quite straightforward for the market, as it is not considered to be a unique project according to the respondents. Nonetheless this is also the fifth SAA project. In addition, the large construction firms in the Netherlands also have knowledge and experience regarding functional specification. Those large firms are also the parties that will conduct this project. On that note there is also trust that the market can handle that kind of assignment. Looking at the market in a broader sense, there is not much knowledge and experience regarding functional specification. Especially the small medium companies are having a rough time figuring out functional specification and the associated contract forms. The respondent from the client side works for both RWS and also a smaller construction firm; he noticed a great difference with the familiarity in functional specification.

5.1.3.2 Readiness for long-term contract

From how it looks now, the respondents (AC1, AC2, AP1) answered the market is willing to take on a long-term contract for this project. However it must not result in a second MAVA A15 as the respondent from the client side answered (AP1). The MAVA A15 also procured on the basis of a DBFM turned out to be a financial disaster, ever since RWS has been very careful.

5.1.3.3 Trust in the market

The trust in the market is considered to be a lot to average by the respondents (AC1, AP1). As mentioned this project is quite straightforward, so there is trust that the market has the ability to conduct this project technically but the client respondent argues (AP1) that there are simultaneous projects running in the region such as the ZuidasDok. Both projects have the same pool when it comes to the choice of construction firms. Therefore there is a risk that a construction firm does has interest to conduct this project but does not have enough time to do so. Whether the project will attract many tenders depends on simultaneous projects in the region as well.

There is trust technical wise, but from a social perspective the trust is less according to the consultant respondent (AC2). One of the objectives is to "maintain public support of the municipality of Amstelveen". The contractor will only take this into account, if RWS makes this explicit by means of contractual agreements. The respondent (AC2) explains that as long as you do not make the maintaining of public support contractual, the contractor will not have an incentive to do so. The contractor's main concern is to conduct the project, constructing the highway and the deepened road. There is no trigger to involve the municipality for the contractor, therefore that has to be included in the contract. However this is not always successful. Putting the risk to the contractor when it comes to direct hindrance is not always logical, because the residents will always come back to RWS or the municipality to express their dissatisfaction.

5.1.4 Interrelations

Now that the answers regarding the conceptual framework have been elaborated, the connections between them will be made explicit.

Type of client/organisational complexity/environmental complexity/trust in market/client's influence/client's ambition/technical complexity

The type of client contributes to the organisational complexity in the case of the A9 Amstelveen. The project team has a variety of organisations and disciplines. The tendency towards a smaller and more efficient government does bring in more market expertise. The involvement of the market is not only implemented after the tendering process, but also in the plan development phase within the project team from the client side. This results in experts from different backgrounds in the RWS core team. This in turn brings in different organisational complexities, such as different working methods and hierarchical wise. The complexity also lies in the fragmentation and the fact that the soft skills need to be handled first before one can delve into the technical content of the project. The type of client also contributes to the environmental complexity. Because we are dealing with a public client, it has to justify its actions towards the public. In this project it has also been included in the objectives and resulted in many information gatherings with stakeholders and detailed representations. The question then is, how will the market cope or translate this objective? This is also where little trust has been detected. The client does have a lot of trust that the market will technically bring this project to a good end, but it will remain a social challenge. This also results in the fact that RWS as public principal must adhere to the wishes of the stakeholders and operates in political spheres, therefore influence of RWS is much needed for this project. The client's ambition relates to the client's influence. In order to achieve the ambitions such as *keeping stakeholders satisfied: the project must remain its connection with the environment*, the principal still needs to exert influence. This is due to the conflict of interests from the client's and the contractor's side.

Technical complexity relates to the type of client or more specifically how the organisation operates. Many project team members from the RWS side are freelancers, hired because of their knowledge and experience. Many also have a contractor's background, therefore having insight on the execution phase. On the one hand this is a good thing, but on the other hand this also results in discussions on the level of detail. Especially the technical team members want to specify into more detail. The system breakdown is risk driven, meaning the breakdown goes as deep as it covers the risks. Technical people have a tendency to see risks behind every detail as mentioned by the technical manager.

5.1.5 Relation between the framework results and the abstraction level

In previous sections the respondents have filled in the framework. Herewith four options were presented. In this section the extreme options is presented giving a clear view on the perceived aspects in relation to the abstraction levels. The orange boxes show the answers that could be answered in extremes. The grey boxes show the in-between answers from the respondents. In the explanation the orange boxes will be referred to as *hard* reasons and the grey boxes as *soft* reasons.

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction Unit to part
Client aspects			
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of the level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price/quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Market aspects			
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 32 Overview framework A9 Amstelveen Badhoevedorp - Holendrecht

5.1.5.1 Client aspects in relation to the level of detail

According to table 32 most answers on the client aspects lean towards the *low level of abstraction* box. Indicating that the client aspects match a traditional approach regarding specification. The *hard (orange boxes)* reasons for specifying into detail is because the client is perceived as a professional client therefore being familiar with the building process as Boot et al. suggests. Nonetheless the client has to be transparent towards the public and therefore a traditional approach is ought to be suited. According to practice and theory RWS does fit profile 6 'the collective sector: professional, public' of Pries et al. (2006) as defined in section 3.3.1.1. The other hard reasons lies in the fact that sustainability is not considered important for this project as stated by the respondents. However there has been an inventory on the opportunities to combine the widening of the road of the SAA program with sustainability. Two sessions were organisation with a total of 100 experts. Nonetheless this was not reflected in this project by the respondents. In order to specify sustainability the guideline 'Handvat functioneel specificeren' states that this happens in the process of functional specification, and therefore on a high abstraction level (Rijkswaterstaat, 2005). Because sustainability is not perceived as highly important the client can go for a traditional approach. Last but not least the abstraction level itself is perceived as low, thus in much detail.

The *soft (grey)* reasons for specifying into much detail are found in the fact that the client has the resources e.g. knowledge and experience to specify into much detail. Although RWS outsourced many tasks, they internally hire experts that are able to specify into detail. In addition the client already has a vision on the aesthetic/spatial integration of the project this was made explicit with the EPVE document set up by the hired architects of RWS. There is little room left for the market on this matter. With EPVE document the client communicates with the stakeholders, therefore steering the promised expectation. The market only has the freedom in the building method. The question than is, how much is the freedom in the building method if it concerns a deepened road. First of all the legislations are fixed concerning the noise and safety standards. For instance the height of the sound barriers are set to 9 meters, in that matter the freedom is reduced. In addition the Route Decision lays down the zoning boundaries and forms the basis for land acquisition or judicial expropriation. The geometrical design is restricted. While the principal of the integrated contract form is to preserve as much freedom in the design and execution as possible to generate creative and smart solutions of the market. The dimensions of the deepened road have also been defined. According to the guideline 'Handreiking functioneel specificeren' the only way to preserve the freedom is by functional specification. For instance stating that the function of the sound barrier is to reduce nuisance up to a certain level. However in this project the dimensions have already been fixed.

In this project innovation is not considered to be important, this relates to a low level of abstraction. The last two *soft* reasons to go for a low abstraction level are observed in the willingness to let go regarding setting requirements and the required influence. The client is not willing to let go regarding setting requirements according to the respondents as this was also reflected in the abovementioned example. The line of reasoning was important; in this case the reason for more detail was the risk-driven challenge the technical team perceived. Next to risk-driven challenges, also the acquisition for support (Dutch: draagvlakverwerving) is often used as reason to specify into more detail. This was expressed in the required influence as well. The project needs to be monitored by the client in order to guard the ambitions, policy and concept of the project. As one of the objectives is to maintain support from the environment and stakeholders, the principal is ought to adhere to this. RWS has launched a virtual visitor center to make the project accessible to all concerned. They also introduced the strategic environment management+ (Dutch: (Strategisch) Omgevingsmanagement: (S)OM+). The question on how to incorporate the SOM+ while a part of the plan development study and realisation is handled by the market remains.

5.1.5.2 Project aspects in relation to the level of detail

The answers in the project aspects show a scattered division. The high level of abstraction shows predominance with only one indicator. The environmental complexity relates most to a low abstraction

level and the cost and time complexity the aspects relate most to a high abstraction level thus an integrated approach.

The answers regarding the technical and organizational complexities seem to be more divergent. The *hard* reason for a high abstraction level is only observed in the need for special technology. The need for special technology lies in the core business of the market, which specializes in the building method and the associated equipment. Therefore in technical sense it is better to specify on a higher abstraction level so the market can choose their own way of incorporating the needed technology.

The environmental and political support is needed as the Municipality of Amstelveen contributes financially to the project and the political support is also needed. However regarding these dimensions as also with the stakeholder's and political influence, the abstraction level could actually go both ways. As section 3.3.2.3 recalls this also depends on if the client is able to specify into much detail in the early phases to present the plans to the relevant parties if not than the market should be involved early to integrate the design and the realisation. Looking at this project the client seems to be able to specify into much detail due to its hired experts in their own organisation. A low abstraction level would be a more fitting strategy in accordance to this line of reasoning.

Looking at the risks; the technical and environmental are perceived as high. While the organizational risk, between W+B and RWS is perceived as low. Nonetheless the organizational risk within RWS is considered high as mentioned due to the diversity of freelancers and becoming familiar with each other and each other's working method. Referring back to Wood & Gidado and Sebastian & van Gelderen from section 3.3.2.3, the organisational aspects contribute more to the complexity of the project than the technical aspect. As mentioned the overall complexity is also related to the degree of control, see figure 11 below:

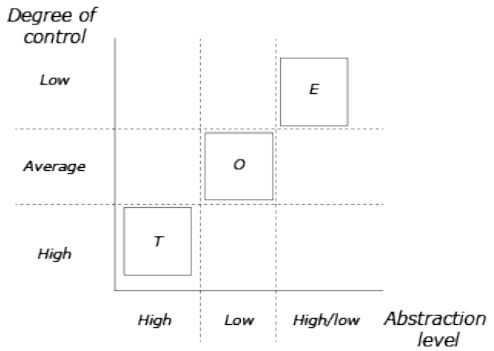

Figure 11 Complexities degree of control and the abstraction level (own ill.)

The environmental complexity is here perceived as high while the organisational complexity is perceived as low. Nonetheless according to literature the degree of control with environmental complexity is the lowest. Therefore the environmental complexity should be guiding for this project, hence a low abstraction level.

5.1.5.3 Market aspects in relation to the level of detail

The market aspects fit the high abstraction level the most. The *hard* reasons for it are perceived in the knowledge and experience, and the knowledge and experience regarding the functional specification. The project is recognized as being straightforward. According to the respondent this is the fifth SAA project, therefore more experience regarding functional specification has also been gained.

The *soft* reasons have to do with the willingness of the market and the trust in the market. These boxes also lean towards the high abstraction level the most. The market is perceived to be willing to take on this project, nevertheless the MaVa A15 project is still in the back of the mind of the client. The MaVa A15 was together with the second Coentunnel one of the firsts DBFM contracts of RWS. In the award of the contract, RWS had a strong belief in an approach in which a large part of the responsibilities were put at the market side. Meanwhile it has become clear by experiences that this approach was not

necessarily working. The project became a financial disaster and almost made Ballast Nedam go bankrupt. There is trust that the market can take on this project, but the client is still hesitant.

5.1.6 Interim conclusion

The most remarkable aspects of this case study are the following:

Client aspects

- The Best Value Procurement seems to clash with the knowledge and experience of the client itself. This lies in the fact that due to development towards a smaller and more efficient government, RWS hires experts internally. To the outside world they are perceived as part of RWS, while the governmental tasks are actually privatizing internally as well. As mentioned the BVP mindset implies that the client makes use of the knowledge and experience of W+B in this case. However at both end of the table there are in fact externally hired experts. Therefore it is unclear to which party the BVP applies to. The question then arises: what is the role of the knowledgeable freelancers and what is the role of W+B?
- The RWS technical team does not make use of the systematic levels as prescribed in literature intentionally as it is perceived too subjective and vague
- One of the ambitions is to maintain support from the environment. This implies that the influence of the principal is needed. The environmental managers of the SAA project are the ones communicating with the stakeholders and maintain the relations. If the project is going to be outsourced according to a DBFM, the contractor will take over the responsibilities. Nevertheless this responsibility is actually tied to the principal. Stakeholders will still address their issues to RWS.

Project aspects

- The technical complexity lies in the amended OTB, the design change from tunnel to deepened road, and the adherence to the legislations derived from when the tunnel design was still leading.
- The organisational complexity is perceived within the organisation of RWS, due to differences in working cultures between the hired experts and also the instability in the organisation. This was due to the low capacity in the line directly under the core team. Respondents attributed this to the short contracts of those lines.
- The environmental complexity lies in the fact that stakeholders and politics have a lot of influence on the project, and in addition their support is needed. This came to expression with the revised OTB. In addition the project goes right through the living area of Amstelveen, making the stakes very high.
- The cost complexity is detected in the fact that the client wants to involve the market early by using a DBFM contract. Nonetheless they want to keep costs control by conducting budget estimates for materialisation while this would be considered to be part of the contractor's work.
- The time complexity depends heavily on politics. As the Minister had already pulled the plug on this project in the past.

Market aspects

- The knowledge and experience of the market is perceived high and the market seems to be willing to take on a long-term contract
- There is trust in the market technically wise, but when it comes to the objective of maintaining support from the municipality of Amstelveen the respondents were hesitant in how the market will maintain that and how RWS should manage that.

Relation between the framework results and the abstraction level

- The client aspects seem to fit a low abstraction level according to the type of client, ambitions of the client and the client's influence.
- The project aspects are more divergent. Looking at the risks, the environmental complexity scored high. The environmental complexity is in this project guiding in contrast to the technical and organisational complexity accordingly to the degree of control one has on the environment

as stated by literature. Both ends of the abstraction levels could apply for this matter, nonetheless because the client is deemed to have the ability to specify into much detail the low abstraction level matches the most. The cost and time complexity fit the high abstraction level.

- The market aspects fit a high abstraction level according to the type of market and the trust in the market.

5.2 Project ZuidasDok

For this case four respondents have been interviewed in which two of them have filled in the framework. Each respondent will be coded in order to present his or her perspective in the analysis. The respondents that did not fill in the framework also provided relevant information for this section, and therefore their answers will be incorporated as well.

Role	Principal/Consultant	Pilot study	Filled in framework	Code
Project manager	Consultant W+B / IBZ	No	Yes	ZC1
Design leader	Consultant W+B / IBZ	No	Yes	ZC2
Technical manager	Principal Municipality / IBZ	Yes	No	ZP1
Plan study manager Amsterdam Assets	Principal Municipality / IBZ	Yes	No	ZP2

Table 33 Respondents coded ZuidasDok

The outcome of the questionnaire, filled in by the respondents of the consultant from W+B has been illustrated by means of the conceptual framework. In the following sub sections the interviews will be elaborated regarding the client aspects (5.2.1), projects aspects (5.2.2) and the market aspects (5.2.3). Nevertheless the interrelations (5.2.4), relation to the abstraction level (5.2.5) and interim conclusions (5.2.6) will also be presented.

5.2.1 Client aspects

In this framework the client aspects relate to the type of client, client's ambition and client's influence, in which they have their own indicators and associated questions. By filling in the table conclusions can be drawn on how the client aspect matches the level of abstraction.

Dimension	Indicator	Question	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Type of client	Professional or incidental client	1. Is the client of the relevant project a professional or an incidental client?	Incidental	Incidental	2 Professional (RWS, ProRail) 1 Incidental (Municipality of Amsterdam)	
	Public or private client	2. Is the client of the relevant project a public or private client?	Private	Private	Public	Public
	Knowledge & experience	3. To which extent does the client has experience and knowledge with the relevant or similar project?	Low	Average	High average	High
	Knowledge & experience regarding functional specification	4. To which extent does the client has experience and knowledge with functional specification?	High	High average	Average	Low
Client's ambition	Aesthetic/spatial integration	5. To which extent is a vision on the aesthetic/spatial integration formulated in this project?	No vision + not stated	Vision + not entirely stated a lot of room	Vision + stated little room	Vision + stated
	Sustainability	6. To which extent is sustainability important in this project?	Highly Important	Important	Average important	Not important
	Innovation	7. To which extent is innovation important in this project?	Highly Important	Important	Average important	Not important
		8. To which extent is there room for innovation? (Using new methods, which have not been applied before)	Plenty	High Average	Average	Low
		8.1. At which stage will the contractor be involved in this project? 8.2. What is the scope of the contractor/market?	Exploratory phase Scope: area	Exploratory phase Scope: area	Draft Route Decision, OTB Scope: b/l	Route decision, TB Scope: b l
Client's influence	Translation to functional requirement	9. To which extent can the ambitions be translated to functional requirements?	Many	High average	Average	Low
	Willingness to let go regarding setting requirements	10. To which extent is the client willing to let go of specifying the requirements?	Very willing	Willing	Not that willing	Not willing
	High abstraction of the level of detail	11. To which extent is the level of detail of the tender specification high/abstract?	High abstraction	High average abstraction	Average abstraction	Low abstraction
	The need to monitor	12. To which extent is influence needed of the principal to guard the ambitions, policy and concept?	No influence required	Low average influence required	Average influence required	Influence required

Table 34 Client aspects ZuidasDok

5.2.1.1 Type of client

The ZuidasDok consists of three principals, namely: RWS, ProRail and the municipality of Amsterdam. All three of them are considered as a public and professional client by the respondents (ZC1, ZC2), however the municipality is rather between professional and incidental because it does not conduct as much building projects as RWS and ProRail. This also emerged in the second aspect knowledge and experience regarding the project or a similar project. RWS and ProRail are considered to have a lot of knowledge and experience as they conduct these kinds of projects on a regular basis as explained by the respondent (ZC2). The respondent stated that, despite there are two professional public parties with knowledge and experience, it could still lead to tension. This showed in the systematic both RWS and ProRail follows. Both have their own way of functional specification, which clashed at the station component. On a certain point they chose the RWS specification approach, but it took quite some effort for everyone to understand that approach.

The municipality of Amsterdam is perceived to have low knowledge and experience, especially regarding the magnitude of this project by the respondent (ZC2). The same applies to functional specification, however lessons have been learned from the Noord/Zuidlijn project. Nonetheless the municipality does not often work with a D&C contract form, especially when it comes to public space. In this respect the municipality was steered by W+B. In addition, the metro and the tram were also parts that Amsterdam usually procures on the basis of a RAW. Yet for these two parts the municipality was internally slightly more advanced in order to put some kind of D&C standard in contrast to the public space part, which had to be set up from scratch. Although there is knowledge on functional specification with RWS and ProRail the experience with functional specification of the municipality is perceived low. In this case the combined knowledge has been marked in the framework, average.

5.2.1.2 Client's ambition

When it comes to the vision on the aesthetics and spatial integration this project is quite unique. Together with a few architects the municipality of Amsterdam have set up design documents. In those documents some very detailed subjects have been laid down, for example the type of trashcans, the type of greens and stones, park benches et cetera. The client already has a certain vision for the ZuidasDok concerning the materialization. However the lay out of the ground level has been left free for the contractor to arrange. In that sense, the municipality has made quite a step according to the respondent (ZC2). Normally the municipality is also accustomed to lay down for example the exact location of the lamppost. With the aesthetic documents they partly give direction to the vision, but the spatial allocation has now been left to the market in order to align it with the client's vision.

Sustainability has not been marked as an important aspect to consider as the respondent answered (ZC1). However this must be revised on the total picture and the detailed translation the client has given. On the one hand the client is believes that he achieves a sustainable development for the environment by means of this sustainable project, in that sense the project is sustainable. On the other hand, it has not been taken into consideration in the detailed translation regarding the materialization. In the detailed design the client has not specified sustainable usage of material.

Innovation was only important in the sense that the client wanted as much freedom for the market, so they can apply the latest techniques. But it has not been mentioned explicitly that innovation was part of the ambition (ZC1, ZC2).

The procurement of this project is *after* the Route Decision, so technically speaking the market is involved late in the process. However the Route Decision has just been made final largely, while the contractors have been on board for approximately nine months. Initially the idea was to have the OTB and the TB later, and have the tendering earlier on. That has been caught up through time, and the phases overlapped. On the one hand the project is more fixed and less flexibility remains for the contractors. On the other hand due to the overlap, the tenderers did give input in the dialogue phase. Things that were not sufficient in the OTB have been repaired in the TB (ZC1). At the moment there are still two tenderers in the race; at the end of 2016 the winner will be chosen. The scope of the project

consists all three elements, line infrastructure, area development and also building (station and tunnel building).

5.2.1.3 Client's influence

Many of the ambitions can be translated into functional specification according to the respondents (ZC1, ZC2). Looking at the top requirements:

- Further realization of an international location as an integral part of the region and the city of Amsterdam
- An optimal functioning quality traffic and transport network;
- A high quality public transport hub of international stature
- Sustainable integration of the infrastructure to the barrier to reduce and to improve the quality of the environment.

As observed the international allure seems to be vague to describe in functional terms. By means of a reference design the client will give a vision to the contractor, on how they envision it (ZC1). In the context of the EMAT the contractor can still give their interpretation on it.

The answer to, *to which extent the client is willing to let go of specifying the requirements*, depends on several reasons. It depends on *the part of the project* and on the *type of client* according to the respondents (ZC1, ZC2). First of all, for some parts of the project the clients are willing to let go of specifying this regard the ends of the project where the highways and nodes are. On those parts the contractor has more freedom to give input. However when it comes to the city center the client wants to specify into more detail. This goes hand in hand with the environmental complexity. Second of all, ProRail wants to specify into more detail as well, even to the last drain cover and the gap between the well and the tile that lies next to it. While RWS remains more functional in their requirements on the service building of the tunnel, leaving the design of the building to the contractor as long as the functionalities are included. As for the public space, the municipality left some parts much freer, while parts on the landscaping has been specified in high detail in order to be certain that good conditions are being created for the trees and plants. This is due to the uncertainty on how organic life grows and because the municipality is probably the one that has to maintain these conditions. If the landscaping is not properly laid down than the greenery might be dead after 2 years by than the contractor has already left the project. If it were a DBFM contract, this part could have been less specified giving the contractor incentive to maintain the greenery. Nonetheless the maintenance will not be outsourced to the same party as with the design and construction. All in all the level of detail of the tender specification has been considered to be average, due to the diversity per part.

