Explaining cost overrun in infrastructure projects

A qualitative comparative analysis (QCA) of cost overrun in road infrastructure projects tendered as a public-private partnership

Source: Dissolve

Master thesis by Joël Goodijk

Faculty of Spatial Sciences
University of Groningen
Environmental and Infrastructure Planning

August, 2019

Explaining cost overrun in infrastructure projects

A qualitative comparative analysis (QCA) of cost overrun in road infrastructure projects tendered as a public-private partnership

Master thesis Environmental and Infrastructure planning
Faculty of Spatial Sciences
University of Groningen

Student name: Joël Goodijk
jgoodijk@gmail.com

Thesis supervisor: Dr. S. (stefan) Verweij
Second supervisor: Prof. ir. W.L. (wim) Leendertse

Internship at Rijkswaterstaat
Afd. Grote Projecten en Onderhoud (GPO) - ICG
Rijkswaterstaat supervisor: dhr. D. (danny) Zwerk

university of groningen

faculty of spatial sciences

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Abstract

Cost overrun is common among infrastructure projects, and can be a result of different causes. There is a research gap in which configuration of conditions have an effect on cost overrun in public-private partnerships (PPPs). The conditions that will be used to analyze the outcome (cost overrun) are: (1) contract type; (2) type of stakeholder management; (3) proper risk allocation; (4) project size. The research method is a qualitative comparative analysis (QCA). In this research, 10 projects from the project database of Rijkswaterstaat were analyzed. The results indicate that D&C contracts in combination with an improper risk allocation and a relative small project size (between €120 million and €410 million) lead to cost overrun. The results also give a solution for cost underrun, consisting of two solution terms. The DBFM contract in combination with process management and a proper risk allocation, and a DBFM contract with a proper risk allocation and a large project size lead to cost underrun. The outcomes are relevant for Rijkswaterstaat, because it confirms the efficiency of the DBFM contract (in combination with other conditions). However, no strong conclusions can be drawn due to the limited amount of cases of the QCA.

Contents

1. Introduction

1.1 Background of the research

Infrastructure, including road infrastructure, is a large expenditure of the national government. Cantarelli, Flyvbjerg, Molin, & Van Wee, (2011) argue that investments in infrastructure are a considerable burden on the national gross domestic product (GDP). The Ministry of Infrastructure and Water Management has spent annually between 7 and 9 billion euro's recent years (CBS, 2018). The executive agency of the national government, Rijkswaterstaat, is responsible for the main road network in the Netherlands.
Flyvbjerg (2003) in Cantarelli et al. (2010b) indicates that in 86% of the infrastructure projects, there appears to be cost overrun, with an average overrun of 28%. In addition, a review by Morris and Hough (1987), which covered about 3500 projects, revealed that cost overruns are the norm, so they occur in most infrastructure projects, and generally range between 40 and 200 percent (Cantarelli et al., 2011). Flyvbjerg et al. (2018) describe cost overrun as the difference between the actual and the estimated costs for an investment. Cost overrun can occur at different phases of infrastructure projects. Verweij, Teisman & Gerrits (2017) argue the relevance of the implementation phase in public-private partnerships. Unforeseen events can occur, and ineffective responses to these events can cause these projects to fail. This can result in cost overrun, time delays, and poor quality. More insight is needed in how cost overrun occurs and which factors influence cost overrun. Cavalieri et al. (2019) argue the relevance of gaining insight into how costs evolve and what their determinants are. This can help to manage project resources more effectively.

Due to the high cost overrun in infrastructure projects, a change was needed to provide infrastructure projects more efficiently. With the rise of the New Public Management (NPM) in the 1990s, there was a change of course, which started in the UK: less governing to more governance (Rhodes, 1996). As a result, the government transferred some services that the government used to deliver to private parties. This was also the case with road infrastructure. The 3E's of economy, efficiency and effectiveness are part of the New Public Management (Rhodes, 1996). Public-private partnerships (PPPs) are a result of this neo-liberalistic turn (Sager, 2011; Yescombe, 2007).
Public-private partnerships are a refinement of private financing initiatives, that describe the provision of public assets and services through participation of the government, the private party, and consumers (Grimsey & Lewis, 2005). Public-partnerships have no single definition. Grimsey & Lewis (2005) argue that the definition of PPPs differs between countries, but a general definition is that PPPs "fill a space between traditionally procured government projects and full privatization". Verweij et al. (2017) p.p. 120, use a broad definition of PPPs: "an enduring contractual relation between two or more partners of which at least one is public body, in which both public and private partners bring some kind of resources to the partnership, and in which responsibilities and risks are shared for the purpose of delivering public infrastructure-based products and/or services". Using this definition gives the opportunity to include different types of partnerships into research in PPPs. For instance, contractual forms with different levels of integration or financing can both be a PPP. However, when thinking about PPPs, the emphasis is often on highly integrated contracts with private financing. For this research, the definition described by Verweij et al. (2017) will be used.

With the idea that private parties (e.g. construction- and engineering companies) would be more effective in the implementation (and later also design) of infrastructure projects, because of their expert knowledge, certain tasks were transferred to these private parties. Chasey et al. (2012) argue that the shift towards PPPs was primarily financial. The idea was that PPPs would create an additional value which only could be achieved by this partnership (E.-H. Klijn & van Twist, 2007).