According to the respondent (ZC1), within the type of client it also depends on *the role of the people*. In the highest line of the project management hierarchy, one wants to give as much design freedom to the contractor. In contrast to the technical team, and network administrators of the different parent organisations they argue that the specification must be in more detail or else they cannot state anything about it. Next to that, it also depends on *the goal of specifying* the design into more detail. They had to prove that the plan was makeable and technical feasible within the budget in order to find out the consequences for the environment and to derive a functional specification for the D&C contract. The question than arises: when will you stop specifying? The parties that have a say in those plans are not satisfied with only functional specifications regarding the spatial matters, they want to see drawings. Because there are so many bottlenecks, the consultants are forced to look at how they must handle the conflicting demands therefore they have to specify into more detail. This is hard to predict beforehand.

The reference design has been set up to provide the potential contractor information. It appeared that there was little solution freedom on different parts. In contrast, there are components of the reference design for which the client is specifically looking for a better solution. However the contractors stated that there is limited time and they want to use that time for the best possible optimization and in order to do that they want the reference design, so they can stay focused on optimizations. This became part of the deal. Therefore the contractor can assume that the reference design is feasible. According to the

respondent (ZC1) it is a misunderstanding of the client that the market wants as much design freedom as possible, especially with a large complex project to be conducted in limited time. If the contractor has to start off from scratch regarding the station, then they have to hire engineering firms as well. This can turn out to be very costly for the contractor. With the reference design the contractor can get a grip of the design and choose the focus for their optimizations.

Due to the complexity of the project the respondents (ZC1, ZC2) answered that the need to monitor from the client's side in order to guard the ambitions, policy and concept is very high. There are simply just too much stakeholders involved, and the project is also under a magnifying glass by the politics. One cannot just throw a billion euro project over the fence to the contractor as stated by the consultant respondent (ZC2).

5.2.2 Project aspects

In this framework the project aspects relate to the following complexities: technical, organizational, environmental, cost and time. In which they have their own indicators and associated questions. By filling in the table conclusions can be drawn on how the project aspect matches the level of abstraction.

Dimension	Indicator	Question	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Technical complexity	Newness of technology	13. To which extent will one make use of new technologies regarding machinery/equipment in the execution phase?	Many new	High average new	Average new	No new
	Experience with the technology	14. To which extent does the project team has experience with the to-be-used technical applications?	None	Low	Average	High
	Requirement of special equipment/ technology	15. Does the project requires the use of special technique?	Needed	Needed	Not needed	Not needed
	Technical risk	16. Do you think that the project is subjected to high risk (number, probability and/or consequences of) regarding technical risks?	High	High average	Average	Low
Organizational complexity	Experience with parties involved	17. To which extent do the relevant parties have experience with each other?	High	Average	Low	None
	Organizational fragmentation	18. To which extent is the project organisation subjected to fragmentation?	None	Low	Average	High
		18.1. Are a lot of different organizations involved in this project? 18.2. Are a lot of different kinds of disciplines involved in the project team? 18.3. Are there a lot of different locations from which the project team operates?	No No No	2x No 1x Yes	2x Yes 1x No	Yes Yes Yes
	Organizational risk	19. Do you think that the project is subjected to high risk (number, probability and/or consequences of) regarding organizational risks?	Low	Average	High average	High
Environmental complexity	Stakeholder's influence	20. Which strategy fits in this case most to the extent of influence the stakeholders have?	High influence (if principal is not able to specify into detail himself, he should involve the market early)		High influence (if principal is able to specify into detail)	
	Political influence	21. Which strategy fits in this case most to the extent of influence the politics have?	High influence (if principal is not able to specify into detail himself, he should involve the market early)		High influence (if principal is able to specify into detail)	
	Environmental risk	22. Do you think that the project is subjected to high risk (number, probability and/or consequences of) regarding environmental risks?	Low	Average	High average	High
Cost complexity	Funding	23. Will this project be financed by means of private or public funds?	Private	Private	Public	Public
	Price certainty	24. To which extent is price certainty important?	Important early market involvement		Important more influence on building process by principal	
	Low management costs	25. To which extent are low maintenance costs important?	Highly Important	Important	Average important	Not important
	Price/quality ratio	26. To which extent is the price/quality ratio important to take into account?	Highly Important	Important	Average important	Not important
Time complexity	Certainty on the lead time	27. To which extent is there room in the schedule in the lead-time of the project?	Tight schedule expertise of the market needed		Tight schedule expertise of the market not needed	
	Continues developments	28. Is the project subjected to many changes/developments in the context and scope between the initial and exploitation phase?	Many (project flexibility is needed)	High average	Average	Low (straight-forward project)

Table 35 Project aspects ZuidasDok

5.2.2.1 Technical complexity

At the time the respondents (ZC1, ZC2) do not think that new kinds of technique regarding machineries or equipment will be needed. However the contractor is free to use the techniques he wishes, because

freedom is provided regarding the building method. The project team has the knowledge and experience with the technique that will be used so far.

Although this project is very large, special technique is not necessary on most parts. However it is thinkable that for some areas around the station special technique is required according to the respondent (ZC2). Because the station must remain in operation and certain objects (Dutch: kunstwerken) need to be replaced and inserted, which is not a standard execution.

In consequence, that also contributes to a high technical risk. Next to that, the tunnel that will be constructed is situated very close to the building. The tunnel will be very deep and is only 3 meters away from the building. The respondents (ZC1, ZC2) answered that the project is technically not that difficult but a lot has to happen on a small area and the consequences are huge. The project area is very busy, in that sense the risk is on the high side.

5.2.2.2 Organizational complexity

There was little experience with the parties involved to start with, not only in the engineering team Arcadis, W+B and AT Osborne but also with RWS, municipality of Amsterdam and ProRail (ZC1, ZC2). The engineering teams from Arcadis and W+B, had worked together in the past organisational wise, but the individuals did not. It was also quite a challenge to make a team out of RWS, the municipality and ProRail according to the respondent (ZC1).

The fragmentation of the organisation expressed itself by the above-mentioned different organisations but also the variety in disciplines (tunnel, A10, rail station, ecology, water, environment, noise etc.). However the different locations where the project teams operate is kept to a minimum. At first the project team had a project office at the Zuidas, thereafter they kept their meetings at the principal's office. There is one distinct location and one meeting venue where the meetings take place.

The organisational risk was marked very high by the respondents (ZC1, ZC2) due to, inter alia, the magnitude of the project but also the fact that this project has three principals with different interests in a complex environment. In the elaboration of objects, details can emerge and the solution might need to be adjusted for financial reasons, perhaps in the advantage for one party but not for the other. The alignment on decisions is therefore hard to predict.

The higher project management levels wanted a D&C contract. Nonetheless lower levels of the organisations, involving technical people, they rather go with a RAW systematic. At the moment it is more an intermediate form. It has become a D&C contract with many fixed parts. As the respondent (ZC1) stated the project plan has a variety of level of abstractions. It is actually how one chooses the right words. For the higher levels it is a D&C contract, which is what they want. On the lower levels many things have been defined and specified into much detail, which is what they want. The D&C contract form is merely a label.

5.2.2.3 Environmental complexity

The environmental complexity is very high in this project according to the respondents (ZC1, ZC2). This project has many stakeholders and the project area is a widely used area. Public support is necessary but also political support is needed. This also means that the environmental risk is very high. As mentioned this project is closely watched by the higher organisation and the politics. Regarding the political decision-making the project is also subjected to a point of no return. An example is hereby the discussion on the length of the tunnel. Over the time many discussions were held whereby the tunnel was shortened frequently for financial reasons. On some point the length became final. However on some parts of the tunnel it is still the question if it has a social function. The parts where the tunnels are needed for instance near the offices and other real estate is legit. But the part that goes parallel with the football fields, thus where the last high rise stops could have been solved with a noise barrier according to the respondent (ZC2). The space above the tunnels will be designed as well, but even the architects are wondering what needs to be done with that amount of space. Nevertheless the tunnel lengths have been

discussed many times that it is politically not negotiable anymore. Even if a shorter tunnel will be financially more attractive, the hassle regarding the decision-making will actually make the project financially less attractive in the end as the respondent (ZC2) states.

5.2.2.4 Cost complexity

The project is publicly funded. There is a task-budget for this project. Task budgeting is based on what is needed on budget to achieve the marketing objectives, not what is desirable or available. However the respondent (ZC2) argues that this project is so big that one can never estimate in advance accurately what is needed. They do want price certainty but it is not political feasible. They did a lot of cost estimation to see if everything fits. The market in the sense of the contractor has not been involved early, but an engineering company has been involved to calculate and make everything feasible. Nonetheless in the dialogue they do question if the contractor can realize it within the bandwidth. They want to ensure that they will get an offer that is feasible within that budget. In that sense the market is involved to reduce uncertainty risks as stated by the respondent (ZC2).

Low maintenance costs were not really taken into account according to the respondent (ZC1); therefore the maintenance has not been outsourced (yet).

The price/quality ratio was considered as a very important aspect to take into account; this is expressed by means of the EMAT (ZC1, ZC2).

5.2.2.4 Time complexity

This project runs on a tight schedule regarding the lead-time of the project, however there is still some room in the schedule according to the respondents (ZC1, ZC2). The tight schedule is due to the many stakeholders involved. The tunnel needs to be realised as soon as possible so that the core area of the Zuidas can be in operation. The schedule is also a subject of discussion in the dialogue with the contractors still. The milestones have been laid down, together with the contractors they are observing whether if it is feasible or not. If there is a bottleneck considerations will be made. Nevertheless the project is set on 10 years.

The respondents (ZC1, ZC2) answered that the project will not have major changes in the future. Of course, the project started quite different. For instance: the tunnels were longer, a lot of real estate was desired and the wish was to have the station and the tracks underground. In terms of technical costs this was not feasible at all according to the respondent (ZC2). In general the presented plan now will not have major changes, however there are still things added, such as an extra bike lane. Those things are however not a complete game changer.

5.2.3 Market aspects

In this framework the market aspects relate to type of market and the trust in market, in which they have their own indicators and associated questions. By filling in the table conclusions can be drawn on how the market aspect matches the level of abstraction.

Dimension	Indicator	Question	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Type of market and trust in market	Knowledge and experience	29. To which extent does the market has experience and knowledge with the relevant or similar project?	High	High average	Average	Low
	Knowledge and experience regarding functional specification	30. To which extent does the market has experience and knowledge with functional specification?	High	High average	Average	Low
	Readiness for long-term contract	31. To which extent is the market ready for a long-term contract?	Very willing	Willing	Not that willing	Not willing
	Trust in the market	32. To which extent is there trust that the market has the capacity to bring the project to a good end taking into account the interests of the client?	High	High average	Average	Low

Table 36 Market aspects ZuidasDok

5.2.3.1 Knowledge and experience (of the market)

Both respondents answered that the market has a lot of knowledge and experience regarding this type of infrastructure project, consisting of tunnel, highway, station etc. This is not a complete new kind of project, nevertheless it is big and a lot to take. It is one of the largest infrastructure projects in the Netherlands as stated by the respondent (ZC2). The Noord/Zuidlijn project was also a large infrastructure project, where knowledge and experience has been gained. Because everything is now in one contract the ZuidasDok project is major and therefore challenging. The components separately are manageable. There is however less knowledge and experience with all the components put together in one contract according to the respondent (ZC2). The respondent mentioned that technically there is the knowledge and experience but less organisational wise. This also applies for experience with functional specification. This project will be procured to in any case a large construction firm that have dealt with functional specification earlier.

5.2.3.2 Readiness for long-term contract

The readiness for long-term contract from the market is linked to the number of tenders according to the respondent (ZC1). The project only had two bidders due to the high risks it is associated with. The summation of project complexity especially organisational wise, the contractor must become familiar with the project in a short time, being responsible for the project for 10 years makes market parties reluctant to take on this project.

5.2.3.3 Trust in the market

The question *to which extent there is trust that the market has the capacity to bring this project to a good end taking into account the clients' interests* is answered with average to little trust. This is due to the following reasons according to the respondents (ZC1, ZC2). First of all the magnitude of the contract is not standard business. Second of all there was also hesitation whether they would get a market party for this project at all. They expected 4 or 5 market combinations in the preliminary phase so that two parties would fall off in the first round and 3 of them would continue and eventually one will be selected out of the 3. However in practice there were only two market combinations to start with, there were no more applications than those two. The reason is the magnitude of the project; it is just too large and comes with a lot of risks. With this project, only the largest construction firms have signed up. Third of all it also depends on the parts of the project. Regarding the parts that can be easily specified into functional requirements there is trust in the market, for example the tunnel part. There is less trust regarding the execution of the station, this part involves a lot of management aspects that needs to be taken into account. This is also a difficult part for the engineering firms to specify into functional

manners. Normally, the management parties are engaged in the design process and they prefer to look at tangible/concrete products. But due to the D&C contract form those concrete products are absent. Last but not least in the dialogue phase many questions are asked to the market parties to ensure the project will come to a good end.

5.2.4 Interrelations

Now that the answers regarding the conceptual framework have been elaborated, the connections between them will be made explicit.

Type of client/organisational complexity/environmental complexity/technical complexity/time complexity/ trust in market

The type of client relates to the organizational complexity. In this case there are three principals to consider namely: RWS, ProRail and the Municipality of Amsterdam. There are differences in knowledge, experiences, way of working, hierarchical structures etc. This makes the organisational risk very high considering all three of them also have different interests in a complex environment. While ProRail and RWS are more concerned about the accessibility of the region, the municipality also has to take into account its inhabitants, stakeholders and the economic activity around the public transport terminals. The project is also highly subjected to political influences and draws a lot of attention. Making the environmental complexity high as well, this also relates to the technical complexity. Although the project is not perceived as technical difficult, it is perceived to be difficult organisational wise. The works is performed in a limited space with a lot of interface projects, such as the Noord/Zuidlijn, OV-SAAL, and the construction of homes and offices. As the ZuidasDok project document states, the area must continue to operate 24 hours a day. Nonetheless objects in the public transport terminal area need to be replaced, and cannot hinder the daily activities there as well. This in turn is connected to the time complexity. The duration aim is 10 years. They want to keep it as short as possible so that the core area of Amsterdam Zuid can operate again. Due to the many stakeholders the schedule is very tight.

The trust in the market and the market's readiness for a long-term contract are related to each other. The readiness of the long-term contract is reflected in the number of bidders, which were only two. The trust in the market is low because the client expected more bidders in the first place. This tells the client that the market is very hesitant on taking this project.

5.2.5 Relation between the framework results and the abstraction level

In previous sections the respondents have filled in the framework. Herewith four options were presented. In this section the extreme options is presented giving a clear view on the perceived aspects in relation to the abstraction levels. The orange boxes show the answers that could be answered in extremes. The grey boxes show the in-between answers from the respondents. In the explanation the orange boxes will be referred to as *hard* reasons and the grey boxes as *soft* reasons.

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction Unit to part
Client aspects			
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price/quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Client aspects			
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 37 Overview framework ZuidasDok

5.2.5.1 Client aspects in relation to the level of detail

According to table 37 a large extent of the answers on the client aspects lean towards the low level of abstraction side. Indicating that the client aspects match a traditional approach regarding specification. The *hard (orange boxes)* reasons for specifying into detail are because the client is perceived as a public client and the influence of the client is required. In this case RWS, ProRail and the Municipality of Amsterdam are perceived as public clients, meaning they have to work transparently towards the public. Especially the municipality has to keep its inhabitants and many stakeholders satisfied. Not only does the project concern roads, but also the public transport terminal, which will be actively used throughout the project. In addition, the project will take about 10 years or more, which might involve much discussions and dissatisfactions with inhabitants and stakeholders. The influence of the client is also much needed in this project to guard the ambition, policy and concept, because this project is under a magnifying glass by the politics. Nevertheless many discussions and decision on political levels have already been taken consequently many decisions made are on a point of no return.

The *soft (grey boxes)* reasons also indicate a low level of abstraction. To start with there are three principals, in which two of them have been considered as professional (RWS and ProRail) and one of them as an incidental client (Municipality of Amsterdam) by the respondents. All three of them are considered to be public clients as well. As stated in previous case study, RWS does fit profile 6 'the collective sector: professional, public' of Pries et al. as defined in section 3.3.1.1. ProRail seems to match profile 6 as well, as it is considered both a public as private railway administrator and a state holder, being responsible for the entire railway construction, maintenance, management and security in the Netherlands. From recent articles (Cohen & Leupen, 2015), the government is contemplating to bring ProRail under the Minister of I&E, just like RWS. The Municipality of Amsterdam fits profile 3 'the collective client: incidental, public, organisation or institution'. It is considered to have little knowledge regarding the building procedure and outsources its tasks. This was also reflected in the steering part of W+B. Only regarding the municipality this would fit a high level of abstraction.

The knowledge and experience regarding the type of project (nodes, tunnel, widening road) is high with the clients. However the knowledge and experience regarding functional specification was observed to be average to low. Both fit a low abstraction level. According to Boot et al. making a proper functional specification requires knowledge and effort. As mentioned in the interviews, the municipality is actually used to procure the metro, tram and public space according to RAW. There was also much stated about the spatial integration and aesthetics of the public space by the municipality. The materialization was already determined, however the layout of the public space was left more freely. According to the SE approach and functional specification guideline, the materialization is actually a detailed level. Therefore this suits a low level of abstraction. Regarding the station, this was also quite difficult to specify in functional terms or on a high level of abstraction, because the network administrator has technical knowledge and wants to see detailed drawings. The team that was concerned with the station wanted assurance and stated the specification into much detail eventually.

Sustainability and innovation were not considered important explicitly. The project is deemed to stimulate a sustainable living area eventually, however this was not expressed in the elaborated design. A sustainability plan was drawn up in the first place, but there was no money to reach a higher sustainability goal, such as generating wind and solar energy by means of the tunnel. Therefore the absence of these two objectives fit a low level of abstraction.

Last but not least, the clients were perceived not to be very willing to let go of setting requirements. Nonetheless it must be noted, that this does not apply for all the clients and parts of the project. Therefore the abstraction level was eventually average to low. This fits a low level of abstraction as well.

5.2.5.2 Project aspects in relation to the level of detail

It is clear from table 37 that the project aspects show predominance on the low level abstraction side of the framework.

The *hard* reasons to choose for a low level of abstraction are, inter alia, concerned with the experience with the technology and no need for special technology. According to the technical manager, the sub projects are pretty straightforward, as the market and the clients have conducted them many times. There is no need for special technology, however the market can come up with their own building method as they please. Technical wise the project is observed to be not unfamiliar to all parties therefore one can specify on a low abstraction level concerning the technical complexity.

Looking at the risks, the organizational and environmental risks are both perceived as high. The technical was perceived to be high average (*grey*), which has to do with the interfaces with the management and coordination of the works. This relates to the organizational and environmental risks as well. The organizational risk was marked high, which has to do with the three different principals with different interests and decisions that need to be aligned. The environmental risk was observed to be the highest. Referring back to Wood & Gidado and Sebastian & van Gelderen from section 3.3.2.3, the environmental aspects contribute more to the complexity of the project than the organizational aspect. As mentioned the overall complexity is related to the degree of control, see figure 12 below:

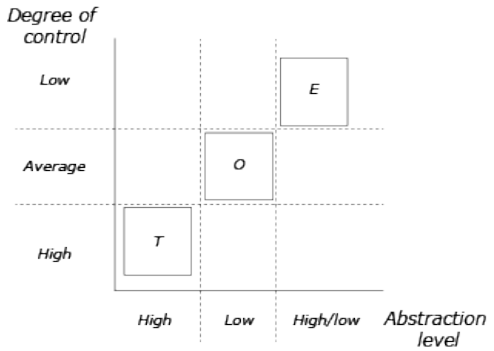

Figure 12 Complexities degree of control and the abstraction level (own ill.)

According to literature the degree of control with environmental complexity is the lowest. Therefore the environmental complexity should be guiding for this project. The environmental complexity leans heavily on the low abstraction level side. This is because the influence of the stakeholders and politics is very high plus the clients are able to specify into detail. Not only does RWS and ProRail have the knowledge to do so, but the municipality as well. In fact, the municipality is used to procure on the basis of RAW.

The *hard* and *soft* reasons regarding the cost complexity are divergent. As the project is funded with public money, one has to make the information transparent and clear on how this money will be used and how it adds social value. There is a task-budget for this project, in 2013 this was set at 1,7 billion, meanwhile it is now set to be 1,9 billion. Price certainty seems not to be feasible. By having the dialogues in September 2016 it might become clear how and if the contractor is able to realize it within the bandwidth. Therefore the market will be involved. However the clients control the price certainty by means of the task-budget. Therefore considering the cost complexity the abstraction level can go either way.

Only on the time complexity, the high level of abstraction is fully applicable. There is a tight schedule on this project. There is a need for a smooth process between the different parts of the project. As mentioned the aim is to have the area up and running while the project is going to be conducted. Minimal hindrance and maximal accessibility will be two important subjects in the dialogue phase with the market combinations in September 2016. An early involvement of the market is considered to be crucial in this project in order to integrate the execution in time and space. Because the project is going to take a while, flexibility of the project is needed. In the estimated 10 years, the political, economical, technological and environmental situation can change. Therefore a high level of abstraction is required in order to adapt to the changes, and not have everything fixed.

5.2.5.3 Market aspects in relation to the level of detail

The market aspects seem to fit both a high and low abstraction level in the first place. The client thought that at least 4 or 5 market combinations would sign up, especially because it is about a one billion contract. In return the contractor must widen a six kilometres road of the A10, lay down a tunnel of 1 kilometre, extend Amsterdam Zuid station and refurbish two nodes. Contractors are very hesitant to conduct this project. It is a lot of work technical wise, but even more so organisational wise. The distrust is not located in the technical parts of the project. It is more about the residents, travellers and the authorities that have to cooperate making the ZuidasDok project extremely difficult. How to work on a station and dig a tunnel through a densely populated area, while cars and trains have to drive and the inhabitants that are not keen on a renovation that will last for ten years.

The distrust does not only come from the principals towards the market, but in this case it is also coming from the market itself. After the disaster of the MaVa A15, contractors want to know if the risks of the construction are divided equally amongst the parties. Just as the MaVa A15 project, this too concerns a complex mega project where many permits need to be requested and also in time. The chief executive of BAM stated earlier to the newspapers: "We do think three times before we sign up for this

project." Due to the lessons learned from the MaVa A15 project there will be some differences regarding the procurement of the ZuidasDok (Houtekamer, 2015):

1. Contractors cannot bid above or under a certain amount, in order to avoid prize fighters. Nonetheless if the bids are the same, one will look at which party handles the minimal hindrance and maximal accessibility of the area the best
2. The principal will examine the soil itself. The cables, pipes, situation of the facades, bridges and tunnels will be the legal responsibility of RWS (this was not the case with the A15 project). If the data are incorrect the government will pay
3. The principal will bear a part of the risk for the permits. If a request will be rejected, than this will be the problem of the contractors. But the organization is going to interfere with the process. Project leader Versteegen stated that they are already making arrangements with the authorities on the licensing in order to speed up that process
4. Usually this project would be procured on the basis of a DBFM. With a DBFM the contractor designs, builds and maintains and arranges the financing. Then RWS would pay afterwards, which is a safer option for the government. In this case one has chosen for a D&C contract in which the contractor will get paid every 4 weeks. The reason for this is because the ZuidasDok is a rapidly changing environment.

The government knows the market is very hesitant in taking this job, as they have to arrange all kinds of things prior in order to get the market on board. Trust is a very important factor in the choice for a building organisation form or an abstraction level. According to the framework if the trust is low and if the market is not willing to take on a long-term contract, than one should have a low abstraction level. However the market does have the knowledge and experience technical wise, this in combination with insufficient trust follows an advice according to literature as stated in section 3.3.3 to go for an alliance collaboration form. Entailing to conduct certain tasks collectively, the client creates the opportunity to increase his trust in the market without giving away full design freedom.

5.2.6 Interim conclusion

The most remarkable aspects of this case study are the following:

Client aspects

- Although there are two clients involved with knowledge and experience on functional specification, namely RWS and ProRail, it does not necessarily mean that this process will go easy. The fact that both of them have knowledge implies that they have their own way of working, which can clash as this case study proofs. In addition, even though ProRail has knowledge and experience in functional specification, it still wants to specify into much detail regarding the station. In this project it showed that a reference design was actually desired by the contractor due to the high complexity of the project and the limited time. With a reference design, where the station was actually defined into much detail, the contractor can focus on optimizations. According to the respondent it is a misunderstanding that the contractor always wants as much design freedom as possible. In fact, that is the perception of the client.
- The Municipality of Amsterdam was used to procure the metro and tram parts on the basis of the RAW. However the municipality showed a good adaption in order to get this in a D&C standard. The public space part was however less easier to do so. Regarding the public space the municipality also has to take into account the life span of the greenery.
- As the project goes more into the city centre, the more details are laid down in the specification. The nodes have been left more freely to the market than for instance the station parts.

Project aspects

- From the environmental complexity it was learned that next to technical complexity there was much more process management involved than was expected in the first place. Lengthy discussions on political level emerged; nevertheless getting all the parties into one direction was quite a hassle.
- The D&C contract form in this project is merely a label. The D&C is still used as a contract form, but many parts have been fixed and defined into much detail.
- The technical complexity in this project lies in the integration of the interfaces within the project and other projects such as the Noord/Zuidlijn, OV-SAAL, and the construction of homes and offices. Also the organisation regarding the minimization of the hindrance and keeping the area accessible throughout the realisation.

Market aspects

- Trust in the market is low due to the magnitude of the contract as it is not standard business, the expected amount of bidders was not achieved and it depends on the parts of the projects. The latter one showed that there is much trust regarding the tunnel, but not regarding the station.
- Low amount of bidders has effect on the trust in the market perceived by the client in this project. Nonetheless past projects with major financial consequences such as the A15 has effect on the trust in the government by the market.

Relation between the framework results and the abstraction level

- The client aspects seem to fit a low abstraction level regarding the type of client, ambitions of the client and the client's influence.
- The project aspects lean towards the low abstraction level the most this is due to the technical, organisational, environmental and cost complexity. The time complexity indicates a high abstraction level.
- The market aspects show to be most fitting to a high abstraction level. The combination of the market's knowledge and experience and low trust perceived from both the principals as the market results in higher abstraction level. The framework based on literature and theory however did not take into account the project complexity in combination with the given limited time. Because in this project, especially regarding the station part, the market did not mind a detailed reference design

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6 Synthesis

Chapter 6 represents the synthesis between the findings in practice and theory on the cases A9 Amstelveen Badhoevedorp – Holendrecht (6.1) and ZuidasDok (6.2). Herewith the findings on the areas of difficulty in the determination of the LoD of the specification in the two case studies will be made explicit by means of the hypothesis as stated in section 2.5.

The analysis in previous chapter showed how the aspects relate to the designated abstraction levels. Chapter 6 will elaborate on the detected deviations that occur (6.1.1 & 6.2.1), and explain *why* those deviations lead to the difficulty in the determination of the LoD (6.1.2 & 6.2.2). The remarkable aspects of the analysis from previous chapter will return as well. An additional case study has been tested to the hypothesis in order to verify the use of the framework this will be elaborated in section 6.3. Finally the problem with the determination of the level of detail for the relevant project will become explicit; this will be the final step in order to derive the conclusions and recommendations in the final chapters.

This chapter gives answer to sub question 4:
What are the causes of the difficulties in the determination of the level of detail in the case studies A9 Amstelveen (Badhoevedorp-Holendrecht) and ZuidasDok?

6.1 Project A9 Amstelveen Badhoevedorp - Holendrecht

In this section the synthesis of project A9 Amstelveen Badhoevedorp – Holendrecht will be elaborated. This project will be put on the market under a DBFM contract, following the UAV-GC 2005. As stated by PIANOo (2016f), when one chooses for an integrated contract form than the contracting party must approach the market on a high abstraction level or functional level.

Hypothesis

The client, project and market aspects of projects based on the UAV-GC 2005 fit the characteristics of high level of abstraction.

The high abstraction level is schematized on the left side of the conceptual framework. This has been coloured grey (see table 38). The assumption is that because RWS procures the works of the A9 Amstelveen based under the UAV-GC 2005, the client, project and market aspects will fall in this grey column. Nonetheless deviations occur in this project, which will be elaborated. The deviations associated with the project are coloured orange in table 38.

		POLICY: UAV-GC 2005 (DBFM)	**Deviations**
Dimension	**Indicator**	**High level of abstraction** **System to subsystem**	**Low level of abstraction** **Unit to part**
Client aspects			
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of the level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price/quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Market aspects			
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 38 Deviations in project A9 Amstelveen Badhoevedorp - Holendrecht

The policy is expressed by means of the high abstraction level the principal wants to achieve with the use of the UAV-GC 2005. Because the policy merely gave this as guideline, the framework based on literature and theories filled the gap on what the high and low abstraction entails with respect to the aspects.

6.1.1 Deviations

In the A9 Amstelveen case study deviations arose in the client and project aspects and not in the market aspects. Therefore, the latter will not be discussed. The deviations in this section give rise to the following assumptions as stated in table 39 on why the determination of the LoD is perceived difficult in the case study. These will be further explored and explained by means of logic reasoning with the aid of the empirical study and literature/theory review in section 6.1.2. The results form part of the conclusions in the final chapter.

	Client aspects			**Project aspects**					**Market aspects**
	Type of client	Client's ambition	Client's influence	Technical complexity	Organizational complexity	Environmental complexity	Cost complexity	Time complexity	Type of market and trust in the market
Deviation	1	2	3	4	5	6	7		
Assumption 1: Privatization has made the determination of the LoD difficult									
Assumption 2: Different intra-organizational objectives on the abstraction level made the determination of the LoD difficult									
Assumption 3: The stated ambitions translated in the EPVE and the policy procedures make the determination of the LoD difficult									

Deviations supporting the stated assumptions

Table 39 Deviations and assumptions A9 Amstelveen Badhoevedorp - Holendrecht

Deviation 1

The type of client differs because RWS is perceived as a public and professional client, having knowledge and experience with the building process and an own construction department. The reason on why these deviations occur is because the starting point of the theoretical framework is: that a professional client is *able* and also *should* specify into much detail, as a public client needs to be transparent and provide detailed information to its stakeholders. As the empirical study recalls, RWS is perceived by the respondents as a knowledgeable client, but is this in its core true? As mentioned in chapter 1, RWS started from a technocratic system. However due to the critic on the perceived technocratic management and its contribution to the modernisation of the Dutch government, RWS developed towards a more responsive and efficient public organization (van den Brink, 2009, pp. 78-81). RWS privatized their tasks. As observed hiring technical external experts in their core team does make the principal more knowledgeable from the outside. RWS itself is not able to specify into detail anymore, therefore they hire experts to do this. The technical hired experts are indeed able to specify into more detail, but this comes with constraints. Because they are external, the core interests and business of hired experts differs from the principal's.

Deviation 1 gives rise to the assumptions that privatization has made the determination of the LoD difficult. Privatization of governmental tasks towards the market brings in hired experts having different interests and objectives not in line with the principal's interest and objectives.

Deviation 2

Regarding the ambitions of the client, the mismatch is found in the stated vision of the aesthetic/spatial integration and the lack of desire for innovation and sustainability. In chapter 1 Van Valkenburg et al. (2008) stated that the Ministry aims for early involvement of the market to achieve added value for society. In this case the added value would be innovative solutions for mobility-related problems, better project control and savings on time and money. The innovative solutions however did not come to expression in this case. The starting point of the framework is that if a contracting authority wants innovation and sustainability and has minimal vision on the aesthetic/spatial integration, one would stay on a high abstraction level. This is not the case. As the client has already made an EPVE document in

order to communicate with the stakeholders as well, a lot has been stated already. Nonetheless the project will be procured *after* the Route Decision, where a lot of procedures, regulations and requirements will encapsulate the design already leaving little room for innovation to the market. The entry point of the market leaves little playing field for the market.

Deviation 2 gives rise to the assumption that the stated ambitions translated in the EPVE and the policy procedures made the determination of the LoD difficult

Deviation 3

Respondents mentioned that the client's influence is required to guard the concept, policy and concept of the project. In addition the client is perceived not that willing to let go of specifying and therefore the specification is also into much detail. The unwillingness to let go of specifying is related to the hired experts with a lot of knowledge and experience clashing with the internal stated objectives as observed in this project. The experts with a technical background want to specify into much detail, while the higher organisational levels want to achieve a functional specification. Nonetheless different lines within the core team of RWS also have different objectives on this matter. There are different organisational lines, horizontally as vertically, with different abstraction objectives, which is presented in figure 13:

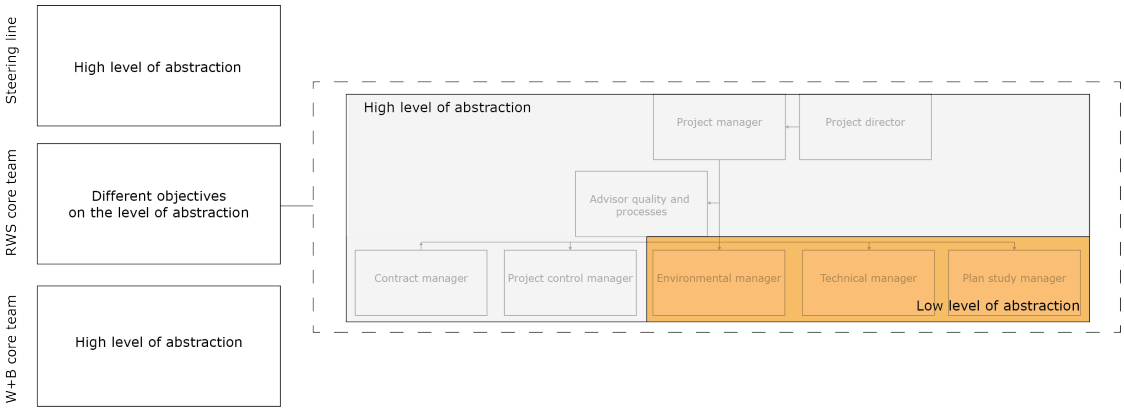

Figure 13 Different objectives on the abstraction level A9 Amstelveen Badhoevedorp - Holendrecht (own ill.)

The unwillingness to let go control in this project is perceived in the role of the different IPM teams; the environmental team, technical team and plan study team. In their perspective a low level of abstraction is more desirable. This will now be explained.

As observed from the empirical study reason for the environmental team has to do with the political spheres and keeping to the objective "maintaining support from the environment". The influence of RWS is herewith needed to guard this. The respondent mentioned that in their consultations with the environment, the people wanted to react on visuals and wanted to know everything in detail. RWS has to comply with the promised expectations of the stakeholders gained in those consultations or else upheaval will occur.

The reason why the technical team wants to specify into detail is for one because they have the knowledge to do so, and two as the respondent stated that the technical team perceives risks in every object and therefore wants to specify into detail. Most team members of the technical team have a background from a contractor. Their core business is to design engineering solutions. To go from a contractors firm, to being hired as an expert at RWS to help in functional specification requires a switch in working culture and adopting a different mindset. Nonetheless their expertise is needed, because only by specifying into detail, one can gain insight on the risks (progressive insight). As mentioned in section 5.1.2.1, this is the chicken or the egg causality dilemma.

The respondent also mentioned that the technical team does not really use the systematic names as defined in literature about SE. The absence of a structured handling on the systematic levels can mean the following things 1) the use of SE in practice has not been matured yet, 2) the use of SE in literature cannot be adopted one-on-one in practice, 3) the systematic levels merely serve as a label to the outside

world, for example 'we will specify only from system to subsystem and leave the rest to the market', to gain support. In this case strategic behaviour can emerge; the client promises on paper technical design freedom to the market, however in the specification process of the client the different systematic levels are not even taken into account. As result the client can label any specification 'system' or 'subsystem' to their advantage, in order to push the rest of the risks to the market.

The reason why the plan study team wants to specify into more detail is because they have to pass the front and end test as mentioned in chapter 5. This became visible in the effectuation of the BVP mindset. The BVP approach requires, according to the performance procurement method (Dutch: prestatieinkoopmethodiek), a new way of thinking regarding the roles of the client and the contractor. Best Value means the shift of *monitor and control* to *let go and trust*, the shift from *being steered by the principal* to *being guided by the contractor*. The principal should only facilitate and the contractor takes the lead. The key aspects here are:

- The expertise of the contractor (in this case W+B)
- The transparency of the results of both client and the contractor

Was this the case? At the start of the collaboration RWS came with factsheets from the parts that needed to be investigated, which were based on their own design studies they did internally. They gave this to W+B, however the consultants questioned why they would do this. W+B mentioned in the interview that it was probably better if they figured out on their own which researches needed to be investigated, because now their focus lies on filling out the factsheets. A few months later they still questioned if this was actually a practical step, because they did not see the point of it. They only executed it because the client asked for it. The client wanted to procure it on the basis of the BV mindset, but everything in practice proved the opposite. The client was reluctant to let go of the steering part. This also reflected in their approach with the design ateliers set up by W+B. W+B created a few design ateliers, which were intended for the consultants and the client to work or brainstorm together. RWS thought this was more like a meeting where W+B would present a plan and RWS would steer on it. In consequence it took much effort and time at the start of the project to switch that mind set, instead of the client-consultant role, it became more jointly eventually.

Again a contradiction is detected here. In the aforementioned reason the W+B wanted RWS to have a more jointly role. While the example with the OTB front and end test states in turn the opposite. As mentioned the client wanted to revise the document prior to the front test. But due to BVP W+B was not obliged to let them revise the document. Nonetheless the client stated that they made agreements that the client could inspect the report on their own initiative. In this respect, the desire to work jointly seems to be off the table. At the start of the project, codes of conduct have been set up in order to introduce a new way of working between A9A and W+B. One spoke of 'old' behaviour and 'new' behaviour.

In the new behaviour it stated that RWS would:
- Leave things open to see what the other comes up with and therefore not prescribe (old behaviour)
- Question/audit/assess/monitor and not approve and disapprove (old behaviour)
- Focus on the desired output 'with what do I want to continue?' and not identify the product (old behaviour)

The same was defined for W+B, where the codes of conduct stated:
- Goal oriented and not service oriented (old behaviour)
- Avoid additional work instead of discussing additional work (old behaviour)
- Taken into account what the project actually needs instead of 'because the principal said so' (old behaviour)

Looking at these codes of conduct both parties are guilty of sneaking in their old habits. From observation the reason might be that W+B was hesitant to involve the RWS members to revise the document prior to the front test because of the fear that would lead to approving or disapproving (old behaviour). However the RWS respondent answered that they wanted to revise it because they found it

too risky not to. Regarding the factsheets, W+B conducted them as told this is the 'because the principal said so' behaviour. This may also be related to progressive insight. One might only knows what he does not need when he already conducted the activity.

All with all both parties agreed to how they were going to collaborate. But the effectuation of it was laborious. Contacts between advisors of W+B and RWS seemed to be foreclosed according to the respondent. The engineering firm saw it as a disruption and the client saw it as an added value. Eventually a crash action was effectuated a week before the front testers came into the picture, insisted by the client. The respondent (AP2) also said that the client was not clear on when they would like to revise the products, and in the future he would like to have that clear in the collaboration agreement. The revision on the product must be done in order to control the risks and the client must know what is in it prior to the front test. He does agree with W+B that one should not discuss about the details but moreover on the outline.

Does the client team serve as a control team or sparring partner? From the empirical study it became apparent that the different perceptions on each other's quality and role seems to stand in the way of a smooth collaboration. In summary the perception of BVP differed on the technical line and was not practical in experience. While on the project control line, the handling of the BVP was more straightforward and in line with the perception of the engineering firm.

In conclusion, different intra-organizational (in one single organization) objectives on the abstraction level have been perceived. The framework marks a low abstraction level if client's influence is needed, if the specification is stated into much detail and if the client is unwilling to let go regarding laying down requirements.

Deviation 3 gives rise to the assumption that different intra-organizational objectives on the abstraction level made the determination of the LoD difficult

Deviation 4

The deviation in the technical complexity occurs in the fact that no new technologies will be used in this project and the project team has the knowledge and experience with the to-be-used technology. From theoretical perspective if this is the status, the specification can be specified into much detail. This relates to the involved experts with a technical background and the ability to specify into much detail. As observed in section 5.1.1.1, the consequence of the mismatch lies in the dissatisfaction of project team members from the client side that cannot make use of their technical knowledge.

Deviation 4 supports the rise to the assumptions, that privatization of governmental tasks towards the market brings in hired experts having different interests and objectives not in line with the principal's interest.

Deviation 5

The organizational mismatch is found in high fragmentation. The organizational fragmentation relates also to the different external hired experts that came into the project team as perceived from deviation 1. According to the framework a high organizational fragmentation should be tackled with detailed specifications. The reason for this is to eliminate misinterpretations as the communication lines between parties will be longer. Nonetheless the fragmentation is perceived in the different organisations and disciplines, but not location wise. The working methods differed amongst organisations and disciplines. More time was spent on the soft skills of the project instead of diving into the substantive technical matters (hard skills).

Deviation 5 supports the rise to the assumption, that privatization made the determination of the LoD difficult.

Deviation 6

The deviation in the environmental complexity lies in all three indicators. The line of reasoning of the framework is that *if* stakeholder's and political influence is present and *if* the client is able to specify into

high detail, then he should. The public client is in most cases the primary point of contact for the stakeholders and politics. By specifying into much detail *if* possible, the client can steer the realisation to match the promised expectations more easily, in contrast to when a third party is involved. This project is subjected to high political and stakeholder's influence as the project is going right through a densely populated area. Maintaining a good relation with the environment is actually the client's core business and concern. The risk of this mismatch lies in the fact that the contractor might not take into account the environmental relations; in addition the environment will always point the finger towards RWS.

Deviation 6 supports the rise to the assumptions, that different objectives on the abstraction level and that stated ambitions translated in the EPVE made the determination of the LoD difficult.

Deviation 7

The final mismatch perceived from the framework lies in the cost complexity regarding how the project is funded and the importance of price certainty in which the principal wants to exert its influence on the building process. The funding relates to keeping stakeholders informed as the municipality contributes financially in exchange for social added value. The latter manifested in the fact that in September RWS will conduct a budget estimation regarding the entire work from poles to asphalt. However by doing this, the project boundaries for the market will become narrow. If leaving the building method to the market is the desire, than the influence of the client should be less in this respect. Nonetheless by not making a cost estimation on this matter, the client cannot control its budget. This is a constraint that needs to be taken into account by both parties because the mismatch leads to the disruption of the level of playing field for the contractors.

Deviation 7 supports the rise to the assumptions, that different objectives on the abstraction level and that stated ambitions translated in the EPVE made the determination of the LoD difficult.

6.1.2 Assumptions

In this section the assumptions stated in 6.1.1 will be substantiated by means of examples from the empirical study and literature/theory review. This section follows the structure of the stated three assumptions.