There are different forms of public-private partnerships. In more traditional forms, the private party was mainly responsible in the implementation stage of the project. In other forms, the private parties are often involved earlier in the process. This gives the private party more responsibility. In the Netherlands, the Design-Build-Finance-Maintain (DBFM) contract is promoted (Verweij, 2017). This type of contract integrates the maintenance in the contract, and is privately financed. The construction company has more responsibilities with this type of contract. The DBFM contract should lead to advantages, such as more efficiency and more quality. But the evidence of the added value for this type of contract or PPPs, compared to a more conventional contract such as Design & Construct (D&C), is lacking (Verweij, 2018).
In practice, it is not always the case that PPPs are performing well. This can result in renegotiations, and even in early contract termination, which causes additional costs instead of the initial reduction of costs (Mladenovic et al., 2013). A pitfall of the DBFM construction is that the construction company has to control a large part of the risks, among which the financial risk. Because, in DBFM contracts, the private partner needs to take out a loan in order to pre-finance the project. Also, most of the project specific risks are transferred to the private party. Therefore, in order for DBFM contracts to be successful, it is important that the private is able to manage these risks.
This also touches upon another important aspect of PPPs: a proper risk allocation. Bing et al. (2005) provides a model for a proper risk allocation (see paragraph 2.4). A proper risk allocation in this research is that the risks are allocated conform this model. The identification and allocation of risks are important in the contractual arrangement (Gordon 1994; Diekmann & Girard 1995, in Zhang 2005). Rijkswaterstaat, the initiator of these DBFM contract forms in the Netherlands, also sees that the high risk private parties bear, can result in financial problems.

It is clear that PPPs do not always lead to the desired outcomes (Verweij, 2015). Also, O'Shea et al. (2019) find no evidence that PPPs leads to faster delivery of infrastructure, and they find limited evidence that PPPs result in better value for money. However, an important goal of PPPs is to be more effective and realize better products and services for less money (value for money). It can also lead to time reductions (Verweij, 2015), better quality (Verweij, 2015), and innovation (Warsen et al., 2018). Both governments and private parties used to be eager to collaborate, because the public sector will be more flexible and can invest in more projects at the same time, and private investors with large cash holdings are looking for stable and predictable returns with low risk (Brown, 2007). However, construction companies bear high financial risks with DBFM contracts, because of the private financing of public infrastructure. In many current (international) infrastructure projects, the government and the private sector share the financial risk (Hodge & Greve, 2017). Minimizing cost overrun will probably cause private parties to be more willing to collaborate in PPPs.
There are multiple views on the evaluation of PPPs. Hodge & Greve (2017) argue that we do not know much about the performance of long-term infrastructure contracts (LITC). There might be underlying mechanisms that influence the performance of these projects. For example, the interrelation of different conditions with each other might have an effect on cost overrun. From a viewpoint of individual relations, this is often difficult to identify, since there might other factors that influence cost overrun. Koppenjan (2005) also argues that it is difficult to find the right organizational forms from comparative studies, since each project has unique factors that influence success or failure. The QCA method resolves the issue of incomparability by focusing on possible configurations of certain conditions which leads to a successful outcome. So, the projects will be compared on the bases of its membership in a few conditions. This research tries to bring more clarity in the effects on cost overrun in PPPs. Cost overrun can be either positive or negative (cost underrun). Four conditions (contract types, stakeholder management, risk allocation, and the project size) will be analyzed for 10 cases in the Netherlands, with different membership in these conditions. This should provide more insight in the advantages of and disadvantages of certain conditions for different types of cases on cost overrun.

1.2 Scientific relevance and connection to theoretical debate

This research elaborates on the article of Verweij (2018) about the lack of proof for the actual benefits of PPPs, and is focusing on cost overruns of infrastructure projects procured as a public-private partnership. Public-private partnerships are popular around the world and have been growing since the last decades (Hodge & Greve, 2017). Public-private partnerships, from a New Public Management perspective, are supposed to lead to more efficiency and are more goal-oriented (E.-H. Klijn & van Twist, 2007). However, cost overrun is still salient in infrastructure projects, several studies showed that the magnitude of cost overrun is the same as in earlier periods (Flyvbjerg et al., 2003; Flyvbjerg et al., 2004; Lind & Brunes, 2014). Also, Flyvbjerg et al. (2004) argue that there is little evidence that private projects would have lower cost overrun than public projects. And O'Shea et al. (2019) find only limited evidence to suggest that PPPs have better value for money. In contrast, a study in Australia comparing a selection of PPP projects and traditional projects, showed PPPs had superior cost efficiency over traditional procurement (Raisbeck et al., 2010).

The three main reasons, according to Flyvbjerg, for the continuous cost overrun are: (unforeseen) technical factors, psychological factors (optimism bias), and political factors (conscious underestimation in early stages of the project) (Lind & Brunes, 2014). Basically, the latter two factors cause the estimated costs to be lower than the actual costs. However, these aspects are related to the phase before contracting. This research is focusing on factors which causes cost overrun or underrun in public-private partnerships. The following conditions will be analyzed in this research whether the configuration of these conditions have an effect on cost overrun: (1) contract type, (2) risk allocation, (3) type of stakeholder management, and (4) project size.