Assumption 1 Privatization has made the determination of the LoD difficult

Privatization, the transferring of the plan development activities towards the market created difficulties in the determination of the level of detail in the A9 Amstelveen Badhoevedorp – Holendrecht project. The core interests and business of hired experts differs from the principal's. In the recent years RWS has downsized its knowledge and experience regarding the technical skills, and focused more on the social responsibilities. This has to do with the aversion of a technocratic system as perceived in the 19th and 20th century (van den Brink, 2009). In the meanwhile, RWS made its core business to focus on social responsibilities, and the private sector has excelled in the technical skills. Both worlds need each other in order to create, but their interests and abilities are worlds apart.

The findings from the case study on A9 Amstelveen supports this assumption. The empirical study showed that the team of RWS consists of hired experts from various backgrounds. The respondent from the client characterized his team as knowledgeable and risk-driven. Most of the hired experts of the technical team have a contractor's background, and are used to think very practical in tackling engineering problems. Respondents mentioned that because they are technical schooled people, they are able to detect technical risks easily and want to eliminate uncertainty through detailed design. This translates to over-specifying by the hired experts. Although they have the ability and the desire to specify into much detail it is not what the policy of RWS requires. The constraint here is that the line organization of RWS needs the experts to crystallize the system to foresee the risks, but wants to specify on high abstraction level. Theoretically RWS does not need this knowledge, yet practically he does. The type of role is tied to the desire and ability for a certain abstraction level. This forms a problem for the determination of the LoD, as the hired experts' objective regarding the LoD is not synced to that of RWS.

In addition, privatization makes the determination of the level of detail difficult, because rapid substitutions led to fragmentation in the organizational future line, which disrupts the traceability in the crystallization of the system as found in the empirical study. The respondents mentioned that the team under the core team of RWS was substituted rapidly due to short contracts. The short contracts are not practical in the sense that knowledge is gained on a project and then leaves the project. For this the term *project brain drain* will be introduced. *Brain drain* actually means: emigration of a relatively large part of the group of highly educated people from a country to a country where it is more attractive for them to work. In a sense, on project level (micro) this also occurs. A new group of hired experts will be introduced to substitute them, however they need time to get familiar with the project and past knowledge has to be obtained. The question also arises; how does RWS deal with information transfer? In turn this has consequences for the collaboration with external parties such as W+B. New faces are introduced and new relationships have to emerge. If this happens repeatedly, this could affect the efficiency on the project.

According to Berggren et al. (2001) and Baccarini (1996) organizational fragmentation increases project complexity. Wiegers (2006) explained that in any case one outsources rather than performing in-house, the project will benefit from comprehensive requirements documentation. When there is distance, one will not have the opportunity for the day-to-day interactions that are needed to flesh out the details, answer questions, and resolve ambiguities. In the A9 Amstelveen case study the client respondent mentioned that her technical colleagues felt they were missing the total picture and the line of reasoning on specifying. The fragmentation caused by the rapid substitutions translate to hired experts, who have been granted an abstract demand from the principal, they work on it and are in turn substituted over time. New experts come into the team, work on the abstract demand and the current specifications from their predecessors, without knowing the line of reasoning.

Next to that, the respondent form the technical team mentioned that he is dealing with an immense organizational complexity. The team members come from different organizations and are not on the same technical knowledge level. Nonetheless, the empirical study also showed that there is no structured handling on the systematic levels. He stated that it is important to work explicitly. If one does not work explicitly it will negatively affect the chain. He mentioned that in the past it was different: the technical department was part of RWS and new employees were educated, making the specification process easier.

The organizational complexity due to the rapid substitutions and *project brain drain* requires explicit requirements, i.e. low abstraction level. Especially when it comes to information that needs to be transferred over and over again as stated by Wiegers (2006). Requirements on high abstraction levels leave too much room for interpretation when it is delegated to different people over the course of time. However low abstraction level does not match the policy of specifying on a high abstraction level, making the determination of the LoD difficult to do.

Assumption 2 Different intra-organizational objectives on the abstraction level occurred making the determination of the LoD difficult

Another area of difficulty was detected in the different objectives regarding the abstraction level in the organisational line of RWS. This expressed itself in both vertical and horizontal lines of the organisation. The unwillingness to let go control was perceived in the following IPM teams: the environmental, technical and plan study team, as their desire was to specify into much detail. Each having their own internal/external superiors to satisfy.

First of all for the environmental team the desire to specify on a high abstraction level makes the acquisition on environmental support difficult. The responsibility of maintaining a good relation with the environment is the client's core business and concern. Due to the desire of high abstraction level, the risk arises that the contractor might not take into account the environmental relations. While the environment will always hold RWS responsible, as RWS is the contact point. Secondly, for the technical team of RWS the core business is to design engineering solutions although their expertise is needed, a switch in mindset and working method is required in order to specify on a high level of abstraction. The technical team was a mix of people with different organizational backgrounds. In order to switch the mindset and working method, more time needed to be spent on the soft skills instead of diving into the substantive technical matters (hard skills). Thirdly for the plan study team the desire to specify on a high abstraction level came with political constraints leading to the disruption of the BVP codes of conduct between RWS and W+B.

Different objectives on the abstraction level and the unwillingness to let go control contribute to making the determination of the LoD difficult in the A9 Amstelveen Badhoevedorp – Holendrecht project. The empirical study showed that the teams that were more engaged with the risks and costs (budget) wanted less detail. While the teams that were more engaged on the technical parts and environment (stakeholders and politics) wanted more detail. The different teams experience different pressures from either the higher organizational line or from external parties such as stakeholders and politics. They all want to have their say in the specification process and each team finds its own part the most important. The internal horizontal and vertical conflict of interests makes the determination of the LoD difficult.

Assumption 3 The stated ambitions translated in the EPVE and the policy procedures make the determination of the LoD difficult

Jansen (2009) stated that the desired LoD of the specification is difficult to determine in advance, due to a contradicting requirement of the contracting authority: on the one hand giving as much solution freedom as possible and on the other hand excluding or limiting risks and failures. Literature study revealed that only early involvement of contractors could give the market design freedom. Van Valkenburg et al. argued that the early involvement must be in the exploratory phase, in the process of giving planning consent; only then the added value for society can be achieved. However in this case study, the market is involved *after* the Route Decision. Early involvement of the contractors to achieve added value for society does not correspond to the little playing field the market has in this project.

From the theoretical framework (section 2.3.3), it follows that if the contracting authority decides to tender it on the traditional basis (UAV 2012), then he describes in detail *how* and *what* must be build or applied. This type of specification is in nature not solution free considering the technical solution – the *how* – is inherently described in the technical specifications. In the case of the A9 Amstelveen, the *what* is pretty much answered, a road from A to B by means of a deepened road. The reason why the design freedom was narrowed down has to do with the initial design, the tunnel. Due to the revised draft Route Decision (Dutch: OTB), from tunnel to deepened road. Although cost wise it is more beneficial to go for a deepened road, but regarding the safety and liveability it is a degradation in the perception of the stakeholders. Inhabitants and stakeholders are questioning if the deepened road will promise the same or a better outcome regarding the nuisance and safety as mentioned by the respondent. After all, the inhabitants and stakeholders will be the ones dealing with the deepened road in the future. The principal has to cope with this and wants to ensure its stakeholders and the inhabitants that the deepened road will be as good as or just as good as a tunnel.

The empirical showed that the Route Decision lays down the type of asphalt, height of the noise barriers and objects. The freedom here for the market lies only in the *how*. The question then is: how much freedom does the market really has if one takes into consideration that certain products requires a certain building method? The policy of the principal is to specify on a high abstraction level but the outcome of the researches to comply with high rates regarding air pollution and noise nuisance in the EPVE document, entry point of the market, and desire for accurate budget estimation states the opposite. The principal has already steered the expectations of the stakeholders by means of the EPVE document, as this document was used to engage with the stakeholders. The EPVE document represents the project visualization on a detailed level and therefore the principal makes promises on that level. However this is in conflict with the stated policy, a high abstraction level. It can be assumed that in the specification process with the technical team, the technical team will stumble upon this document. This makes the determination of the level of detail difficult, as the desire of high abstraction is not reflected in the outcome due to regulations and wishes. The more one delves into the specification process the more one incorporates rules/requirements to safeguard their expectations on the project.

6.2 Project ZuidasDok

In this section the synthesis of project ZuidasDok will be elaborated. This project will be put on the market under a D&C contract, following the UAV-GC 2005. As stated by PIANOo (2016f), when one chooses for an integrated contract form than the contracting party must approach the market on a high abstraction level or functional level.

Hypothesis

The client, project and market aspects of projects based on the UAV-GC 2005 fit the characteristics of high level of abstraction.

The high abstraction level is schematized on the left side of the conceptual framework. This has been coloured grey (see table 40). The assumption is that because RWS, ProRail and the municipality procure the works of the ZuidasDok based under the UAV-GC 2005, the client, project and market aspects will fall in this column. Nonetheless deviations occur in this project, which will be elaborated. The deviations associated with the project are coloured orange in table 40.

		POLICY: UAV-GC 2005 D&C	**Deviations**
Dimension	**Indicator**	**High level of abstraction System to subsystem**	**Low level of abstraction Unit to part**
Client aspects			
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of the level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price/quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Client aspects			
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 40 Deviations in project ZuidasDok

6.2.1 Deviations

In the ZuidasDok case study deviations arose in all three aspects. The deviations in this section give rise to the following assumptions as stated in table 41 on why the determination of the LoD is perceived difficult in the case study. These will be further explored and explained by means of logic reasoning with the aid of the empirical study and literature/theory review in section 6.2.2. The results form part of the conclusions in the final chapter.

	Client aspects			**Project aspects**					**Market aspects**
	Type of client	Client's ambition	Client's influence	Technical complexity	Organizational complexity	Environmental complexity	Cost complexity	Time complexity	Type of market and trust in the market
Deviation	1	2	3	4	5	6	7	X	8
Assumption 4 The variety of principals made the determination of the LoD difficult									
Assumption 5: Different inter-organizational objectives on the abstraction level made the determination of the LoD difficult									
Assumption 6: The organizational and environmental complexity challenge of the project made the determination of the LoD difficult									
Assumption 7: Distrust between the principal and the market made the determination of the LoD difficult									

Deviations supporting the stated assumptions

Table 41 Deviations and assumptions ZuidasDok

Deviation 1

The starting point of the theoretical framework regarding the type of client is, that the professional client has knowledge and experience regarding the building process. In this case there are three principals. Although the municipality is perceived as the most inexperienced principal between the RWS and ProRail, it still often conducts building projects. Nonetheless their experience with functional specification is low. The municipality has laid down many detailed subjects in the design documents. In addition, ProRail has a tendency to specify into much detail in this project regarding the station area. The consequence of this mismatch is that the contractor's level of playing field decreases and the risks will shift back towards the clients.

All three principals also have a responsibility towards the public and their stakeholders. One of the critical success factor as detected in this project is that both the principals as the potential contractor must be trustworthy towards the environment. This means, that the information of the contracting parties on the expected nuisance is reliable, transparent and realistic and that the nuisance caused must be communicated in due time. Only then, the environment will have the ability to anticipate and to take the situation into account. It is essential that compliance with created expectations and the information of the contractor and the client is reliable. Stakeholders such as AkzoNobel and ABN Amro have already express their dissatisfaction regarding the project plans. They foresee significant inconvenience, complaining that the effects are not well researched and are filing claims.

All the characteristics regarding the type of client and more importantly their relevant type of environment fit a detailed specification. This also relates to the required influence of the client. Herewith the mismatch is detected, as the desire is to specify on a high level of abstraction. The consequence of specifying on a high level of abstraction is that the environment may not see their created expectations

come to effectuation and upheaval can occur. Especially in this case with the diversity of exceptional stakeholders[6] it is very complex to manage it if the contractor will take over the design part as well.

Deviation 1 gives rise to the assumptions that the variety of principals and the organizational and environmental complexity challenge of the project, made the determination of the LoD difficult

Deviation 2

The client's ambition aspect is also different from what the framework would suggest and what the client wants regarding the specification level. Although the project encourages innovation and sustainability, they have not been mentioned explicitly in the functions, usage of materials or working methods. This is also not in line with the stated objective of the Ministry of I&E as stated by Van Valkenburg et al. (2008) in chapter 1. The absence of these two aspects would fit a low abstraction level. Nevertheless, the municipality together with a few architects have made a detailed design document, where a lot of materialization matters have been stipulated. ProRail has also stated much into detail on the station part. The consequences of wanting to specify on a high level of abstraction but having everything into much detail lies in; narrowing the level of playing field of the future contractor and taking back (a part of) the design risks. Certain materials can be bound to a certain building method therefore the core business of the contractor might not come fully through. Overall, the policy is to specify on a high abstraction level. According to the respondents RWS stayed more on a high abstraction level than the other two principals. This also relates to deviation 3 in the dimension *client's influence*.

Deviation 2 gives rise to the assumption that different inter-organizational objectives on the abstraction level made the determination of the LoD difficult. In addition, it supports the rise to the assumption that the variety of principals made the determination of the LoD difficult.

Deviation 3

In the client's influence, the deviation was perceived in the unwillingness to let go control, the detailed specifications and the need to monitor. This was most evident regarding ProRail as analysed in section 5.2.5.1. RWS was more willing to let go control. The characteristic of a network administrator is that they communicate by means of detailed drawings. The respondent mentioned that the station part started with designing and afterwards one would look if the requirements would fit the design. The team on the station preferred to have certainty and were not willing to let go detailing. The network operator has knowledge on his specific field and is also the one responsible for the station maintenance. By specifying into detail he will have control over that process in the future, which will enable him to anticipate on the future works and costs. This was also detected in the unwillingness to let go regarding the public space. As the public space will not be maintained in the future by the same contractors, the municipality wants to specify more into detail on this matter. The consequence of letting go specifying into detail in this matter is the risk that the contractor will not take into account the maintenance. This project will be procured on the basis of a D&C contract and therefore maintenance is not their responsibility. The different objectives on the abstraction level are perceived between the three principals, thus inter-organizational.

Deviation 3 supports the rise to the assumption, that different inter-organizational objectives on the abstraction level made the determination of the LoD difficult. In addition, it supports the rise to the assumption that the variety of principals made the determination of the LoD difficult.

Deviation 4

The deviations in the technical complexity are encountered in the perception that no new technologies will be used, the project team has the knowledge and experience with the to-be-used technology and special technology is not needed. From theoretical perspective if this is the status, the specification can be specified into much detail. This relates to the involved experts with a technical background and the

[6] This includes drivers, public transport passengers, residents, workers, students, 'users' of the Zuidas or adjacent areas (such as universities, hospitals) and those who for other reasons are traveling and / or living in the Zuidas and the companies that have settled and are going to settle in the Zuidas.

ability to specify into much detail. Nonetheless this project is marked as pretty straightforward technical wise, it is the logistics and coordination that will become a challenge. It is actually *that* challenge: the coordination skills that will be tested and outsourced. Therefore the core business of the market shifts from technical to organizational. The consequence of the mismatch lies in the fact that the technical team cannot exert their knowledge and experience.

Deviation 4 supports the rise to the assumptions, that different inter-organizational objectives on the abstraction level and the organizational and environmental complexity, made the determination of the LoD difficult

Deviation 5

The organizational mismatch is found in high fragmentation. According to the framework a detailed specification fit a high organizational fragmentation. The different organisations and their own working methods lead to tension regarding the alignment of the project plan and to fit it into one contract. The consequence of high fragmentation and the desire for high abstraction level lies in misinterpretations that can occur and lengthy discussion on political and organizational level. The project is already subjected to more process management than one expected. Nonetheless if the desire is to specify into detail, the same discussions could arise on political level but it is assumed that it decreases the discussions on organisational level.

Deviation 5 supports the rise to the assumption, that the organizational and environmental complexity challenge of the project made the determination of the LoD difficult

Deviation 6

The deviation in the environmental complexity lies in all three indicators. The line of reasoning of the framework is that *if* stakeholder's and political influence is present and *if* the client is able to specify into high detail, then he should. By specifying into much detail *if* possible, the client can steer the realisation to match the promised expectations more easily, in contrast to when a third party is involved. Why does the client still involve a third party in this project if he is able to specify into much detail?

When specifying into much detail and therefore also following a traditional approach, the design, execution and maintenance will be executed separately. The contracting authority will then tender the contracts to various market parties for parts of the construction process. However this was not desired. This is due to the accessibility and availability of the area that needs to be secured throughout the estimated 10 years. In the perspective of the principals, this can only be achieved if the market party handles the coordination themselves. The principals do not want to deal with different contractors blaming each other regarding logistic interferences between the different contractors.

In case of the environmental complexity, both abstraction levels can be applied. Although the teams of the principals are able to specify into much detail, the choice fell on high abstraction level. The starting point of the framework however, formulates from the client's ability to specify and informing the stakeholders as early as possible to mirror the design and realisation. It did not take into account the execution process in itself, regarding a smooth coordination and preventing logistic problems.

Another mismatch was perceived between the high environmental risk and the desire for a high abstraction level. The difficulty here is that the principals are responsible for the management of the environment as it is their core business and concern. Nonetheless the desire for a high abstraction level and the D&C contract form shifts this responsibility to the contractor.

Deviation 6 supports the rise to the assumption, that the organizational and environmental complexity challenge of the project made the determination of the LoD difficult

Deviation 7

Cost complexity deviates only on one indicator. The price certainty indicator and the reasoning behind it fitted both columns of abstraction levels. The mismatch is thus only perceived in the funding. With public funding one has to make the information transparent and clear on how this money will be used

and how it adds social value. The consequence of high abstraction level and public funding is that there is less information available towards the public, and therefore the legal certainty of the stakeholders cannot be guaranteed. In consequence, this can lead to upheaval from the stakeholders and political interferences will occur. This complexity and mismatch is closely linked to the environmental complexity.

Deviation 7 does not provide enough information to derive an assumption on its own, but it supports the rise to the assumption, that the organizational and environmental complexity challenge of the project made the determination of the LoD difficult

Deviation 8

According to the framework a low abstraction level is applicable in the situation of the two deviations. If there is low trust in the market, than why outsource the design as well to the market. Here we have to look at where the distrust takes place in this case study. The distrust is encountered regarding the interface between the organizational and environmental complexity. The contractor must have the organizational skills to maintain the accessibility and minimal hindrance of the area in the upcoming 10 years, which the principals are concerned about. However in this project there is also distrust from the market in the government, resulting that the market is hesitant in taking on this long-term contract.

Literature lacks on giving advice on the combination of project complexity and limited time and the desire for a low abstraction level by the market itself. Literature only perceives the trust from the client side in the contractor, however in this project it has become clear that the market's trust in its client is very important as well.

Deviation 8 gives rise to the assumption that distrust between the principal and the market made the determination of the LoD difficult. In addition, this deviation supports the rise to the assumption, that the organizational and environmental complexity challenge of the project made the determination of the LoD difficult.

6.2.2 Assumptions

In this section the assumptions stated in 6.2.1 will be substantiated by means of examples from the empirical study and literature/theory review. This section follows the structure of the stated four assumptions.

Assumption 4 The variety of principals made the determination of the LoD difficult

There are three clients involved in this project, all with different knowledge, experience, working methods and objectives this leads to difficulties in the alignment of all three of them into one direction. From the empirical study the respondents mentioned that getting the three clients into one direction was difficult. The interests of the three principals differ because they all have different stakeholders to take into account, different future scenarios to take into account and different working methods. This makes the determination of the level of detail very difficult, to substantiate this examples of the empirical study will be given on the interests, scenarios and working methods and why these clash.

First of all, the empirical study showed that each principal has its own responsibility in project ZuidasDok. To be more specific, RWS is responsible for requirements of the A10 Zuid, ProRail is responsible for the requirements on the railway system, public transport terminal and train station RAI and the municipality of Amsterdam for the metro and public transport terminal Zuid. Each principal and part of the project brings in another environment and interests. The respondents mentioned that aligning the three principals into one direction was quite a hassle. Given that the municipality has the inhabitants and the economic activity to consider, and the municipality and ProRail both want to anticipate on the maintenance of the project. Therefore they want a low abstraction level. RWS, on the other hand, was perceived to be more functional in its requirements. The respondent also mentioned that in the elaboration of objects, the solutions might need to be adjusted for financial reasons. However this could be in the advantage of one party but not for the other. In this case three principals have to be considered. Making the determination of the level of detail hard to predict.

The RWS specification method was also guiding in the overall project. The municipality and ProRail had to adjust their working method. As mentioned by the respondents RWS works with basic specifications, with basic specification less discussion arises. In the perception of the respondents basic specifications can be analysed and parts that are too much into detail can then be left out. For the municipality and ProRail this was a different story, as they adopted the RWS method. This contributed to the difficulty in the determination of the LoD. It is therefore not only about the alignment of the different interests, but also the working method and familiarity with functional specification.

Assumption 5 Different inter-organizational objectives on the abstraction level occurred making the determination of the LoD difficult

In this case study the inter-organizational (between two or more organizations) came forward more explicitly than the intra-organizational (within one organization). This is tightly coupled to the fact that this project is subjected to three principals (assumption 4). The highest line of the project management hierarchy wants high abstraction level, as this is also in line with the policy. However the technical teams and the network operators wanted to specify into more detail. This was perceived for the station part. As the network administrator, ProRail, has the knowledge and experience and wanted to communicate by means of detailed drawings. The respondent mentioned that the team that was involved with the station was unwilling to let go control, leading to detailed specifications. As mentioned, ProRail and the municipality also want to take the maintenance phase into consideration. Because this will not be outsourced to the same contracting party, as the contract will be a D&C. Nonetheless as stated in assumption 4, the municipality also has the inhabitants and the economic activity to consider. RWS on the other hand specified on a higher abstraction level than the other two parties as mentioned by the respondents. The empirical study showed that the project area of RWS was the furthest away from the city centre, hence they have also less stakeholders to satisfy than the other two principals.