A lot of research has been done on cost overrun in infrastructure projects, but (due to data limitations) different contracting approaches are often not systematically researched (Anastasopoulos et al., 2014). Anastasopoulos et al. (2014) argue that contracting approach plays a role in cost overrun. Integrated long-term contracts, where the contractor is also responsible for the maintenance, are assumed to be more efficient, (Engel, Fischer, & Galetovic, 2011) and sustainable (Lenferink et al. 2013), and thus have a positive relation with cost underrun.

The type of stakeholder management, especially in public-private partnerships, is argued to be important, and have a positive effect on the outcome of the PPP (De Schepper et al., 2014; El-Gohary et al., 2006; E. H. Klijn, Edelenbos, Kort, & van Twist, 2008; Kort, Verweij, & Klijn, 2016; Verweij, 2015). Verweij et al., 2017 argue that stakeholder management in the implementation phase has received little attention in research. However, they state the importance of the implementation phase of a PPP, since projects can still fail during the implementation phase, and thus the implementation phase requires more attention by research.

In PPPs, there are high financial risks which have to be allocated to the parties involved. It is evident that the risks involved in large and complex projects are significant. Because of the complexity of risk allocation in these projects, the risks need to be analyzed and researched thoroughly (Ng & Loosemore, 2007). A proper risk allocation is needed in order to gain more value for money (Ng & Loosemore, 2007).

The relation between project size and cost overrun is disputed (Cantarelli et al., 2012c). According to Odeck (2004) cost overrun is predominant in smaller infrastructure projects compared to larger projects. However, Anastasopoulos et al. (2014) argues that larger projects are generally more likely to have cost overrun, however with Performance Based Contracting and incentives these projects are more likely to result in cost underrun. This already shows the importance of configurational research.

Academics can build upon the results from the outcomes of the QCA or case studies. The outcome is expected to give more insight in the configurational effects of contract types, stakeholder management, a proper risk allocation, and the project size on the cost overrun of PPPs. Since there are few studies that research the configurational effect of conditions on cost overrun, this study aims to fill this research gap.

The results are relevant for planning because it gives insight in the configurational effects of contract types, type of stakeholder management, a proper risk allocation, and the project size on cost overrun of PPPs. Rijkswaterstaat can use the results in order to be improve current methods in infrastructure projects (procurement). Rijkswaterstaat will get more insight in the configurational effect of conditions on cost overrun (and cost underrun).
The results may also be relevant for private parties. Since private parties are aiming for profit, insights in conditions which influence cost overrun are beneficial for them. More efficient infrastructure projects procured as a public-private partnership are important for construction companies who collaborate with Rijkswaterstaat.
The societal relevance of this research is aimed at the financial aspect of public-private partnerships. Infrastructure projects are costly and often they often take longer than planned, and cost more money than expected in the beginning. If infrastructure projects cost less, more money will be available for other sectors or other projects. This research aims to give insight in the relation between different factors and their influence on the cost overrun. The societal relevance would be that road infrastructure PPPs can be made more financially effective. This can also relate to other forms of effectiveness, like time efficiency, or more efficient collaboration between the different parties.

1.3 Research objective

The aim of this research is to evaluate the conditions that may cause cost overrun of PPPs as to provide recommendations to Rijkswaterstaat on the basis of a comparative study on various conditions, which is based on data from the projects database (PDB) of Rijkswaterstaat. The objective is to show associations between configurations of conditions. This research contributes to the scientific debate on the efficiency of PPPs.

The expected results of this research can be relevant for parties who are involved in public-private partnerships. Rijkswaterstaat is an important stakeholder, because Rijkswaterstaat is responsible for the national roads, and some regional roads in the Netherlands. This means that Rijkswaterstaat is almost always involved in road infrastructure projects tendered as a public-private partnership. Insights in the cost overrun and the factors that influence this, would thus be relevant for Rijkswaterstaat. This research is mostly focused on cost overrun for the public party and is therefore mostly relevant for Rijkswaterstaat and the scientific literature on cost overrun in PPPs.

Primary research question

How do contract types, type of stakeholder management, a proper risk allocation, and the project size influence cost overrun of road infrastructure tendered as a public-private partnership?

Secondary research questions

What is the relation between contract types and the cost overrun of public-private partnerships?

What is the relation between stakeholder management and the cost overrun of public-private partnerships?

What is the relation between a proper risk allocation and the cost overrun of public-private partnerships?

What is the relation between project size and the cost overrun of public-private partnerships?

Which configurations of conditions will lead to cost overrun road infrastructure public-private partnerships?

1.4 Research design

First, a literature study was done to create a theoretical framework for this research. The four conditions and the outcome were used as boundaries for this research. In the literature study, the relation between the individual conditions and cost overrun was researched.

After designing the theoretical framework, the data for the conditions 'type of stakeholder management' and 'proper risk allocation' was collected via questionnaires and a few semi-structured interviews. For the conditions 'project type', 'project size' and the outcome cost overrun data was used from Rijkswaterstaat (see 3.3.2).

The conditions needed to calibrated in order to be used for the QCA. To do this, literature was used and cluster analyses for external measures. The QCA method was used to analyze the configurational effect of the conditions on cost overrun.

The QCA method was chosen for this research, because the goal was to get insight in the configurational effect of the conditions on cost overrun. This is expected to give more insight in useful combinations of conditions for Rijkswaterstaat.

1.5 Reading guide

In the next chapter, the theoretical framework will be discussed. There cost overrun and the condition will be elaborated and finally a conceptual model is presented. In chapter 3, the methodology will be explained. Chapter 4 will provide the results from the data collection, and chapter 5 discusses the results.

2. Theoretical framework

In this chapter, the conditions will be discussed and the individual relation between the conditions and cost overrun will be researched. The conditions described in this chapter are the boundaries of this this research.

Infrastructure

In this research, the definition of infrastructure is narrowed down in order to create a certain homogeneity in the context against which cases can be analyzed. Only road infrastructure projects are included, so water related projects are not a part of this research. Also, rail projects are excluded of this research. This has to do with the findings that rail projects have a different performance than road projects (Cantarelli 2012c). Furthermore, infrastructure is limited to roads that are connected to the main road network.

2.1 Cost overrun

The term cost overrun is used in different contexts and has different definitions. Therefore, cost overrun has to be defined for this research first in order to be used in a comparative study. Flyvbjerg et al. (2018) describe cost overrun as the following:

"Cost overrun is the amount by which actual cost exceeds estimated cost, with cost measured in the local currency, constant prices, and against a consistent baseline. Overrun is typically measured in percent of estimated cost, with a positive value indicating cost overrun and a negative value underrun. Size, frequency, and distribution of cost overrun should all be measured as part of measuring cost overrun for a certain investment type."

This definition is comprehensive and commonly used in international literature regarding a range of case studies. The baseline is a time point of measurement. It is important to be consistent in choosing the baseline to which cost overrun will be measured. Projects can have changes in different ways which leads to changed estimated costs for the project. Therefore, in order to compare projects consistently it is important to use a consistent baseline. This research focuses on cost overrun in the implementation phase. The baseline of the estimated costs is therefore the initial contract value, and the actual costs are the costs at the end of the implementation phase (see 3.4.1). Only the construction contracts are included in this research, because the conclusion of the construction contract marks the beginning of the implementation phase of a project; construction contracts have a significant part of the total value of a project (Verweij et al., 2015).

It depends on what you want to measure which baseline is most relevant to choose (Flyvbjerg et al., 2018). For example, political lock-in in the decision-making phase needs a different baseline than cost overrun in the implementation phase.

Several studies on cost overrun are focusing on effective decision making in estimating the cost for infrastructure projects (Flyvbjerg et al., 2003; Cantarelli et al., 2010; Flyvbjerg et al., 2018). Therefore, the baseline in research on effective decision making chosen is *"the budget at the time of decision to build"* (Flyvbjerg et al., 2018). It has to be noted that cost estimations made at the time of decision making, which turn out to be wrong, have consequences on cost overrun. This means changes in the plans after the decision making, result in cost overrun. Thus, in some cases, cost overrun has more to do with underestimation of the costs or political lock-in (Cantarelli et al., 2010b) than with the efficiency of a PPP. This research focuses on cost overrun in the implementation phase, and therefore the initial contract value is a valid baseline in order to measure cost overrun. Jørgensen, Halkjelsvik, & Kitchenham (2012) show that projects with a project size measure based on the actual cost have a higher cost overrun, than projects with a project size measure based on the estimated cost. This is also the conclusion based on the study by Cantarelli et al. (2012b), they identified two main project phases in Dutch large-scale transportation infrastructure projects: the pre-construction phase, and the construction phase. The cost overrun in the pre-construction phase has an average of +19.7%, while the construction phase has a cost underrun of 4.5%. Therefore Cantarelli et al. (2012b) conclude that projects with a longer the pre-construction phase have a higher chance to be adjusted, and thus probably a higher cost overrun.

There can be different types of cost overrun in infrastructure projects. A literature review by Andrić, J. M., Mahamadu, A.-M., Wang, J., Zou, P. X. W., & Zhong, R. (2019) gives an overview of types of cost overrun in different countries. They show key types of cost overrun in Korea by Lee (2008) which are scope changes, unexpected changes in construction environment, delay of construction, irrational cost estimation, and no practical use of the earn value management (a process to measure project performance). In Asia, the lowest bidder is identified as the most significant type of cost overrun, and lump-sum contracts, which have fixed prices and high risks for contractors, had the most influence on the occurrence of cost overrun (Andrić et al., 2019).
There is a wide variety in classification of causes for cost overrun in different countries and also in literature (Verweij et al., 2015). In this research, the classification of Rijkswaterstaat will be used. This classification has four types of reasons for cost overrun: scope changes; omission; technical necessity; laws and regulation. This classification is also used in Verweij et al. (2015).

It has to be noticed that some of the causes of cost overrun can be controlled by the contractor, while the contractor has not control over some causes of cost overrun. Classifying cost overrun makes it possible to distinguish into controllable and uncontrollable causes of cost overrun. Controllable causes of cost overrun are in this research omission and technical necessity, while scope changes and laws and regulation belong to less or uncontrollable causes of cost overrun. In this research, all of these four types of cost overrun are included.