The respondent mentioned that the determination of the LoD was difficult because the design process was continuously accompanied by a lot of laborious and slow decision-making due to the many parties with a variety of interests. On every level of the design, the pros and cons had to be presented and discussed. If the design were to be prescribed in general terms, someone from the client side would come along to request more detail. This was necessary to get the parent companies on board of the project. Although the policy prescribed a high level of abstraction, the overall project had all kinds of abstraction levels eventually. The project management line wanted high abstraction level, but when the decisions were taking into the decision-making process the request was in turn to specify into more detail.

Assumption 6 Challenge of the project lies in the organizational and environmental complexity, which made the determination of the LoD difficult

The challenge of the project lies in the organizational and environmental complexity rather than the technical complexity. Why does this make the determination of the LoD difficult? The organizational and environmental complexities are more difficult to anticipate on and harder to control as mentioned in section 5.2.5.2 and supported by Wood & Gidado and Sebastian & van Gelderen. The environment is unpredictable and therefore the project needs flexibility. A clear specification of policy goals or products is hard to make because of institutional fragmentation and strategic and knowledge uncertainty. The ZuidasDok project is subjected to more process management than one expected. Leading to a specification process that is subjected to a complex decision-making process. The tender specification is the communication tool to the market. But in its core the tender specification is focused on the requirements of the system rather than the handling of the environment (stakeholders and politics). The market's core business lies in its technical skills. The core business of the principals lies in the environmental management. However the principals want to see the bridge between the technical and environmental matters, by means of a contractor that is also organizationally skilled. The difficulty of the determination of the LoD arises here on how one can incorporate requirements that take into account both technical as environmental matters.

The high environmental complexity in combination with the limited time in this project leads to the desire of the market for a reference design in order to focus on the optimizations. Therefore the core of the project requires a contractor that is not necessarily technically skilled, but the project and the client longs for an organizational skilled contractor. However this is not (yet) the core business of the contractor.

Assumption 7 Distrust between the principal and the market made the determination of the LoD difficult

According to Jansen (2009) for any kind of building organisation form, trust is of importance in the decision of transferring more tasks towards the market. When specifying on a high abstraction level, and thus letting go more tasks, the more important the trust of the client in the market is. In the ZuidasDok case, distrust has been detected from both the principals' as the market's side. This was reflected in the low amount of bidders showing the unwillingness to take on the project and a long-term contract, the high environmental risk and high project complexity both parties are aware of, and past project fails (MaVa A15). If distrust would occur than clients tend to go for specified contracts and close control according to Kadefors et al. (2001).

Zooming in, the distrust is merely detected on the station part. The team on the station part wanted certainty and in response specified much into detail. The greater dilemma is therefore not encountered on the technical matters of the project, but the environmental and organizational. Tending to specify into much detail was observed here, in order to eliminate the uncertainties. Nonetheless the respondent mentioned that the market knows that much has been stated into detail, but does not mind. The market even requested the reference design in order to focus on optimizations, due to the complexity of the project and the limited time given. The respondent mentioned that it is a misconception that the market wants design freedom to start with. He mentioned that it is the perception of the client that more design freedom will inspire the market to come up with smart solutions. Because more design freedom, will also mean that the market has to hire engineering firms itself to work out the design, which comes with high

costs. In this case, the reference design will be handed, and they have the freedom to choose where they want to optimize.

It was assumed that the distrust between the principal and the market would make the determination of the LoD difficult. As the client would respond by specifying much into detail (which is the case), and the contractor would find this dissatisfying to always be suspected and not being allowed to contribute their knowledge leading to heavy discussions on the LoD. However in this case, both parties were aware of the distrust. Uncertainties of the project have been put on the table and revealed that the market does not mind a low abstraction level or less design freedom. It is of importance to emphasize that the high environmental risk and complexity in combination with the limited time given, has contributed to this outcome.

6.3 Framework verification additional case study

In this section the synthesis of the counter case study Utrecht CU2030 HOV-viaduct will be elaborated. This project will be put on the market under a RAW contract, following the UAV 2012. With the traditional approach the specifications are written with the aid of a standard system, in this case the RAW. The most important difference from the integrated models are the technical provisions that has been laid down in the contract (A.A. Boot et al., 2014).

The low abstraction level is schematized on the left side of the conceptual framework. This has been coloured grey (see table 42). The assumption is that because the contracting authorities (Municipality of Utrecht, Klepierre, ProRail, NS and Jaarbeurs) procures the works of the Utrecht CU2030 HOV-viaduct based under the UAV 2012, the client, project and market aspects will fall in this column. Nonetheless deviations occur in this project, which will be elaborated. The deviations associated with the project are coloured orange in table 42.

It must be noted that this project is already in the realisation phase and the other cases are analysed regarding the plan development phase. Therefore the answers of this framework are filled in for the plan development phase.

		Deviations	**POLICY: UAV 2012 (RAW)**
Dimension	**Indicator**	**High level of abstraction System to subsystem**	**Low level of abstraction Unit to part**
Client aspects			
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of the level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price / quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Market aspects			
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 42 Deviations in project Utrecht CU2030 HOV-viaduct

6.3.1 Deviations

The deviations occurring in this project are observed in the client's influence, organizational complexity, cost complexity, time complexity and the market aspects. In this case, the difficulty of determining the level of detail was not perceived. Discussions on technical substantive matters did occur, but there was no hassle regarding to which extent one has to specify the LoD. The explanation will only focus on the largest deviation, i.e. market aspects.

The most remarkable deviation lies in the market aspects. The market is perceived to be knowledgeable and having experience regarding this type of project and also in the functional specification. Currently, the market party Van Boekel has been chosen to execute the project. Although the market does have the knowledge and experience, it was observed that with Van Boekel this was eventually more on the public space and less on the tram viaduct. The trust in the market was perceived very high. There were a lot of bidders for the project as well. The market showed willingness in the assignment. There were around 10 tenders and they also showed the willingness for a long-term contract.

As mentioned in chapter 1 PIANOo (2016f) stated that the traditional approach works well when the client wants to keep project control, has in-house expertise to create designs and specifications, knows and controls the risks and has the capacity to monitor the contractor. The W+B respondents stated that the client has high average knowledge, but they outsource everything. The focus of their knowledge was more on the location and the wheeling and dealing regarding public organizations. They do have a lot of experience as the other side of the project is also subjected to many objects. In this project the design of the tram viaduct was outsourced to the engineering firm Verhoeven & Leenders. While the traditional approach here implies that the client would have in-house expertise to create designs and specifications. The knowledge and experience of the client does not guarantee that the client can/will fully use it.

This connects to the positioning of the market aspects in the framework that it fits a high abstraction level more, due to the market's technical expertise in which the client actually lacks off. The consequences of the privatization of the governmental activities manifests here even more explicitly considering the outsourcing of different parts of the project.

6.3.2 Interim conclusion

This additional case study is to verify the usability of the framework. In this case the framework does reveal the difficulty area, market aspects, as the only deviation. This is also the only junction where this project does not fit RAW. The respondent mentioned that this project fits a RAW approach because the planning dictated it, as limited time was perceived. In addition, also the design appearance was established and in the respondent's experience if this is the case than a RAW is suitable.

7 Reflection on the framework

Chapter 7 presents the reflection on the framework (7.1), the evaluation on the framework results (7.2) and the improvement points (7.3).

7.1 Reflection on the framework

The following section contains a reflection on the application of the framework. The framework does help deciding a suitable abstraction level, as it detects the areas of difficulty if one (wants to) deviates from it. This will help decision-makers to detect the corresponding constraints and pay attention to it. The initial run of the framework however has also identified some issues that could be improved. These issues are:

Conflicting statements
In the framework conflicting statements were perceived. As literature and theory discuss that certain choices can follow both high as low abstraction level. In this framework, choices have been made following the assumptions based on literature and theory to its best.

Completeness of the framework
The framework is based on current literature and theories. It is not unthinkable that over time, more knowledge will be gained on the LoD and more accurate advices can be given to which abstraction level a certain indicator matches. In addition, new aspects and indicators could be added.

Answer choices
Even though the two additional options were incorporated to give respondents in-between answers, some of them still found the difference in the in-between answers too large. For example, question 14 'to which extent does the project team has experience with the to-be-used technical applications?', the respondent said that the difference between the answers was sometimes too large, while the answers had already been expanded from two choices into four.

Framework handling
The final answers of the framework as presented in this thesis is now comprised of different filled in frameworks by the consultants of W+B. Whereby the presented answers has been observed by the researcher in order to come to one filled in framework. Herewith the researcher took into account the elaboration of the answers and the way the respondents answered the questions (with/without hesitation). However one can question if this method of assessment is correct or does it needs to be changed.

Subjective answers
The framework is subjected to the respondent's perspective in time. One can question if the given answers still apply over time or if someone else from a different department (e.g. contract management) would answer the same.

7.2 Evaluation on the framework results

The answers could not be generated and analysed during the interviews, but it showed a divergent pattern regarding the abstraction levels. At the end of the questionnaire, the question was asked to the respondents *what kind of abstraction level or building organizational form would be more suitable for the relevant cases?* The following answers were given:

A9 Amstelveen Badhoevedorp – Holendrecht
Regarding the A9 Amstelveen Badhoevedorp – Holendrecht the W+B respondent stated that the project leans towards a D&C contract rather than a DBFM contract as it is now. This is due to the fact that the client wants to specify a lot and wants too much control over what should come soon. He noticed that the client could only make an estimation if something was certain or risk-averse if everything was specified into detail instead of relying on their expert judgement. They outsourced many things just to investigate and investigate because they are afraid that the contractor will see those errors. He mentioned that a client with a technical orientation finds it hard to let go. While a less technical oriented client is more on the process management. He stated that it is either he does not trust the market or he wants the assurance that he will get what he asks for.

The same question was asked to the client respondent. He stated that it *has* to be functional specification. Even if the project will be finished he said that he would not know to what abstraction level it should be. He did state that although the abstraction must be high he noticed that many stakeholders and their clients actually have no need for high abstraction and functional specifications towards a system. They just want to discuss about e.g. a bridge of 10 meters and grey concrete. The reason for this is because they are busy with materials that are not even remotely like aerospace. The respondent explains that with aerospace, one will go with a rocket ship to an unknown planet and then SE would be applicable. In that case you can only define the question/demand. How you want to get there you do not know. However in the civil engineering, everything is already known. Thus is functional specification really necessary? It is wisely to apply it in order to control if the stated design is delivered. In other words, if the system complies with the desired functionalities and not because you want to know the solution. Therefore he thinks it is useful to apply functional specification on a high abstraction level.

ZuidasDok

Regarding project ZuidasDok the W+B respondent mentioned that in his opinion the contract form, D&C, does fit the project. The mix of high and low abstraction levels has taken 2 years to get it in order. Nonetheless on some parts the traditional way was more suiting. For example they questioned if D&C is suitable for the public space and if a RAW would be more fitting. Because the public space is not the biggest expense therefore they could have designed it themselves. In contrast to the tunnel which can be specified functionally. And in the case of the station, it could have been in more detail because the network administrator wanted so much certainty on it. All in all he thinks that a D&C is suitable, nonetheless on some parts it could just as well be a RAW.

The other W+B consultant shared the same opinion regarding the suitability of the D&C contract. He also mentioned that the station part could just as well be a RAW. However there was a very clear desire to procure the project as one project to the market. In the question on why it could not be procured as one RAW project, he answered that there is no support from the parent companies. It would be weird to procure the ZuidasDok in a traditional form, it would seem like going back 20 years. In addition, also to get the implementation expertise of the market on board and let them have the responsibilities.

Utrecht CU2030 HOV-viaduct

Last but not least, the same question was also asked regarding the additional case study, Utrecht CU2030 HOV-viaduct. The W+B respondents answered that they think that the client could have also used another building organisation form. Nonetheless the planning dictated the RAW approach, because it must be executed in a relatively limited time. He stated that this is also due to the establishment of the design appearance. In his experience when this is the case one has to be careful on how to record this in the contract. And if one is not going to elaborate on that, than one should let go of the design appearance. However if you are going to establish the design appearance you also have to prove that it is makeable before you hand it to the market.

Reflecting back on the pilot study

Reflecting on the stated outcomes as perceived in the pilot study in chapter 1. The following assumptions can be made merely based on the *areas of difficulty*. Based on the stated EPVE, late entry point of the market and the client's desire for accurate budget estimation the design freedom of the market in project A9 Amstelveen (B-H) is low. The unwillingness to let go control and the expectation of the low abstraction level as perceived by the respondents makes the risks higher for the client. Based on the aforementioned reasons the legal certainty of the stakeholders will be high. See figure 14.

In case of the ZuidasDok, the stated design document, late entry point of the market, the distrust (plus reshaping the project due to lessons learned from MaVa A15) leads to low design freedom for the market. The difficult alignment between three clients, and the complex decision-making process can lead to low legal certainty of the stakeholders. The different objectives in the inter-organizational line can lead to increase of risk for the clients and also because of the reshaping of the project. However the latter does mean less risk for the project in general. For example, a part of the responsibilities regarding the permits have now been taken back by the contracting authority therefore the project risk will in turn decrease, but not the client's risk. See figure 14.

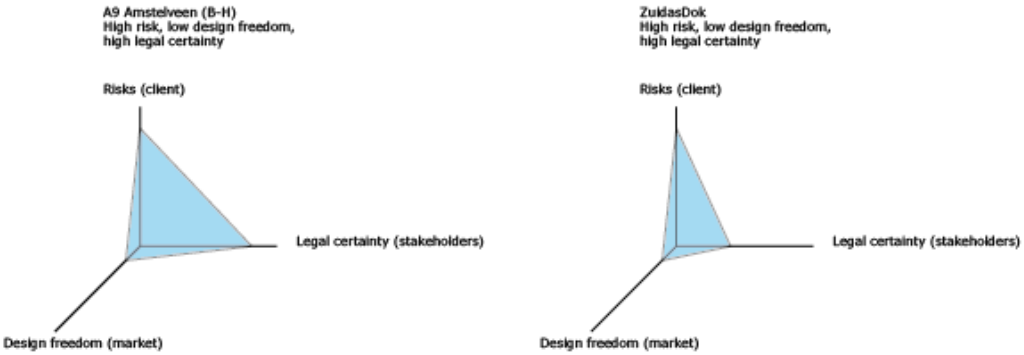

Figure 14 Assumption triple constraint for the case studies (own ill.)

The outcomes of these graphs are based on the assumptions of the researcher by investigating the cases. The difference in the observation came forward in the legal certainty, in which the ZuidasDok *scored* lower than the A9 Amstelveen. The aspect, that the ZuidasDok has a variety of principals was encountered, as the alignment of objectives is more difficult compared to the A9 Amstelveen case (one principal). With different objectives in the steering line it is assumed to be more difficult to present (detailed) information to the stakeholders.

7.3 Framework improvement points

The issues that have been identified can now be used to improve the framework if possible.

Conflicting statements and completeness of the framework
The theoretical application of the framework serves the purpose for this research, as it has become a framework to detect deviations occurring putting the desired and the existing situation next to each other. However it is thinkable that for practical use more information is needed to back up a certain choice for the abstraction level. The literature and theory search for this research has stopped due to limited time. It is assumed that more literature and theories on this topic could reduce or eliminate conflicting statements.

Assessment of the framework
The assessment of the framework could be enhanced by approaching the answers differently. Such as, using score models instead of textual answers. Herewith one could think of an answer within a range from 1 to 4, and 1 being low and 4 being high. In addition the respondent can elaborate on it. Also no weighing factor has been used. The client, project and market aspects are all equal in this case in order to produce an as much as possible objective profile of the case study.

It is thinkable that for the client the project aspects or even an indicator of the project aspects, such as environmental complexity, is more important than the technical complexity. By giving a weight to it, the advice can be personalized.

Nonetheless the framework has now been conducted with a limited number of respondents. For a more accurate result this framework can be approached quantitatively with a larger set of respondents from both client as consultant side or even from the market side. When conducted on a larger scale one can generate a general project profile regarding the client, market and project aspects. In addition, the framework can also be used to evaluate a project to observe the shifts in projects and draft lessons to be learned.

Last but not least a quantitative approach with the framework can lead to new aspects/dimensions/indicators for the framework. In this research, the case studies introduced two new insights in the determination of the LoD, which are the design appearance (this one has been incorporated in the framework eventually) and the trust of the market in the client. These were not found in literature or theories, but in practice.

8 Conclusions and recommendations

Based on the results from the case study research, literature and theories, conclusions with regard to the causes of the difficulty in the determination of the level of detail are drawn. Consecutively, based on these insights, recommendations will be made regarding the difficulties in the determination of the level of detail.

8.1 Summary

The goal of this research was to find out the areas of difficulty in the determination of the level of detail regarding civil engineering projects based on the UAV-GC 2005. A theoretical framework for the determination of the LoD was constructed, because there were no existing frameworks available regarding this specific topic. Inspired by the statements of Jansen (2009) and PIANOo (2016b) a starting point for the conceptual framework was derived. The framework helps the principal to become aware of his risks in the plan development phase as it reveals the perceived difficulties. In addition, it can form a part of the dialogue between the client and the consultant to tackle the obstacles. This can help project teams to focus on their core activities.

In chapter 2 and 3 the insights needed to construct the framework are investigated. In chapter 2 the theories on the LoD in the field of Systems Engineering, building organisation forms and public organisations are discussed. In chapter 3 the relevant aspects for the determination of the LoD are derived and there the framework was constructed. Chapter 4 elaborated, inter alia, on how the difficulties could be extracted by means of the hypothesis. Chapter 5 applies the framework to the cases A9 Amstelveen Badhoevedorp – Holendrecht and ZuidasDok. Chapter 6 investigated the analysis further by conducting a synthesis, putting the policy (desired situation) and practice (existing situation) next to each other. Herewith the hypothesis was tested and revealed the difficulties and why they complicate the determination of the level of detail (causes). Chapter 7 elaborated on the usability of the framework, which functioned as the means in order to unravel the difficulties.

8.2 Conclusions

This section presents the answers to the sub questions and the main research question.

SQ1: What insight(s) are needed in order to determine the level of detail of the specification according to literature/theory?

Literature study showed that if a contracting opts for an integrated structure, the contracting party must approach the market on a high abstraction level. Many models on how one can choose between building organisation forms (traditional, integrated and life-cycle) were available but not on determining the level of detail. While the latter is the essence in which project teams want guidance on in practice as observed in the pilot study.

Literature on Systems Engineering showed that different systematic levels portray the explicitness of a tender specification. The systematic levels of Perrow have been investigated, in which the high abstraction level is linked to system and subsystem, and the low abstraction to unit and part. However literature on both the building organisation form as SE gave no substance to the concept of a high and low abstraction level. Literature showed that although there is no framework to determine the level of detail, the contracting authority can be largely guided by the same considerations as with choosing the building organisation form as stated by Jansen (2009) and PIANOo (2016b).

The research on the level of detail in public organizations revealed that RWS and ProRail have a policy to outsource their works by means of integrated contracts, thus on high abstraction level. Resulting in the following **hypothesis**:

Projects based on the UAV-GC 2005 fit the characteristics of high level of abstraction

SQ2: What elements of the project do contribute to the determination of the level of detail of the specification according to literature/theory?

To fill the gap of knowledge, the elements contributing to the determination of the LoD have been investigated. By means of 14 literature and theory sources a list has been made on the determinants of the LoD. Herewith it became apparent that the client, project and market aspects were the main aspects

to take into consideration. In turn dimensions and indicators under those aspects have been detected and defined. In addition to fill the gap on the concept of high and low abstraction level, the indicators have been matched to its relevant systematic level, by means of the linked keywords found in literature, see table 43. Resulting in the conceptual framework, see table 44.

Systematic level	Specification	Involvement market	Collaboration form	Design freedom	Abstraction level
System	Functional	Early	Integrated / life-cycle	Freedom	High
Subsystem					
Unit	Technical	Late	Traditional	No freedom	Low
Part					

Table 43 Systematic levels and the relevant characteristics

Dimension	Indicator	High level of abstraction System to subsystem	Low level of abstraction Unit to part
Client aspects			
Type of client	Professional or incidental client	Incidental	Professional
	Public or private client	Private	Public
	Knowledge & experience	Low	High
	Knowledge & experience regarding functional specification	High	Low
Client's ambition	Aesthetic / spatial integration	No vision + not stated	Vision + Stated
	Sustainability	Important	Not important
	Innovation	Important	Not important
Client's influence	Translation to functional requirement	Many	Low
	Willingness to let go regarding setting requirements	Willing	Not willing
	High abstraction of level of detail	High abstraction	Low abstraction
	The need to monitor	No influence required	Influence required
Project aspects			
Technical complexity	Newness of technology	Many new	No new
	Experience with the technology	Low	High
	Requirement of special equipment/technology	Needed	Not needed
	Technical risk	High	Low
Organizational complexity	Experience with parties involved	High	Low
	Organizational fragmentation	Low	High
	Organizational risk	Low	High
Environmental complexity	Stakeholder's influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	Political influence	High influence (if principal is not able to specify into detail himself, he should involve the market early)	High influence (if principal is able to specify into detail)
	Environmental risk	Low	High
Cost complexity	Funding	Private	Public
	Price certainty	Important (early market involvement)	Important (more influence on building process by principal)
	Low management costs	Important	Not important
	Price / quality ratio	Important	Not important
Time complexity	Certainty on the lead time	Tight schedule expertise of the market needed	Tight schedule expertise of the market not needed
	Continues developments	Many (project flexibility is needed)	Low (straightforward project)
Market aspects			
Type of market and trust in market	Knowledge and experience	High	Low
	Knowledge and experience regarding functional specification	High	Low
	Readiness for long-term contract	Willing	Not willing
	Trust in the market	High	Low

Table 44 Conceptual framework

SQ3: What insights are needed to construct a theoretical framework in order to determine the level of detail and to detect the areas of difficulty?