A study on cost overrun in the Netherlands conducted by Cantarelli et al. (2012b) indicates that the Netherlands deviate from worldwide findings regarding cost overrun related to type of project. In the Netherlands, rail projects have the smallest average cost overrun, whereas worldwide rail projects are the category with the largest cost overrun. Also, the average cost overrun for all type of projects in the Netherlands is lower than worldwide, and the frequency of cost overrun is lower compared to worldwide findings (Cantarelli et al., 2012a; Cantarelli et al., 2012b). It has to be noted that for roads and tunnels, the Netherlands perform similar to the rest of the world, but for bridge and rail projects, the Netherlands perform better with statistical significance in difference in cost overrun for rail projects (Cantarelli et., 2012c).
As already mentioned, there are different possible moments to choose as baseline for studies. In this research, the focus is on the effect of the four conditions which I already mentioned on cost overrun. The project phase that will be focused on is the implementation phase. Therefore, the focus is on construction contracts only. The baseline which will be used in this research is the moment of contracting. In the project database of Rijkswaterstaat, this is defined as the initial contract value. The costs that will be included in this research are all the costs of the construction contracts between the initial contract value and the end of the implementation phase.

2.2 Contract type

In this research, two contract types will be analyzed. These contract types are Design & Construct, and DBFM contracts. These contract types are both considered as PPP because of the broad definition of PPPs that was used in this research. What is the influence of Design & Construct contracts and DBFM contracts

on cost overrun? To get a better understanding of this, first the different phases of infrastructure projects will be explained briefly.
Infrastructure projects are going through several phases from the beginning until the end. Figure 2.1 shows a main overview of the different phases from strategic planning, until operation. In general, these are the phases which every infrastructure project goes through. In the Netherlands, in total, there are eight phases, which can be categorized within these general phases (Rijkswaterstaat, 2014). The different phases will be elaborated first, before the contracts will be addressed.

In the plan-making phase, the first phase is the initiative. In this phase a political decision has to be made that an infrastructure project will be executed. After this decision, Rijkswaterstaat, the executive agency of the Ministry of Infrastructure and Water Management, will take the project to the market. The second phase is the exploration phase. The problem will be analyzed, and possible solutions will be thought of. In this phase, often the market will be involved to think of solutions which are innovative and sustainable. In the third phase, the study, different alternatives will be proposed and public participation is possible. The minister has to make the final decision (in Dutch: *het tracébesluit*). In the fourth phase, elaboration (*uitwerking*), a marketing plan (*inkoopplan*) is made in which the procurement type is chosen, contract type, and the project instruments. Projects instruments that can be used for procurement are:
economic most valuable enrollment (EMVI) in price and (mostly) quality
System based contracting, the client manages the quality of the delivered products
Best Value Procurement, the contractor with the most expertise
Performance measurement
The fifth phase, assessment, is about the procurement process. Here, the market parties will be assessed on quality and price, and the party who is the best according to procurement type can do the project. The previous phases described belong the plan-making phase in figure 2.1. In the sixth phase, implementation, the design and construction will be implemented. Rijkswaterstaat uses the model of integrated project management (IPM) in order to keep an overview of the various task divisions of the project. In paragraph 2.3, IPM will be elaborated more. In the seventh phase, delivery (*oplevering)*, the implementation is finished and Rijkswaterstaat will check the result of the project.

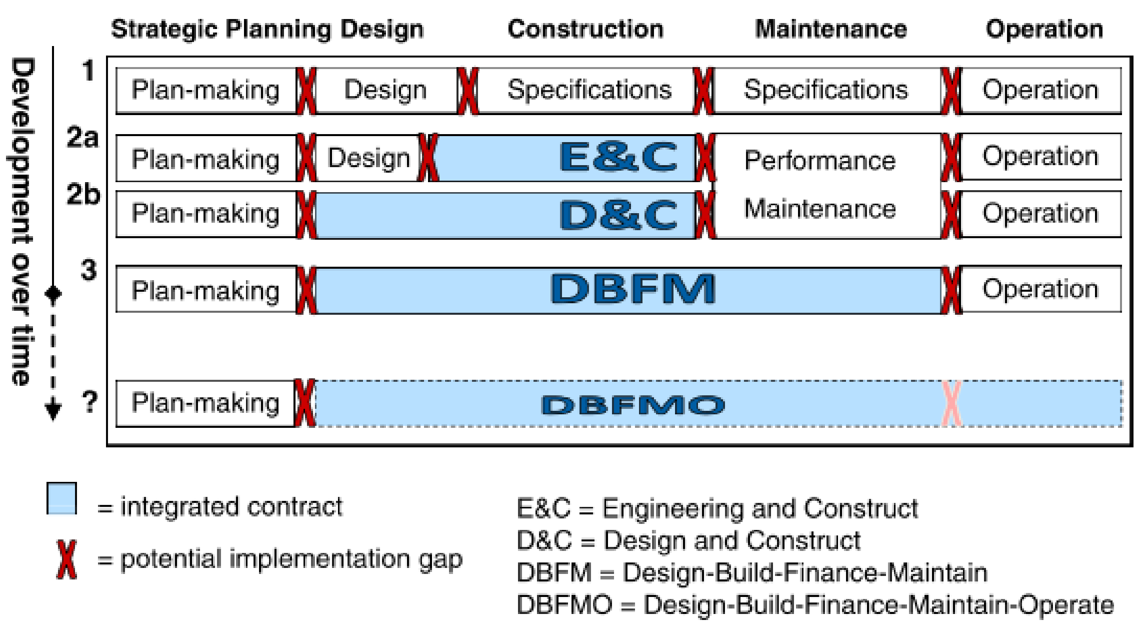


Figure 2.1: Developments of integrated contracts in the infrastructure project lifecycle (Lenferink et al., 2013)

In the last phase, maintenance, the road will be maintained for the length of the contract. The maintenance is included in integrated contracts like Design Build Finance Maintain (Operate).

Phase 1: Initiative	Plan-making
Phase 2: Exploration	Plan-making
Phase 3: Study	Plan-making
Phase 4: Elaboration	Plan-making
Phase 5: Assessment	Plan-making
Phase 6: Implementation	Design and Construction
Phase 7: Delivery (oplevering)	Post-construction
Phase 8: Maintenance	Maintenance

Table 2.1: Overview of project phases

There are different types of contracts with the market. The DBFM contract is considered for larger projects, while other projects use a more traditional contract. In the Netherlands, this is generally a Design & Construct contract. Procurements higher than 60 million euros are obligated to the public-private comparator (PPC-toets) with a DBFM contract (Rijkswaterstaat, 2015). However a DBFM contract has to give additional value to the project. This can be related to lower cost overrun, better quality of the outcome, or more sustainability for example.
A DBFM contract is a long-term contract, and the private party is responsible for the maintenance and financing. In a Design & Construct contract, the contractor is more involved in the project compared to traditional procedures, but less involved compared to DBFM contracts. D&C contracts do have some level of integration within the contract, but the maintenance and the financing differ from DBFM contracts.
Traditionally, Rijkswaterstaat controlled the planning procedure from beginning to the end. This was done until the late 1990s by the 'RAW-bestek', which is defined the following: *"a specification including a detailed design with underlying preliminary calculations of materials needed and construction time. Based on this estimate, contractors could calculate their bids and the lowest bidder was awarded with the construction contract. After completing construction, maintenance was performed by public road districts or contracted out in separate maintenance contracts, which were also specified in detail"* (Lenferink et al., 2013). After the neoliberal turn, maintenance was outsourced to contractors by so-called performance maintenance contracts (Lenferink et al., 2013). This resulted in a shift to Engineering & Construct contracts, where the contractors were responsible for the technical design specifications, and later Design & Construct contracts. With the Design & Construct contract, the contracting authority only demands a certain output. The contractor is then responsible for the design and construction.

DBFM contracts aim to integrate different phases of the project into a single contract. Traditionally, the design, construction and maintenance were separated, which led to sub-optimizations (Lenferink et al., 2013). In a DBFM contract, the design, construction and maintenance are integrated and implemented by the private contractor. These contracts are long-term, and can last from 15 until 30 years (Lenferink et al., 2013). The advantage of this integrated contract is that the contractor has to make an efficient design, because the contractor is also responsible for the construction and maintenance. Additionally, there is fewer need for coordination between the various components which leads to lower costs (E.-H. Klijn, 2009). The contractor is often a consortium of several private parties. The consortium will deliver a service for a lifecycle (e.g. the availability of a road) instead of a product (constructing the road) (Ministry of Finance, 2016).

It is assumed that integrated contracts in PPPs (DBFM contracts) will lead to more efficient infrastructure projects (Rijkswaterstaat, 2019; Ministry of Finance, 2016; Klijn, 2009). The bundling of the different project phases into an integrated contract brings more responsibility to the private party. In traditional procurement processes, the contractor building a highway often has little incentive to build efficient in order to minimize future operation and maintenance costs (Engel, Fischer, & Galetovic, 2011). Ng & Loosemore (2007) argue the relevance of this whole lifecycle approach of PPPs, since this can result in huge savings in the maintenance costs. In Australia the health facilities had huge maintenance liabilities and can have cost savings of $390 million per year with PPPs (Ng & Loosemore, 2007). Therefore, an important aspect is the integration of maintenance in construction contracts.
Also, integrated contracts can lead to more sustainable infrastructure development (Lenferink et al., 2013). But research also shows that contractual aspects have no significant relation on the (perceived) outcome of partnerships (Klijn & Koppenjan, 2016; Warsen et al., 2018). However, integrated contracts seem to have an impact on the outcome compared to traditional contracts. Anastasopoulos et al. (2014) argue that Performance Based Contracting (PBC) and “cost-plus-time and incentives/decentives contracting” are less likely to result in cost overrun for large-sized projects, while generally large-sized projects are the most likely to result in cost overrun. Da Cruz & Marquez (2012) and Zietlow (2005) also argue the relevance of proper incentives in order for PPPs to be more efficient.

An important aspect of a PPP is the financial contribution of the private partner. In the DBFM contract, the private partner is responsible for the financing and the maintenance of the project (Rijkswaterstaat, 2014). Private finance also stimulates the private partner to control the project in a better way. The private party needs to pay off the loan, so they have a strong incentive to control the risks of the project (Ministry of Finance, 2016). The government, generally can get a loan at an almost risk-free rate (Leruth, 2012), whereas the private party has to pay a risk premium which makes the loan more expensive (van Wee, 2007). DBFM contracts are often only applied to large infrastructure projects. Also, if there is additional work for a project, with private finance it is the question whether the private party / SPV can get resources for this, therefore the private party tries to minimize additional work (Verweij & van Meerkerk, 2018).