The third step encountered how the hypothesis could be tested. This was also a part of the method to conduct the research. The conceptual framework made a clear division on the determinants on high and low abstraction level. This is needed in order to portray in one glance the policy of the public organisations. To test the hypothesis, the framework was supplemented with questions accompanying the indicators. By means of the division the hypothesis could be tested to two single cases, the A9 Amstelveen Badhoevedorp – Holendrecht and ZuidasDok, which follow the policy of a high abstraction level. The aspects that fall in the characteristics of the low abstraction level are considered not to fit the

policy, i.e. deviations. This is the gap between the desired and the existing situation, in other words the problem.

SQ4: What are the causes of the difficulties in the determination of the level of detail in the case studies A9 Amstelveen Badhoevedorp-Holendrecht and ZuidasDok?

8.2.1 Conclusions concerning the project A9 Amstelveen Badhoevedorp - Holendrecht

The results showed that the difficulty in the LoD determination of A9 Amstelveen B-H was due to the privatization of the governmental activities towards the market, different intra-organizational objectives on the abstraction level and the ambitions of the principal and policy procedure, which have been elaborated below:

Conclusion 1 Privatization has made the determination of the LoD difficult

Privatization brings in external experts with technical enthusiasm, i.e. the ability and desire to specify into much detail, however their objective to specify into much detail does not correspond with the high abstraction level objective of RWS. In addition, privatization disrupts the traceability in the crystallization of the system, because it makes organizational and communication lines longer as the line under the core team is substituted rapidly. Occurrence of rapid substitutions and *project brain drain* in a project requires working explicitly to support clear communication in the chain cooperation. However the policy of RWS is to specify on high abstraction level.

Conclusion 2 Different intra-organizational objectives on the abstraction level occurred making the determination of the LoD difficult

Different objectives on the abstraction level disrupt the policy of specifying on a high abstraction level. This was perceived within the IPM teams. Teams that are more engaged with risks and costs (budget) want a high level of abstraction in order to tame the risks and costs of the project. Teams that are more engaged with technical, environmental and political matters are unwilling to let go control and desire a low abstraction level. This brings friction in the determination of the LoD.

Conclusion 3 The stated ambitions translated in the EPVE and the policy procedures made the determination of the LoD difficult

Last but not least the policy of the principal dictates a high level of abstraction. While the stated vision (EPVE document), late entry point and the desire for accurate budget estimations in this case study implicate a low level of abstraction. The EPVE was used to engage with the stakeholders, the document is presented into much detail and steers the expectation of the project. Promises made regarding the presented details are expected to be included in the contract. However this is in conflict with the stated policy. This makes the determination of the LoD difficult, as the desire of high abstraction is not reflected in the outcome due to regulations and wishes. The more one delves into the specification process the more one incorporates rules/requirements to safeguard their expectations on the project.

8.2.2 Conclusions concerning the project ZuidasDok

The results showed that the difficulty in the LoD determination of ZuidasDok was due to the variety of principals, different inter-organizational objectives on the abstraction level, and the organizational and environmental challenge of the project, which have been elaborated below:

Conclusion 4 A variety of principals (comes with different ambitions, knowledge, working methods, project areas and type of environment) made the determination of the LoD difficult

The variety of principals brings different ambitions, knowledge (working methods), projects areas and the related type of environment making the determination of the LoD difficult. As in the elaboration of the objects, choices can be made that can be more favourable for one party but not for the other. Making the determination of the LoD hard to predict. In addition, the working methods of the principals were not aligned in this project. RWS and ProRail both have their own specification method, however RWS's was chosen. Subsequently, the municipality, which is used to the RAW systematic, and ProRail had to adjust their working method. This took quite some effort, making the determination of the LoD difficult.

Conclusion 5 Different inter-organizational objectives on the abstraction level occurred making the determination of the LoD difficult

Different inter-organizational objectives on the abstraction level occurred making the determination of the LoD difficult. In this case ProRail was unwilling to let go of specifying due to its technical knowledge and wanting to communicate by means of detailed drawings. Given that the municipality has the inhabitants and the economic activity to consider, and the municipality and ProRail both want to anticipate on the maintenance of the project. RWS specified on a higher abstraction level than the other two parties. Aligning the three principals into one direction was experienced as quite a hassle. Although the policy prescribed a high level of abstraction, the overall project had all kinds of abstraction levels eventually. The design process was continuously accompanied by laborious and slow decision-making due to many parties with a variety of interests, making the LoD difficult to determine.

Conclusion 6 Challenge of the project lies in the organizational and environmental complexity, which made the determination of the LoD difficult

The ZuidasDok project is subjected to high organizational and environmental complexity. A clear specification of policy goals or products is hard to make because of institutional fragmentation and strategic and knowledge uncertainty. The tender specification is in its core focused on the system rather than the handling of the environment. The difficulty of the determination of the LoD arises here on how one can incorporate requirements that take into account both technical as environmental matters. Taking into consideration that the market's core business lies in its technical skills.

Assumption Distrust between the principal and the market made the determination of the LoD difficult

Last but not least it was assumed that the distrust between the principal and the market would make the determination of the LoD difficult. As the client would respond by specifying much into detail (which is the case), and the contractor would find this dissatisfying to always be suspected and not being allowed to contribute their knowledge leading to heavy discussions on the LoD. However in this case, both parties were aware of the distrust. Uncertainties of the project have been put on the table and revealed that the market does not mind a low abstraction level or less design freedom. It is of importance to emphasize that the high environmental risk and complexity in combination with the limited time given, has contributed to this outcome.

8.2.3 Conclusions concerning integrated projects

In this section, the main research question will be answered:

What are the causes of the difficulties in the determination of the level of detail of the specification in integrated contracts of large infrastructure projects?

In the two single cases, the answers that have been found for the causes of the difficulties in the determination of the LoD show a variety per case, which are elaborated in this section.

The deviations that occurred in the A9 Amstelveen project were perceived in the client and project aspects. Projects similar to the A9 Amstelveen Badhoevedorp – Holendrecht can be subjected to the difficulty in the determination of the LoD due to privatization, different objectives on the abstraction level, and the ambition of the client and policy procedures. This project has one principal, this explains why the difficulties in the specification process stood out in the different objectives on the abstraction level of the intra organization (within a single organization) and therefore the consequences of privatization could be pinpointed.

The deviations as occurred in the ZuidasDok were perceived in all aspects. Projects similar to the ZuidasDok can be subjected to the difficulty in the determination of the LoD due to the variety of principals, different objectives on the abstraction level, and the organizational and environmental challenge of the project. The assumption remains that distrust between the principal and the market can also contribute to the difficulty. In this case study it was found that although much has been stated into detail the market did not mind it due to the environmental complexity and limited time given for the

project. The distrust between the market and the client has reshaped the demand of the project as mentioned in section 5.2.5.3 due to lessons learned from the MaVa A15 project. Nonetheless it can be assumed that in others projects where environmental and organizational complexity and lead-time are not perceived as explicitly important, the market would still want design freedom, i.e. a high abstraction level. The findings on the distrust do not provide a unanimous answer whether distrust leads to difficulty of the LoD, more research is needed on this subject.

The area of difficulty that occurred in both cases is the different objectives on the abstraction level in the organization. Every infrastructure project is subjected to a diversity of disciplines that have to take into account their own sphere of influence and interests. Therefore it is not unthinkable that different objectives on the abstraction level will occur. However in the case of A9 Amstelveen, there was only one principal. The focus lied on one organization and therefore the privatization of governmental tasks towards the market showed its consequences explicitly. The ZuidasDok on the other hand, deals with three principals, shifting the focus from intra to inter-organizational (between two or more separate organizations) cooperation. This explains why the outcome of the different objectives on the abstraction level within the organization in the A9 Amstelveen case was more into detail.

Another aspect that emerged from the empirical study is that both projects were perceived not that difficult technical wise according to the respondents. The environmental complexity had the upper hand, even more explicitly in the ZuidasDok case. The ZuidasDok deals with different sub projects into one contract, while the A9 Amstelveen project is one project part in one contract. The deal breaker in the ZuidasDok case to go for an UAV-GC is because the desire is to execute the project in an integrated manner. This is also the reason why the challenge of the environmental and organizational complexity stood out and forms one of the difficulties for the ZuidasDok case. Regardless the magnitude of the project, the market is trusted more with its technical skills than with its ability to cope with the environment in both cases.

According to the framework (based on literature/theory), for both cases a low level of abstraction suits the observed deviations in the client and project aspects, and for the ZuidasDok also the market aspects. The question arises: does the policy needs to change? The answer is that it depends on the greater purpose. The shift to a smaller and more efficient government will only develop further. Both the government as the market need the experience to become familiar with the new way of working. The sector needs the incremental process to finally get to the point where the government wants it to be now. The policy does not need to change, but the areas of difficulty should be taken into account.

8.2.4 Conclusions concerning the framework

In this research, the hypothesis has been tested by means of the framework on two integrated cases and on one traditional case. The results showed that the client and project aspects of the traditional case correspond to the desire of low abstraction level. In the two integrated cases both the client and project aspects did not match the policy of high abstraction level. Therefore the framework can indeed detect the difficulties if deviations occur, because in the traditional case study the discussion on the LoD was absent and deviations only occurred in one aspect (market).

Although the framework is suitable in order to detect the areas of difficulty, which can help the principal or consultant to take into account where difficulties could arise in the determination of the LoD process, there are limitations to the framework. The framework is now qualitative in nature and needs to be refined with improved quantitative analysis. Empirical study showed that there might be more indicators in the determination of the level of detail. As learned from this research two additional parameters have been revealed: the design appearance and the market's trust in the client (thus not only the client's trust in the market). Another limitation can be perceived in the chosen literature and theory, after all the literature and theory and the interpretation of it are also exposed to subjectivity.

The framework is now used as a means to reveal the difficulties, if supplemented and improved it could form a starting point into accurately determining the level of detail. Nonetheless the current framework

can be used as a supporting tool in the dialogue between the client and the consultant to detect the difficulties and to prevent, eliminate or anticipate on the obstacles, so project teams can focus on their core activities. When refined, the framework can be used as a product for engineering firms and form a part of acquisition.

8.3 Recommendations

In this section, recommendations have been set up to support the specification process between the client and the consultant. The following four recommendations have been established:

1. **Awareness on the problems occurring in the determination of the LoD**
   From the pilot study to the in-depth case studies, problems in the determination of the LoD arose. Giving recognition to the areas of difficulty that can jeopardize the specification process, consultants of the principal can anticipate and modify their specification process to the needs of the project. As perceived in both cases the different objectives on the abstraction level can form a difficulty in the determination of the LoD. In order to align the objectives of the abstraction level in the organization the principal must become aware what he brings into the organisation and make sure their competencies have room to flourish. Currently, in the A9 Amstelveen case the different teams only communicate through the IPM management lines. Just like the dialogue phase that the client has with the market, a dialogue phase should be incorporated in the specification process with the teams that are engaged with the technical, budget, risk and environmental matters. Herewith the different teams should present their line of reasoning regarding their objective on the LoD to each other and discuss openly about it. This will also clarify each other's role in the specification process. The line of reasoning on the LoD was also the missing link for the teams to understand the specification process in the A9 Amstelveen case (disrupting the traceability in the crystallization of the system).

2. **Anticipate on the environmental and political influence the project is subjected to**
   The case studies showed that both projects are technically less of a challenge, and the greater challenge lies in the market's organizational approach in the environmental complexity as perceived explicitly in the ZuidasDok case. Public and private organizations should give recognition to the environmental and political influence the project is subjected to. Herewith the focus on technical specifications consultants are dealing with should shift in thinking along with the client on an environmental strategy. The core focus of contracts lies now in the system as a technical challenge. Questions such as 'How are we going to incorporate environmental incentives in the procurement phase to the market' should be asked in the client-consultant engagement. By means of the EMVI, in which the client assesses the market on how to deal with the environment, nothing has been laid down formally and uncertainty remains for the execution phase. W+B can think of an award system every time the winning contractor shows its engagement with the environment in the execution phase or a way to specify environmental engagement into the functional specifications.

3. **Awareness on the added value of the market**
   Due to the developments in the industry, it is not unthinkable that the core business of the market has to shift. As the public organizations are downsizing, their control capacity will be less. Currently public organizations have a tendency to outsource everything. Even in the case study of the RAW this was detected. The development requires a contractor that is no longer only technically skilled but also organizational. Awareness on the added value of the market should be created and supported by the principal or consultants of the principal where gaps still occur. Public organizations should therefore also take the wishes of the market into consideration. It is a misperception that the market always wants design freedom. Public and private organizations should define the right reason(s) why they want to bring the market on board. Is this technical or organizational, or both? Strengths and weaknesses of the market and the public organisation itself should be defined. It can be assumed that the strength of the public organisation lies in the handling of the environmental complexity (political, stakeholders, permits) and that of the contractor lies in dealing with technical complexity. By defining the strength and weaknesses of the project parties, one can complement each other to increase the effectiveness of their roles. As learned from the

ZuidasDok it has been detected that the hired experts are more than capable of doing the standard design and the market should only focus on optimization challenges, therefore the market requested the reference design.

4. **Think along with the client**
   The core of the aforementioned recommendations is to advice engineering firms to think along with its client. The client respondents mentioned that it is important for any engineering firm to consider the greater picture and they expect a critical attitude from them. Engineering firms should make their clients aware that a stated policy can effect the determination of the LoD. As perceived in the A9 Amstelveen case it is of importance to be critical on the handed assignment and question 'what the greater purpose is of the assignment and if the outcome will add value to the overall process'. Think outside the own assignment (specifying the system) by also anticipating on the effects of the specification towards the market and the environment.

8.4 Recommendations for further research

This study offers different subjects for further research, of which the most outstanding ones are discussed in this section:

1. **Supplementing the research by means of multiple case studies**
   This research has been conducted by means of two single case studies, in which no cross-case study analysis has been conducted. The projects were perceived to be too unique and therefore generalizing on the basis of a cross-case study seemed not to be fitting. For further research it is interesting to take multiple cases with similar project characteristics (size and complexities for instance). When conducted on a larger scale one can compare the cases and generate a general project profile regarding the client, market and project aspects. This will generate valuable information on projects and difficulties can be extracted from projects with a similar profile.

2. **Research on the effect of trust/distrust in the determination of the LoD**
   In this research it came to conclusion that the market's trust in the government is also very important to take into consideration. In the ZuidasDok case, distrust was detected and resulted in reshaping the demand of the project, but also the request of the market for the reference design. In future research it is recommended to investigate the exact relation on trust from both perspectives (client and market) on the abstraction level and which interventions parties take to relieve the tension in the distrust.

3. **Research on the effect of hybrid contracts in the determination of the LoD**
   Last but not least, an interesting research would be to investigate the influence of hybrid contracts on the determination of the LoD. This research dealt with integrated and life-cycle contracts, but a new form is emerging. Hybrid contracts have the basis of the UAV-GC 2005 but follow the RAW systematic for the tender specification. This development answers to the pros the RAW and the integrated forms offers that the contracting authorities want. However what will this mean for the determination of the LoD?

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Appendices

Appendix A Pilot study

Purpose of the pilot study

The reason why a pilot study was conducted is due to the abstract graduation assignment. From the engineering company Witteveen+Bos there was a need to gain more insight on the decision-making process of the client together with the design process of the consultant. The engineering company felt that the dialogues between the client and the consultant were not going smoothly and observed an area if tension in this phase, however W+B could not pinpoint the exact problem. Therefore the first move was to conduct an empirical study in order to locate the exact issue(s).

The method of the pilot study

The method of this empirical study is based on an inductive qualitative research. Meaning that the researcher does not start his/her research from a theoretical analysis, but from the reality, the empirical. Without much theoretical study, the researcher starts to study the concrete reality. Subsequently the researcher tries to discover, step-by-step, certain regularities in reality, to then write these regularities in the form of a theoretical argument.

The case studies have an explorative nature. According to Yin (2003, pp. 22,29) even an explorative cast study should be preceded by statements about:

- What is to be explored
  In this case: the perceived tension in the plan development phase between the client and the consultant regarding the decision-making process of the client and the design process of the engineers in projects based on UAV-GC
- The purpose of exploration
  In this case: finding out what the tension field is
- The criteria by which the exploration will be judged successful
  In this case: Common area of tension field in all three UAV-GC case studies

Conducting the pilot study

Four case studies were used as starting point. These were not randomly chosen to start with. The characteristics of the case studies were based on the fact that:

- W+B is/was involved in the plan development phase
- The principal is a public organisation (RWS/municipality)
- Three cases based on UAV-GC, nonetheless one RAW project was intentionally chosen as a counterpart

Because the goal of this pilot study was to investigate the exact issue(s) the interviews were not specific topic-wise, however they were specific regarding the development phase and the engagement between the client and the consultant. Interviews were held with relevant individuals from the client side, in order to observe if there is a tension field at all in the client-consultant engagement and if so what the tension field is. The tables below show the respondents and their observations on the issues:

Case		Respondents	Detected issues from the perspectives of the respondents
A9 Amstelveen (B-H)	UAV-GC	Project control manager Manager plan study	▪ **RWS must not specify in detail towards the market, which is experienced difficult to do and to find compliance in** ▪ Communication lines are chaotic ▪ Different interests in the hierarchical organisation, not one objective ▪ New legislations are often a bottleneck ▪ RWS and consultant are still searching for a right way to implement BVP and SE ▪ Different expectations regarding the noise barriers ▪ **Lot of discussion on the right level of detail of the tender specification** ▪ **Different interests regarding the level of detail** ▪ Engineering company not making enough use of the knowledge of RWS advisors (tension field because of BVP) ▪ Insufficient analysis on what was to be expected from the environment

			▪ The plan of approach stated that RWS can lodge for advice by own initiative, nonetheless attention to this matter from the W+B side did not go smoothly ▪ No clarity at the start of the tender specification and what was going to be outsourced

Case		Respondents	Detected issues from the perspectives of the respondents
ZuidasDok	UAV-GC	Technical manager Technical manager of the assets of Amsterdam	▪ The design process was taken place rapidly instead of first looking at the requirements process or stakeholder analysis ▪ No proper implementation of SE at the start of the project ▪ Client requirements came in continually disturbing the iterative process ▪ Abstract tender specification ▪ Municipality of Amsterdam little experience with SE ▪ Too much requirements, no overview ▪ Most network operators were not used to formulate the wishes textual, they preferred drawings ▪ **Level of detail was difficult to determine leading to many (contractual) discussions** ▪ Going from reference design back to formulating the requirements was considered difficult by the engineering firms ▪ Engineering firms find it too tempting to engage in designing instead of specifying

Case		Respondents	Detected issues from the perspectives of the respondents
A9 omlegging Badhoevedorp	UAV-GC	Technical manager	▪ Insufficient stakeholder analysis ▪ Stakeholders found it difficult to ask the right questions without details or drawings. The design workshops of W+B were a good instrument, but still too highly abstract ▪ **Functional specification too often leads to an abstract tender specification and discussion on the level of detail** ▪ The contractors were satisfied with the specifications, however the question is *are there enough requirements to keep the stakeholders satisfied?*

Case		Respondents	Detected issues from the perspectives of the respondents
Utrecht CU2030 HOV-Viaduct	RAW	Manager realisation infrastructure & public space Project manager infrastructure & public space	▪ Insufficient interface analysis with the surrounding environment, a risk analysis should have been conducted earlier ▪ The design was too quickly conducted, instead one should conduct a requirements or stakeholder analysis ▪ Insufficient exploration of the environment by the consultant ▪ Tender specification from the principal side was insufficiently formulated

Analysing the pilot study

In the observation on the findings several issues were detected. The most relevant one for the plan development phase and in the client-consultant engagement was the issue regarding *the discussion on the level of detail (LoD)*. The discussion on the LoD however was not detected in the RAW case study (Utrecht CU2030 HOV-viaduct), because in the light of RAW, one specifies in detail and outsources the works to the market. This will leave no room for discussion on the LoD.

The level of detail of the specification was experienced difficult to determine in practice. Reasons by the respondents had to do with complying with the stakeholder's wishes and requirements, the risks of the client and giving design freedom to the market. In the analysis on the ZuidasDok the technical manager also stated that the discussion on the LoD creates an area of tension because it also states the amount of work that needs to be done, which in turns relates to the contractual relationship between the client and the consultant. Nonetheless if one wants to stay on a high level of specification, it does not mean that one does not have to elaborate in the specification process, because you still want to know what you want to keep on a high level of abstraction. In the analysis on A9A (B-H) the project control manager stated that RWS itself had difficulty with prescribing abstractly, due to the different interests internally. Technical managers tend to describe in detailed specs, while the project control manager with its focus

on the budget wants the tender specification to be in less detailed specs. Last but not least the technical manager of the A9 omlegging Badhoevedorp, argues that functional specification too often leads to an abstract demand and also to solutions proposals they do not want. The margin in which the solution can be found is too large. He would rather see a smaller margin by specifying the technical requirements and therefore also in a lot of detail, and have the discussion with the market on it afterwards.

Conclusion of the pilot study leading to the graduation research

The tension spotted in the three UAV-GC cases regards the discussion on the level of detail in the tender specification. Project teams struggle for different reasons in the process of determining the level of detail as mentioned above. The empirical study revealed the presumption that the determination of the LoD is considered to be difficult, but why is this the case? Leading to the main research question: **What are the causes of the difficulties in the determination of the level of detail of the specification in integrated contracts of large infrastructure projects?**

Appendix B Building organisation form

The building organisation form is the manner in which the tasks are divided amongst the participants in the building process. Nonetheless the choice for a building organisation form is not the same as choosing a contract form. The contract concerns the legal establishment of the contractual agreements made between the participants.

Different types of building contract model

The choice for a building organisation form answers the questions who is going to perform which tasks, regarding:

- The design of the project (design or engineering)
- Execution of the project (build or construct)
- Acquisition project finances (finance)
- Provision long-term maintenance and management of the actual construction process (maintain)
- Exploitation of the actual construction process (operate)

In most cases the market always conducts the execution. There are three common building contract models in the Netherlands, which will be elaborated below:

1. *Traditional building contract model*

   This is the most common form of procurement in the civil engineering, also known as the Bid-Build model. The client is herewith responsible for the design and for the provision of the tender package. The specifications are written with the aid of a standard system, e.g. RAW (CE) or STABU (building industry), on the basis of descriptions of the works detailing 'output performances'. Here another distinction can be made in the traditional form and the building team. In the traditional model the design, execution and maintenance are separated executed and the contracting authority tenders the contracts to various market parties for parts of the construction process. The building team is a variant of the traditional model, in addition to the various contracts; a construction agreement is closed between the contracting authority, the architect or consulting engineer and the construction contractor. This form is still used when one is looking for a strong cooperation between the contracting authority and the executing party. This form is attractive to the performing party because the client often still takes the risks and the financial consequences.

   The traditional building contract model is based on the legal framework UAC 2012 (Dutch: UAV 2012, Uniforme Administratieve Voorwaarden). This is the most common used general condition for contractors in the Netherlands. The UAV was written for the so-called *traditional legal relation*, or in other words the *classic triangle* (Dutch: klassieke driehoek). The classic triangle implies an agreement for the design with an architect/consultant based on the DNR 2011 (Dutch: De Nieuwe Regeling 2011) and subsequently an UAV 2012 based contract with the contractor (A. A. Boot & Chao-Duivis, 2012, p. 67).

   In figure 15 the structure of an UAV 2012 contract is visualised. In short the contract consists of three parts: the general part, the description and the standard provisions. As can be seen from figure 16 the contract has a part with the technical provisions, which is the most important difference from the integrated models.

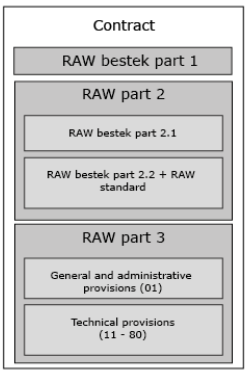

Figure 15 Structure of an UAV 2012 (CROW, 2016)

2. *Integrated building contract model*
In the integrated building contract model, both the task of execution as well as another task is being outsourced to a single party. The contracting party motivates its choice stating that the tasks can be better coordinated this way. In the most familiar basic form it involves the integration of the design and the execution tasks. The most common forms of integrated contracts are:

- D&C (Design & Construct), where the design and the execution works are integrated. A large part of the design is executed by the contractor
- De Ridder (2009) also emphasizes on the Design-Build (also know as the D&C in the Netherlands) contract with repayable performance. According to de Ridder this is the only option that meets the requirements whereby the risk is allocated in such a way that it can be controlled in the best possible way.
- E&C (Engineering & Construct), where the engineering and the execution works are integrated. The client or the client's advisor executes a large part of the design, in this case the contractor works out the detailing
- Turn-key contracts, where the client does not provide any design at all, but only the program of requirements will be the basis of the contract

3. *The lifecycle building contract model*
This model not only combines the design and the execution but is also responsible for the maintenance or exploitation, for example

- DBM (Design, Build & Maintain), where the design, execution and maintenance are integrated
- DBFM (Design, Build, Finance & Maintain), where the design, execution, maintenance and the financing are integrated
- DBFMO (Design, Build, Finance, Maintain & Operate), where the design, execution, maintenance, financing and the exploitation are integrated

A special form procurement is the alliance building contract model
The traditional and the integrated model are similar in their clear task division. The contracting authority and the market party each have their own individual factual and legal responsibility for the tasks they are to perform separately. In the traditional model there are more responsibilities and risks for the contracting authority than with the integrated form. However, in the alliance form the contracting authority and the market party carry out one or more tasks together and therefore share the associated risks.

This form is often used in combination with an integrated model and is often limited to a task where the risks are insufficiently to oversee and no party benefits from bearing the risks, nor from pushing the risks to another party. In rare cases a joint company is set up, which performs all the tasks of the building process, also called an institutionalized PPP or IPPP.

Table 45 below gives a broad overview of the contract forms, the role of the contractor and the accompanying design process. The processes that the client takes responsibility for are left white in the table.

Project phases	Initia-tive	Feasi-bility	Defini-tion	Design				Realisa-tion	Mainte-nance	Exploi-tation	Fi-nance
				Conceptual design	Prelimina-ry design	Final design	Detail design				
Contract form and the role of the contractor											
Traditional											
Building team											
E&C											
D&C											
Turn-key											
DBM											
DBFM											
DBFMO											

Table 45 This table is based on Moonen and (Rijksoverheid, 2015)

Advantages and disadvantages of the different building organisation forms

The building organisation forms and their related contract forms bring several pros and cons in their use. De Ridder (2009, pp. 49-55) mentions the following:

Traditional model / Bid-Build
Advantages
▪ The detailed and standard clauses hardly give any reasons for discussion ▪ The parties clearly know their position, tasks, authorities and responsibilities ▪ It offers good checking possibilities
Disadvantages
• The strict separation of design and construction stages causes a 'slowdown' effect on the building process ▪ The expertise of the contractor can only be used in the construction / execution stage ▪ There is a high chance of additional works arising as a result of the inadequate 'turning' of design and construction ▪ In case of complex projects this procurement model can lead to unacceptably high costs of additional work that can lead to serious conflicts between client and contractor

Table 46 Traditional model /Bid-Build pros and cons based on De Ridder (2009)

Integrated contract / D&B (also known as D&C in the Netherlands)
Advantages for the *employer* ▪ Time and quality can be gained by integrating detailed design and construction ▪ The client only deals with one party, which makes the relations much simpler between the parties involved in design and construction ▪ Fewer discussions about responsibilities and liabilities. The design partner cannot say any more that the construction is badly done, and the construction partner cannot say any more that the design is poor ▪ Execution of the works is improved. This appears as follows; the design and works preparation are fully defined by the construction process, which means that: ▪ Design is aimed at efficient method of construction, which means that: ▪ Standardisation can be pursued so that ▪ In the design, use of modular components and elements is maximised because they simplify production, transport and assembly ▪ In the design a better account is taken of the construction conditions on site (unnecessary complexity is avoided, construction time can be shortened considerably if the final stages of design overlap with the early stages of construction, consultancy costs can be reduced and cost and time estimates are more reliable
Disadvantages for the *employer* • The number of companies capable of performing DB tasks is not that large implying that the number of competing companies is not that large as compared to the traditional construction industry. This could lead to price consequences • The employer is, already in an early stage, legally bound to adhere to contractual conditions (including financial regulations). This is in contradiction with the desire, in the early stages of a project, to have certain freedom of action because a number of aspects still are vague in nature • In general it is difficult to attain the desired balance between construction costs and running cost
Advantages for the *contractor* • For the construction company, accepting a DB contract could be a help to profile itself for a strategic market position, because the number of companies that are competent in this field is restricted • The contractor can increase his technical ability to deal with problem solving • 'Project harmony' is improved. First of all because there only two player; and secondly, it becomes possible to bring together in one organisation 'design culture' and 'construction culture'. The latter is not easy though
Disadvantages for the contractor • The most fundamental difference between DB and the traditional procurement model concern responsibilities. Traditionally the contractor is only responsible for the costs actually made; whereas in DB the contractor also becomes responsible for the (estimated) cost. However, this is not yet clear to everyone. In most cases the design stage, preceding the construction stage, is not considered to be very important, fortunately not costing a great deal of money and which must be finalised as soon as possible. What is not commonly realised is that the largest uncertainties actually arise during this stage. Subsequently, most of the risks can be found here.

Table 47 Integrated contracts / D&C pros and cons based on De Ridder (2009)

Professional literature state that the most important advantage for the employer is the transferring of risks to the contractor with the integrated approach. However de Ridder (2009, p. 54) argues that this is incorrect. Because a DB procurement is merely a form task distribution and does not answer how risks should be distributed between the parties involved. The distribution of risks depends on a certain reimbursement system and many options exist here, ranging from DB cost plus to DB fixed price contracts and everything in between.

Appendix C Systems theory and Systems Engineering

In this appendix a brief background will be given on the systems theory where Systems Engineering stems from, to start with, with the need for classification.

The need for classification

In the construction sector there is a need to find a means to facilitate communication among actors in a field of practice, which is through classification. Classification plays a major role in the construction industry for inter alia structuring information in specifications and structuring of documents (Ekholm, 1996). According to Ekholm (1996, p. 6) the purpose of classification is to distinguish between the objects in a collection. In order to design a grounded classification, the criteria is that every object in the collection must be assigned to a class, and in order to be definite each object may only belong to one class. If this is not the case, than classes are not properly defined. Magee & de Weck (2004) emphasizes the need for classification of complex systems as well. First of all from an academic perspective stating that classification framework has often been a major step forward and a significant accelerator of development of the field. Second, a framework of complex system may help delineate the "intellectual boundaries" of engineering systems. Last but not least to contribute to the engineering and design of such systems. However to classify is not to build a theory, "classifications summarize and order available knowledge" (Bunge, 1983). Bunge states that in order to create deep classifications, one needs theories, the deeper the better.

In civil engineering one uses Systems Engineering to manage a system / project, this kind of thinking comes from systems theory. "*System thinking is a holistic philosophy capable of uncovering critical system structure such as boundaries, inputs, outputs, spatial orientation, process structure, and complex interactions of systems with their environment" (Parnell et al., 2011, p. 11).* Pioneers from the systems theories include Ludwig von Bertalanffy (biologist), Kenneth Boulding (economist), Anatol Rapoport (mathematical psychologist), Kurt Lewin (psychologist) etc. (Laszlo & Krippner, 1998, p. 2). In the current world there is a leading three-fold distinction of system ideas: hard systems approaches (Systems Engineering), soft systems approaches (humanistic psychology), and mixed systems approaches (operations research). The classification of systems into hard and soft draws attention to the degree of knowledge about a system and the system's aims or purposes. Hard systems are easier to define and have more clear-cut aims or purpose. This is typically the subject matter of engineers concerned with real-world problem solving: mechanisms, machines, aircraft, and power plants are examples. Although the purpose can be put in simple terms that does not necessarily apply to the ease of design, operation, or maintenance. Hard systems can be highly complex. On the opposite side are the soft systems characterized by human beings as principal component. These systems can be defined as difficult, no clear-cut and agreed aims or purposes. These include multiple processes of perception, representation, communication etc. (Laszlo & Krippner, 1998, pp. 15-16).

The philosophy of system thinking as described above underlines a Systems Engineering thought process based on the belief that the study of the whole should come before that of the parts, recognizing that there are system level behaviours, interactions, and structural attributes that are not present when the system is decomposed into its elements. Parnell et al. (2011, p. 30) argue that this distinguishes Systems Engineering from classical engineering whose thought process is founded on the principle of decomposition as the basis of understanding. This philosophy has become vital when addressing modern systems whose size and complexity were not feasible less than a decade ago. Systems of Systems Engineering, model-oriented Systems Engineering, and techniques for designing complex systems were all emerged from the Systems Engineering community in response to this growing challenge. None of these approaches and their associated methods would exist in the absence of systems thinking.

Appendix D The systematic levels of Perrow

In this appendix a brief background will be given on the systematic levels as defined by Perrow (1984).

Perrow normal accident theory: the systematic levels

In literature different authors and institutions have made classifications of hard systems. Within this domain the creative thinkers are the social scientists such as Charles Perrow. In his book "Normal accidents: Living with High-Risk Technologies" (1984) Perrow investigates different case studies on air traffic, marine traffic, chemical plants, dams and especially nuclear power plants according to their riskiness in order to characterize complex technological systems. He defined a framework for the classification of accidents. Perrow proposes a division of the system into four levels of increasing aggregation: units, parts, subsystems, and system (the four levels of complexity). What extends beyond the overall system belongs to a possible fifth level, the system environment (Change, 2013, pp. 170-171). Depending upon the systematic level, the specific degree of complexity entails a variety of risks. Herewith he makes a distinction between accidents and incidents regarding the failures of a complex system and linked it to the four levels. Incidents involve damage to or failures of parts or a unit only, even though the failure may stop the output of the system or affect it to the extent that it must be stopped. Accidents involve damage to subsystems or the system as a whole, stopping the intended output or affecting it to the extent that it must be halted promptly. The incidents and the accidents at the various levels manifest into differing outcomes of qualities and magnitudes for the system environment. According to Perrow's theory, the system accidents are the ones considered "normal accidents", since they cannot be prevented. Nonetheless it must be emphasized that despite their name, the normal accidents are an exceptional, rare kind of accidents. Below two tables are presented to summarize the aggregation levels and the event classification of Perrow.

1. Aggregation level: identifies the level of the event according to the system involved

Levels	
Part	Is considered as the smallest component of a system, for example a valve
Unit	Is a functionally related collection of parts, for example those parts constituting a steam generator
Subsystem	Is an array of units, for example the union of a steam generator and the water system
System	When different subsystems come together, then we have a system, like a nuclear power plant

Table 48 Aggregation level (Perrow, 1984)

2. Event classification

Events	
Incident	Involves damages to parts or unit (whether the failure disrupt the system or not)
Accident	Is a failure in a subsystem or in the system as a whole
Component failure accident	Involves one or more component failures (part, unit or subsystem) that are linked in an anticipated sequence
System accident	Involves the unanticipated interaction of multiple failures

Table 49 Event classification (Perrow, 1984)

Perrow designed his systematic levels on the basis of failures of systems (accidents and incidents). His classifications take mainly into account the technological systems and the way they work. Humans are considered as part of the system and they constitute a part, a unit, as well as a subsystem.

Among the systematic levels, processes and elements, there are closely knit junctions and bifurcations, functional links, feedback loops and shifts from linear to complex interactions. This is another important aspect in Perrow's theory in his analysis of organizational handling of risks, which he defined by means of two dimensions in analysing systems: *interactions* and *coupling.*

- *Interactions (linear/complex)*
  Perrow states that systems are not linear or complex, strictly speaking, only their interactions are. Linear systems have very few complex interactions, while complex ones have more linear ones, but complex interactions are still few in number. Linear interactions are those in expected and familiar production or maintenance sequence, and those that are quite visible even if unplanned. Complex interactions are those of unfamiliar sequences, or unplanned and unexpected sequences, and either not visible or not immediately comprehensible (Perrow, 1984, p. 78). Below a table is shown with summary terms linked to the complex and linear systems:

Complex systems	Linear systems
Proximity	Spacial segregation
Common-mode connections	Segregated connections
Interconnected subsystems	Segregated subsystems
Limited substitutions	Easy substitutions
Feedback loops	Few feedback loops
Multiple and interacting controls	Single purpose, segregated controls
Indirect information	Direct information
Limited understanding	Extensive understanding

Table 50 Complex and linear systems (Perrow, 1984, p. 88)

- *Coupling (tight/loose)*
  In the table below the differences between tightly coupled and loosely coupled systems have been summarized:

Tightly coupled systems	Loosely coupled systems
Delays in processing not possible	Processing delays possible
Invariant sequences (e.g. B must follow A)	Processes are alterable
Only one method to achieve goal	Alternative procedures or approaches are possible
Little slack in resources	Materials, equipment and personnel are available with ore or less great leeway
Buffers and redundancy have to be present by design	Buffers and redundancy are available through chance circumstances
Substitution of resources has to be designed in	Materials, equipment and personnel can be replaces as required

Table 51 Tight and loos coupled systems (Change, 2013, pp. 170-171; Dorner, 2014, pp. 35-36; Perrow, 1984, pp. 72-96)

  It must be noted that these are tendencies. No system has for example absolutely invariant sequences. Nor is a system likely to have all of the various characteristics.

To sum up Perrow completed his analytical work by means of defining accidents, distinguishing them from incidents: defined various classes of victims in a way that allows to be better assess catastrophic potential; defined system and component failure accidents; and defined the two key concepts, types of interaction (complex and linear) and types of coupling (loose and tight), which are the system characteristics. By laying out the variables the organizations or activities could be located. This resulted in the interaction/coupling chart (I/C chart) below where systems have been placed based on Perrow's judgements.

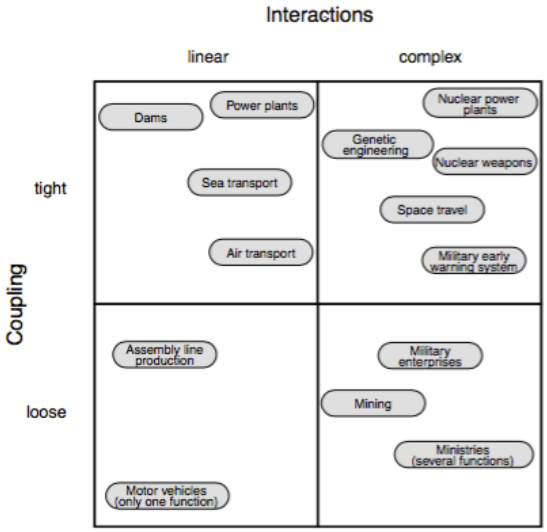

Figure 16 I/C chart by Perrow (1984)

The infrastructure projects with high-risk technologies Perrow investigated are the rail transport, dams, sea transport and air transport (see I/C chart). However in this research the aim is to provide a framework for dry infrastructure within an urban context. This contemplates inter alia highways, viaducts, bridges, public transport and public transport terminal. This has not been investigated nor placed by Perrow considering the technology used in these project are not as high-risk as for example with nuclear power plants.

Appendix E List of elements from literature

Keywords		Elements	Author	Type of source	Rephrased / clustered
Level of detail		Project complexity	Kalin et al 2010	Book	Project complexity
		Quality			PM Aspect GROTK
Level of detail		Organization (geographical)	Wiegers 2006	Book	PM Aspect GROTK
		Market			Market aspects
		Customer involvement			Stakeholder
		Knowledge and expertise			Client's characteristics
		Package solution			x
Specification detail		Goals and expectations of client	AIA 2000	Book	Client's ambition
		Understanding project requirements			x
		Knowledge and skills			Client's characteristics
Level of detail		Complexity and size of project	BIS 2010	Guideline	Project complexity
		Scope			Project complexity
		Drivers			x
		Scale			x
		Amount of expenditure			x
		Risks			PM Aspect GROTK
		Number of stakeholders			Stakeholder
Level of detail	Internal context	Organizational	Jansen 2009	Guideline	PM Aspect GROTK
	Internal context	Financial			PM Aspect GROTK
	Internal context	Policy			PM Aspect GROTK
	Internal context	Knowledge, experience and capacity			Client's characteristics
	External context	Market			Market aspects
	External context	Politics and society			Environemtal aspects
	External context	Laws and regulations			Juridical aspects
	Project context	Money			PM Aspect GROTK
	Project context	Time			PM Aspect GROTK
	Project context	Quality			PM Aspect GROTK
	Project context	Influence on the project			PM Aspect GROTK
	Project context	Complexity			Project complexity
	Project context	Risks			PM Aspect GROTK
Level of detail		Wish of client	Pianoo 2016: vraagspec in GWW	Website	Client's ambition
Level of detail		Scope	Group 2011	Website	Project complexity
		Goals			Client's ambition
Building organization form		Project type	Roelofs 2005	Book	Project type
		Project complexity	ONRI		Project complexity
		Technical level			Project complexity
		Including/excluding management and/or maintenance			x
	Project	Finance			PM Aspect GROTK
	Project	Specification (functional/technical)			x
	Project	Landowner			x
	Project	Time			PM Aspect GROTK
	Project	Market situation			Market aspects
	Project	Division ability of the works into parcels			x
	Process	Responsibilities design/realisation			PM Aspect GROTK
	Process	Risk allocation			PM Aspect GROTK
	Process	Process responsibility			PM Aspect GROTK
	Process	Drivers (cost/value)			PM Aspect GROTK
	Process	Cost settlements (lump sum, unit cost or fee +)			PM Aspect GROTK
	Parties	Client type			Client's characteristics
	Parties	Expertise client			Client's characteristics
	Parties	Desirability of early price certainty by the client			Client's ambition
	Parties	Ability to make decision and implement changes			PM Aspect GROTK
Building organization form		Scope	Pianoo: afwegingsproces bouworganisatievorm	Website	Scope
		Projectcomplexiteit			Project complexity
Procurement strategy / contract type		Decision maker's knowledge, experience and intuition	Antoniou 2013	Scientific article	Client's characteristics
		Project complexity			Project complexity
Procurement strategy		Government directive	Ojo 2012	Scientific article	
		Project risk sharing and allocation			PM Aspect GROTK
		Project technicality (type/complexity)			Project type & complexity
Procurement strategy		Project time, cost and risk profile	Love et al 2008	Scientific article	PM Aspect GROTK
		Project value			PM Aspect GROTK
		Project complexity			Project complexity
		Market forces			Market aspects
		Location (area/geography)			Environmental aspects
		Client knowledge, maturity and control			Client's characteristics
		Refurbishment/new project			x
		Political considerations			Environmental aspects
		Project quality			PM Aspect GROTK
		Stakeholder integration			Stakeholder
		Client's needs			Client's ambition
		Industry culture			Market aspects
Procurement strategy		External factors	Davis 2009	Report	Environmental aspects
		Client characteristics			Client's characteristics
		Project characteristics			Project complexity
		Ability to make changes			PM Aspect GROTK
		Cost			PM Aspect GROTK
		Time			PM Aspect GROTK
Procurement strategy		Project requirements in terms of time, money and quality	Hagemann 2002 (RWS)	Report	PM Aspect GROTK
		Conditions			x
		External factors			Environmental aspects
		Juridical aspects			Juridical aspects
		RWS-organizations			PM Aspect GROTK
		Market aspects			Market aspects
		Maintenance			x

Elements	Occurence in literature: LoD / specification detail	Occurence in literature: Building organization form / Procurement strategy	Total occurence in literature
Project complexity	4	5	9
PM aspects GROTK	5	6	11
Market aspects	2	3	5
Stakeholder	2	1	3
Client's ambition	3	2	5
Client characteristics	3	4	7
Environmental aspects	1	3	4

The ones only occuring once/twice or the ones that could not be grouped are left out			
Project type	0	2	2
Juridical aspects	1	1	2

Appendix F Jansen's model

Interne context		Externe context		Projectcontext	
Invalshoek	Aspect	Invalshoek	Aspect	Invalshoek	Aspect
Organisatie	Organisatie-Structuur Organisatie-Cultuur	Markt	Kennis en ervaring Capaciteit Vertrouwen Bouwcultuur	Geld	Beloningssystematiek Prijs/kwaliteit-verhouding Prijszekerheid
Financiën	Wenselijkheid van private financiering Toegepaste begrotingssystematiek Lage beheers-Kosten	Politiek en Maatschappij	Draagvlak voor project Invloed politieke dynamiek Invloed besluitvorming Grondpositie	Tijd	Gewenste fasering Gewenste doorloop-tijd Tijdzekerheid Fase waarin project zich bevindt Gewenste contract-duur
Beleid	Uitbestedings-Beleid Behoefte stimuleren innovatie Voorgeschreven producten, leveranciers, adviseurs	Wet- en regelgeving	Ruimtelijke ordening Aanbesteding	Kwaliteit	Kwaliteits-Garantie Architectonische en ruimtelijke kwaliteit Belang van onderhoud
Kennis, ervaring en capaciteit	Werkzaamheden zelf uitvoeren Werkzaamheden controleren en Sturen			Invloed op het project	Detailniveau vraagspecificatie Gewenste invloed Bevoegdheid projectorganisatie
				Complexiteit	Product Proces Gewenste scope Uniciteit Optimalisatie-potentieel
				Risico's	Risicobeheersing

Figure 17 Aspects to consider according to Jansen (2009, p.87)

Appendix G Explanation indicators

This appendix shows the summary of all the dimensions and its indicators based on findings in literature. Several indicators have been mentioned explicitly by authors in relation to its relevant level of detail and/or building contract model (traditional/integrated/life-cycle). Nonetheless other indicators, where no explicit relation was to be found, are inspired on literature.