To summarize, it is expected that DBFM contracts will result in less cost overrun, because of the integration of project phases, the inclusion of the maintenance, and private finance. Because of the private finance, the contractor has an incentive to reduce cost overrun. D&C contracts are less integrated, without maintenance, and paid with money from the government. There is no private finance, and therefore less an incentive to be more efficient. Therefore, it is expected the DBFM contracts perform better than D&C contracts in terms of cost overrun.

2.3 Stakeholder management

A stakeholder is an often-used term in literature and practice. Stakeholder involvement (SI) is interdisciplinary, and is used in various disciplines such as transportation, water resources, water supply, mining and land development projects (El-Gohary et al., 2006). What is the role of stakeholder management in public-private partnerships, and eventually cost overrun?

First, the stakeholder concept will be explained more to clarify and distinguish different types of stakeholders. There have been many definitions of who a stakeholder is. A lot of the definitions are related to corporations or businesses. Evan & Freeman (1988): “have a stake in or claim on the firm”, or Thompson et al. (1991): in “relationship with an organization”. These definitions are about having a certain voice in a firm or organization. Savage et al. (1991) in (De Schepper et al., 2014) consider two aspects of importance to identify stakeholders: an interest in the actions of a firm, and the ability to influence a firm.

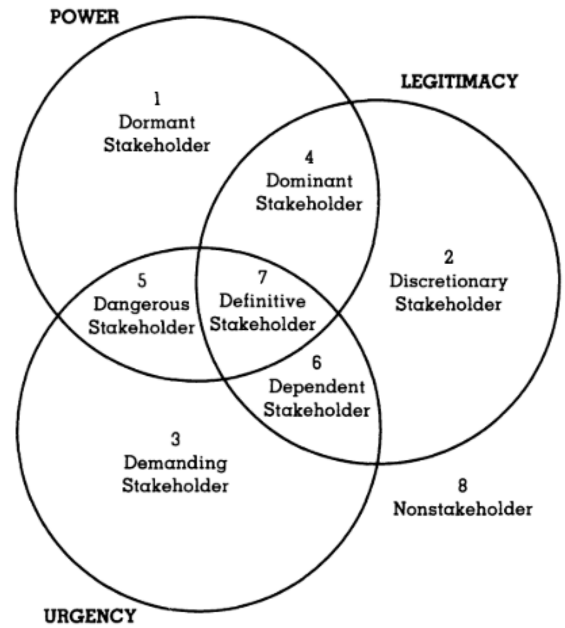


Figure 2.2: Stakeholder typology (Mitchell et al., 1997)

Stakeholders were classified based on three attributes: power, legitimacy, and urgency (Mitchell et al., 1997). This enabled firms or organizations to categorize stakeholders within these classes. As a result, eight groups could be identified, shown in the stakeholder typology (figure 2.2), whereas number eight is a nonstakeholder.

De Schepper et al. (2014) have developed a framework for identifying stakeholders influences within public-private partnerships (figure 3). They left out the legitimacy part, because this is a more static attribute. The framework is divided in three parts of main stakeholder groups. Stakeholders in part A have minor influence on the project and the uncertainty in the environment. Stakeholders in part B pay have a potential influence on the project and the uncertainty in the environment. And stakeholders in part C (definitive stakeholders) have a direct influence on the project and its environment.

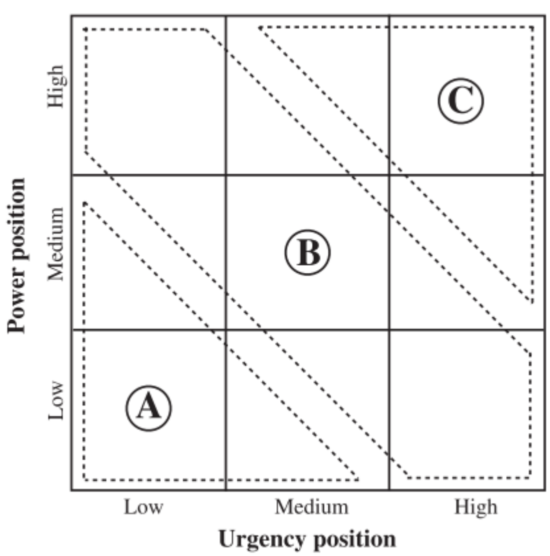


Figure 3: Stakeholder influences identification matrix (De Schepper et al., 2014).

However in public-private partnerships, stakeholder complexity is expected to be high due to potentially diverging objectives of the partners involved (De Schepper et al., 2014). The private party for example wants to maximize profit, while the public party is more concerned with the satisfaction of the (external) stakeholders. To correct for the possible diverging objectives, the public party can place incentives such as payment for the availability of a road. Also, in public-private partnerships, there can be issues of complex trust relations between public and private actors (De Schepper et al., 2014; Edelenbos & Klijn, 2007; Smyth & Edkins, 2007). As Mok, Shen, & Yang (2015) put it, there are three major challenges in the project management of mega projects: the complex stakeholder interrelationship and conflicting interests; the dynamics and growing capacity leading to high project uncertainty; and their governance by a stringent multi-role administrative structure leading to high public attention and controversies. Therefore, stakeholder management is an important aspect of public-private partnerships, and its influence on a successful outcome is regarded relevant by several scholars (De

Schepper et al., 2014; El-Gohary et al., 2006; E. H. Klijn, Edelenbos, Kort, & van Twist, 2008; Kort, Verweij, & Klijn, 2016; Verweij, 2015).