Element: Client aspects

Dimension	Indicator	Explanation	Based on author / source
Type of client	Professional or incidental client	This indication is based on the knowledge and experience the client has. An incidental client is often unfamiliar with the building process, while the professional client will have more knowledge and experience with conducting projects and the project's processes. The knowledge and experience is herewith based on the project that will be conducted, and if the client has done a similar project in the past.	Boot et al. (2014) and Pries et al (2006)
	Public or private client	Public client is considered here to conduct a project for the public use and has often a collectively decision-making process. The public client, government, is a non-profit organisation and works for the public interest. The private client conducts projects for its own use and in most cases has a delegated decision-making process.	Boot et al. (2014) and Pries et al (2006)
	Knowledge & experience	Knowledge & experience regard to the project or a similar project to be conducted.	Boot et al. (2014) and Pries et al (2006)
	Knowledge & experience regarding functional specification	Functional specification aims for a solution-free specification, and describes on every level of detail (LoD) the functions that must be realised and which requirements it must meet. Making a proper functional specification requires knowledge and effort.	Boot et al. (2014)

Dimension	Indicator	Explanation	Based on author / source
Client's ambition	Aesthetic / spatial integration	The aesthetic/spatial integration of infrastructural projects is expressed here as the design and the integration with its environment/surroundings	Behesti (1999) and Sasaki Jonny Klakegg & Haavaldsen (2011) Empirical study
	Sustainability	Sustainability touches upon the well-being of future generations not to decline and regards the social, economic and environmental dimensions. Sustainability covers largely the environmental dimension. In practice there is not one definition for infrastructural sustainability. If the sustainability ambition is high and made explicit, the indicator is considered to be important.	Jansen (2009)
	Innovation	Innovation is often viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. The term "innovation" can be defined as something new with high-level of originality that breaks into society and the market. If innovation is desired than less detailed specs are an important factor contributing to that aim. An integrated approach may also be required when there is a need for innovation in order to reuse the lessons learned for further innovative endeavours.	Van Valkenburg et al. (2008)

Dimension	Indicator	Explanation	Based on author / source
Client's influence	Translation to functional requirement	The ability of translating the expectations and wishes to functional requirements by the client is an important indicator to go or not go for an integrated approach whereby the client can procure on a high level of abstraction.	PIANOo (2016f) and Boot et al. (2014)
	Willingness to let go regarding setting requirements	The willingness to let go of specifying relates to how much control the client wants to keep. If he is willing to let go of specifying, he will specify on a higher abstraction level. If it is not the case he will specify on a low level of abstraction, thus in much detail.	PIANOo (2016f) and Boot et al. (2014)
	High abstraction of the level of detail	If there is already a (part of) the specification, whether this is of high or low abstraction level.	Based on logic reasoning
	The need to monitor	If there is a lot of need to monitor in order to realise the desired ambition/concept/policy the client would usually go for the traditional way of procuring, thus more into detail. As the traditional model offers good checking possibilities.	De Ridder (2009)

Element: Project aspects

Dimension	Indicator	Explanation	Based on author / source
Technical complexity	Newness of technology	Newness of technology will be referred to as the application of scientific knowledge for practical purposes, such as the development of machinery and devices.	Bosch-Rekveldt (2011) Jansen (2009)
	Experience with the technology	The experience with technology refers to the experience of the project team regarding the to be used technology, concerning the procedures and management of it as well.	Bosch-Rekveldt (2011)
	Requirement of special equipment/technology	If a project such as the drilled tunnel requires a specific technology, than this must be taken into account. Because it will also require a special kind of knowledge and in most cases it will be outsourced.	Bosch-Rekveldt (2011) Jansen (2009)
	Technical risk	Higher technical risks coincide with higher quality requirements, more uncertainties in methods, application of new technology, lack of experience with technology, interface problems, higher organizational risks and occurrence of interference with the existing site	Bosch-Rekveldt (2011) Sebastian & van Gelderen (2007)

Dimension	Indicator	Explanation	Based on author / source
Organizational complexity	Experience with parties involved	If the size of the project team is large and composition varies than it can be assumed that communications lines will extend and therefore it is more logical to specify into more detail. However if there is experience with the involved parties it will make it easier to understand each others working method.	Berggren et al (2001) Baccarini (1996) Wiegers (2006)
	Organizational fragmentation	Organizational fragmentation here is meant that tasks are divided amongst different organizations, different disciplines and operating from different locations. The composition of the project teams influences the decision-making. With more project team members from the parent company, the communication lines will be shorter and less feedback loops can be encountered.	Berggren et al (2001) Baccarini (1996) Wiegers (2006)
	Organizational risk	The organizational risk entails the planning, coordination, and procedural uncertainties within an organization.	Berggren et al (2001) Baccarini (1996) Wiegers (2006)

Dimension	Indicator	Explanation	Based on author / source
Environmental complexity	Stakeholder's influence	If stakeholder's and political influence is high (high complex environment) than one would logically choose to specify into detail in order to inform the stakeholders and politics. This also depends on whether the principal is able to specify into detail in an early phase or not. If the principal is already able to do so than it can specify into detail and steer in order to integrate the design to the expectations and correspond his ideas too the stakeholders and politics. However, it can also be the other way around. If there are a lot of stakeholders involved, and public support is needed than it is better to specify on a higher abstraction level in order to involve the market to do both the design and execution. In this way the design will correspond more to the outcome i.e. expectations of the stakeholders.	Jansen (2009) Sebastian & van Gelderen (2007)
	Political influence		Jansen (2009) Sebastian & van Gelderen (2007)
	Environmental risk	The environmental risk meant here has to do with the environmental (stakeholders/political) upheaval that can emerge and their influence to disturb the project.	Remington (2016) Sebastian & van Gelderen (2007)

Dimension	Indicator	Explanation	Based on author / source
Cost complexity	Funding	Projects can be either privately or publicly funded. In case of private funding and what the architect specifies is what must be provided by the contractor, without alternate manufactures or substitutions and without substantial descriptions of the installation and quality control provisions, then the level of detail may be low. If the project is publicly funded or will be competitively bid, then greater detail will be necessary.	Kalin et al. (2010)
	Price certainty	When the client determines the specification more into detail, he will get more influence on the building process and therefore also on the outcome and the price. However if the client specifies in less detail, and involves the market with the design process than more price certainty can also be achieved. Because the uncertainty risk will decrease, and therefore price certainty will increase.	Jansen (2009)
	Low management costs	By making the designing contractor responsible for long-term maintenance and optionally the exploitation, he will be stimulated to keep the life cycle costs as low as possible.	Jansen (2009)
	Price / quality ratio	According to theory outsourcing integrated tasks to one market party should lead to a better price/quality ratio. Nonetheless Jansen stresses that this principle is not absolute. Because the choice of a building contract model depends on many circumstances.	Jansen (2009)

Dimension	Indicator	Explanation	Based on author / source
Time complexity	Certainty on the lead time	The traditional model would be a logical consideration if certainty on lead-time is desired, in other words, specifying into more detail. Nonetheless this also correlates to the knowledge and experience of the client. In case of an incidental client, he will not be able to specify into more detail leading to inaccurate estimates and uncertainty on the lead-time. In such case, it is more logical to go for an integrated approach, where the market is early involved, thus the client specifies on a higher abstraction level.	Jansen (2009)
	Continues developments	The long duration of planning and construction means that citizens will have difficulties realising which impact a project will have on their living circumstances. This was made explicit in the case of Canton Uri. Due to the extended timescale, people tend to think the project will not mature and are surprised when the project is executed and impacts heavily on their environment. With a long time frame / lead time the project must be flexible due to the changing context and the project delivery organisation itself. In this case an integrated approach would suit more.	Hertogh & Westerveld (2010)

Element: market aspects

Dimension	Indicator	Explanation	Based on author / source
Type of market and trust in market	Knowledge and experience	An important indication to go for an integrated approach is when the market has a lot of **knowledge and experience** regarding the relevant project. On the other hand when stimulating the innovation in the market is an important aspect, than the client must consider allowing the market to develop the knowledge (in case of insufficient knowledge and experience).	Jansen (2009)
	Knowledge and experience regarding functional specification		
	Readiness for long-term contract	This regards if the market is willing and able to take on a long-term contract. This also relates to the capacity of the market	Boot et al. (2014)
	Trust in the market		Jansen (2009) Kadefors et al. (2001)

Appendix H Conceptual framework to be used for the interviews

Client aspects

Dimension	Indicator	Question in Dutch	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Type of client	Professional or incidental client	1. Is de klant van project X een professionele klant of een incidentele klant?	Incidental	Incidental	Professional	Professional
	Public or private client	2. Is de klant van project X een publieke of private klant?	Private	Private	Public	Public
	Knowledge & experience	3. In hoeverre heeft de klant ervaring en kennis met het desbetreffende of een soortgelijke project?	Low	Average	High average	High
	Knowledge & experience regarding functional specification	4. In hoeverre heeft de klant ervaring en kennis met functioneel specificeren?	High	High average	Average	Low
Client's ambition	Aesthetic / spatial integration	5. In hoeverre is er al een visie op de esthetiek/ ruimtelijke inpassing van het project?	No vision + not stated	Vision + not entirely stated a lot of room	Vision + entirely stated little room	Vision + stated
	Sustainability	6. In welke mate is duurzaamheid belangrijk in dit project?	Highly Important	Important	Average important	Not important
	Innovation	7. In welke mate is innovatie belangrijk in dit project?	Highly Important	Important	Average important	Not important
		8. In hoeverre is er ruimte voor innovatie (methodieken een kans geven die niet eerder zijn toegepast)	Plenty	High Average	Average	Low
		8.1. In welk stadium wordt de aannemer betrokken bij het project? 8.2. Wat is de scope van de markt / aannemer?	Exploratory phase Scope: area	Exploratory phase Scope: area	Draft Route Decision, OTB Scope: building / line infrastructure	Route decision, TB Scope: building / line infrastructure
Client's influence	Translation to functional requirement	9. In welke mate kunnen de ambities vertaald worden naar functionele eisen?	Many	High average	Average	Low
	Willingness to let go regarding functional specification	10. In hoeverre is de klant bereid om het stellen van eisen los te laten?	Very willing	Willing	Not that willing	Not willing
	High abstraction of the level of detail	11. In hoeverre is het detailniveau van de vraagspecificatie hoog/abstract?	High abstraction	High average abstraction	Average abstraction	Low abstraction
	The need to monitor	12. In hoeverre is er invloed nodig van de OG om de ambities, beleid en het concept te bewaken?	No influence required	Low average influence required	Average influence required	Influence required

Project aspects

Dimension	Indicator	Question in Dutch	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Technical complexity	Newness of technology	13. In welke mate wordt er gebruik gemaakt van nieuwe technologieën m.b.t. machines / apparaten t.b.v. de uitvoering?	Many new	High average new	Average new	No new
	Experience with the technology	14. In hoeverre heeft het project team ervaring met de te gebruiken technische toepassingen?	None	Low	Average	High
	Requirement of special equipment/technology	15. Is het gebruik van speciale techniek nodig?	Needed	Needed	Not needed	Not needed
	Technical risk	16. Bent u van mening dat het project een hoog risico (aantal, waarschijnlijkheid en/of de gevolgen van) heeft op het gebied van technische risico's?	High	High average	Average	Low
Organizational complexity	Experience with parties involved	17. In hoeverre hebben de betrokken partijen ervaring met elkaar?	High	Average	Low	None
	Organizational fragmentation	18. In hoeverre is er sprake van fragmentatie in de projectorganisatie	None	Low	Average	High
		18.1. Is er sprake van veel verschillende betrokken organisaties? 18.2. Is er sprake van veel verschillende soorten disciplines in het project team? 18.3. Is er sprake van veel verschillende locaties waar vanuit het project team opereert?	No No No	2x No 1x Yes	2x Yes 1x No	Yes Yes Yes
	Organizational risk	19. Bent u van mening dat het project een hoog risico (aantal, waarschijnlijkheid en/of de gevolgen van) heeft op het gebied van organisatorische risico's?	Low	Average	High average	High
Environmental complexity	Stakeholder's influence	20. Welke strategie past in dit geval het beste bij de mate van invloed van de stakeholders?	High influence (if principal is not able to specify into detail himself, he should involve the market early)		High influence (if principal is able to specify into detail)	
	Political influence	21. Welke strategie past in dit geval het beste bij de mate van invloed van de politiek?	High influence (if principal is not able to specify into detail himself, he should involve the market early)		High influence (if principal is able to specify into detail)	
	Environmental risk	22. Bent u van mening dat het project een hoog risico (aantal, waarschijnlijkheid en/of de gevolgen van) heeft op het gebied van omgevings-risico's?	Low	Average	High average	High
Cost complexity	Funding	23. Op welk manier wordt dit project gefinancierd, privaat / publiek?	Private	Private	Public	Public
	Price certainty	24. In welke mate is prijszekerheid belangrijk?	Important early market involvement		Important more influence on building process by principal	
	Low management costs	25. In welke mate zijn lage beheerskosten belangrijk?	Highly Important	Important	Average important	Not important
	Price / quality ratio	26. In hoeverre is de prijs/kwaliteit verhouding een belangrijk aspect om mee te nemen?	Highly Important	Important	Average important	Not important
Time complexity	Certainty on the lead time	27. In welke mate is er speling m.b.t. de doorlooptijd van het project?	Tight schedule expertise of the market needed		Tight schedule expertise of the market not needed	
	Continues developments	28. Ondervindt het project veel veranderingen/ontwikkelingen in de context en scope tussen initiatie en exploitatie fase?	Many (project flexibility is needed)	High average	Average	Low (straightforward project)

Market aspects

Dimension	Indicator	Question in Dutch	High level of abstraction		Low level of abstraction	
			System	Subsystem	Unit	Part
Type of market and trust in market	Knowledge and experience	29. In hoeverre heeft de markt ervaring en kennis met het desbetreffende of een soortgelijk project?	High	High average	Average	Low
	Knowledge and experience regarding functional specification	30. In hoeverre heeft de markt ervaring en kennis met een functionele uitvraag?	High	High average	Average	Low
	Readiness for long-term contract	31. In hoeverre is de markt bereid om een lange contractduur aan te gaan?	Very willing	Willing	Not that willing	Not willing
	Trust in the market	32. In hoeverre is er vertrouwen dat de markt de capaciteiten heeft om het project tot een goede einde te brengen met inachtneming van de belangen van de klant?	High	High average	Average	Low

Appendix I Interview protocols

Casus:	Casus, locatie
Geïnterviewde:	functie, organisatie
Datum:	tijd, datum
Locatie:	plaats
Codering:	Interview XXX

1. *Uitleg onderwerp aan geinterviewden*
   De huidige ontwikkelingen m.b.t. geïntegreerd samenwerken resulteerde in het gebruik van nieuwe bouworganisatievormen (GC en life-cycle) en de bijbehorende nieuwe manier van ontwerpen m.b.v. Systems Engineering. Hierbij staan functioneel specificeren en op hoog abstractieniveau specificeren centraal.

   Zowel vanuit een empirisch onderzoek als vanuit een literatuuronderzoek is naar voren gekomen dat het komen tot het juiste detailniveau een vrij complexe opgave is. Dit onderzoek richt zich op de mate van specificeren bij publieke infrastructuur projecten waarbij er gebruik is gemaakt van Systems Engineering.

2. *Introductie*
   Dit interview protocol is bestemd voor de interviews in het kader van het afstudeeronderzoek van Iet Fon, masterstudente Construction Management & Engineering aan de TU Delft. Daarbij verricht ik het onderzoek bij Witteveen+Bos met gebruik van hun case studies. Hierbij word ik begeleid door mijn afstudeercommissie vanuit zowel de TU Delft als vanuit W+B. Alle interviews zullen worden afgenomen door de afstudeerder, Iet Fon. Geinterviewden zullen worden geselecteerd op basis van de volgende criteria: onder meer ervaring, huidige functie en het veronderstelde kennis niveau binnen project X m.b.t. de vragen.

3. *Doel van het interview*
   Het doel van het interview is om empirische data te verzamelen welk zal bijdragen aan het beantwoorden van de gestelde onderzoeksvragen. Aan de hand van een literatuur onderzoek is een framework ontworpen met bijbehorende vragen die beantwoord dienen te worden. Met het interview moet de praktijk dilemma blootgesteld worden middels de discrepantie tussen het theoretisch kader en praktijk kader.

4. *Resultaat van het interview*
   Het interview is semigestructureerd, deels op basis van open vragen en deels op basis van gesloten vragen. Het interview levert informatie op over de mening, ervaring en beleving m.b.t. de gestelde aspecten en elementen geformuleerd in het framework.

5. *Verwerking van het interview*
   De interviews worden opgenomen en verwerkt in het kader van het afstudeeronderzoek. De vragen in het framework zullen in de meeste gevallen leiden tot een bepaald niveau (“in hoeverre”, “in welke mate”) van de aspecten/elementen. Waarbij de geïnterviewde het hokje in het framework zal aankruisen die het meest van toepassing is voor het project. Mocht het antwoord niet gegeven kunnen worden dan zal een discussie plaatsvinden.

6. *Privacy*
   Indien de respondenten toestemmen, zullen de interviews worden opgenomen voor academische doeleinden. Alle interviews zullen anoniem verwerkt worden.

Interviewvragen

Het interview zal starten met enkele algemene en inleidende vragen:

- Wat is uw rol binnen dit project?
- Hoe lang bent u al bij dit project betrokken?
- Wat is uw rol binnen uw organisatie?

Het interview bestaat uit twee delen. Het eerste deel bevat de vragen die zijn opgenomen in het framework. Om het proces eromheen te snappen zal ook een tweede set aan vragen gesteld worden m.b.t. het proces van tot een detailniveau komen en hoe het project is gedecomponeerd. Ofwel inzichtelijk krijgen hoe het SE is uitgevoerd.

Deel I interview

Zie Appendix H Conceptual framework to be used for the interviews

Deel II interview

Eisen

1. Wat waren de belangrijkste eisen in dit project die gewaarborgd moesten blijven?
2. Waren er eisen die in eerste instantie niet expliciet waren genoemd maar later wel erg belangrijk waren om rekening mee te houden? Welke consequenties had dit voor het ontwerp proces?

Detailniveau

3. In literatuur worden diverse decompositie niveaus gedefinieerd met SE, zoals systeem, sub-systeem, component en element. Welke decomposities zijn bij dit project gedefinieerd door de OG i.s.m. W+B?
4. Tot welk detail is/zal de uitvraag zijn?
5. Hoe is men gekomen tot dat detailniveau? Hoe is dat proces tot stand gekomen?
6. Was het makkelijk/moeilijk om het juiste detailniveau te bepalen, waarom?
7. Wat waren de belangrijkste leerpunten vanuit dat proces?
8. Wat is uw mening m.b.t. het gestelde detailniveau? Had de OG minder moeten specificeren of meer? En wat dan?
9. Sluit het functioneel specificeren aan bij de behoeftes van dit project?
10. Sluit het gekozen bouworganisatievorm (indien al bekend) aan bij het gestelde specificatieniveau? Of was een andere bouworganisatievorm meer geschikt, zo ja welke?

Framework (validatieronde)

11. Vindt u dat het detailniveau gesteld door het framework overeenkomt met wat het zou moeten zijn?
12. Welke elementen missen er volgens u nog in dit framework?

Afsluiting

Tot slot, zijn er nog vragen die u wel had verwacht maar die ik niet heb gesteld? Bedankt voor het interview. Mocht u geïnteresseerd zijn in het resultaat, dal zal ik u het eindrapport toesturen.