Besides stakeholder identification, the management of the stakeholders is needed. Literature on management of PPPs distinguish two perspectives: project management and process management (Edelenbos & Teisman, 2008; E. H. Klijn et al., 2008; Verweij, 2015). Klijn et al. (2008) describe project management as primarily concerned with the project internally and less concerned with the external environment. Internally oriented management is focused on the achievement of predetermined goals despite unforeseen events, with a DAD (decide, announce, and defend) communication strategy (Verweij et al., 2017). Klijn et al. (2008) describe process (or network) management to focus more on strategies to involve actors, create variety in content to enhance the attractiveness of proposals and ways to connect interactions between actors. This external oriented management emphasizes interaction with the societal environment. Characteristics of external oriented management are an outward orientation, focused on support for project implementation by including stakeholders to look for possible solutions, the communication follows a DDD strategy (dialogue, decide, and deliver) (Verweij et al., 2017). Edelenbos & Klijn (2009) argue that process management leads to better (perceived) outcomes than project management. However, the type of stakeholder management is related to the complexity of the project. Process management is mostly suited for projects with a high complexity, many stakeholders, and a variety of problem definitions, whereas project management is more suited that have a clear focus and less uncertainty (Edelenbos & Klijn, 2009).

Stakeholder management is seen as one of the main success factors of public-private partnerships (De Schepper et al., 2014; El-Gohary et al., 2006). Also the importance of trust and managerial effort in establishing successful PPPs are highlighted by several scholars (Huxham & Vangen, 2005; Kort, Verweij, and Klijn, 2016) mentioned in (Warsen et al., 2018). Management of a PPP is important to ensure successful outcomes (Klijn et al., 2008; Verweij, 2015). Research shows that externally oriented, and cooperative management responses are associated with satisfactory outcomes, while internally oriented, and non-cooperative management responses are associated with unsatisfactory outcomes (Edelenbos & Klijn, 2009; Verweij, 2015; Verweij, Teisman, & Gerrits, 2017). So, process management is expected to lead to better outcomes than project management. However, project complexity may play a role in the type of stakeholder management that may fit the best for a project. Project management may be more effective in smaller or simpler projects, while process management is more suited for projects that have a higher complexity (Edelenbos & Klijn, 2009). In infrastructure projects, due to stakeholder opposition for example, something what started as a project with clear goals can turn into a more complex process. This is explained as the external dynamics that can influence a project (De Bruijn et al., 2010). In this case, uncertainty increases and process management will be more suitable to deal with the situation. The right type of stakeholder management is needed to have a positive impact on cost underrun.
So, it is expected that the type of stakeholder management has an impact on cost overrun. For smaller projects with a low complexity it is expected that project management will lead to less cost overrun, and for larger projects with a higher degree of complexity it is expected that process management will lead to less cost overrun. It is also expected the more capacity of stakeholder management has a positive relation on cost underrun. However, the orientation has a higher relevance than the capacity of stakeholder management. So, it is expected that the right type of stakeholder management, which is dependent on the complexity of the project, should lead to less cost overrun.

2.4 Proper risk allocation

In infrastructure PPPs, risks need to be allocated properly between private and public sectors (Ng & Loosemore, 2007). A risk can be seen as an uncertain possibility, and it can result in increased costs and it can cause delays (Wang et al., 2018). A literature review by Osei-Kyei & Chan (2015) showed that risk allocation and risk sharing are among the mostly identified Critical Success Factors (CSF) for PPPs. In other words, appropriate risk allocation is relevant for successful outcomes in PPPs, which is cost underrun in this research. The choice for a PPP is based on the more "Value for Money" principle it provides compared to traditional procurement. Value for Money can be achieved by allocating risks to the party who is most able at managing the risks (Burke & Demirag, 2017). Driven by this requirement, the government has to decide how the risks should be best allocated between the parties (Ng & Loosemore, 2007). The idea behind a risk transfer to the private party is that it is provided with an incentive to manage these risks effectively (Ng & Loosemore, 2007). So, some risks are transferred to the private party, because they are ought to be able to manage these risks better than the public party.

In this thesis, the focus will be on a proper risk allocation between the public and private partner. There are different types of risks than can be allocated between the different parties in a public-private partnership. What risks should be allocated to which party in order to achieve the best value for money? And what is the perception of the project manager of this risk allocation? Therefore, it is important to identify the different types of risks first.

Risk can occur at different levels during the whole process of a project. In Bing et al. (2005), risks are classified at three levels: macro level, meso level, and micro level. At the macro level, risks are sourced exogenously, external of the project itself. These risks can be related to political and legal conditions, economic conditions, social conditions and weather (Bing et al., 2005). At the meso level, risks are sourced endogenously, within the system boundaries of the project. These risk are related to the implementation, and can be risks in location, design, construction and technology (Bing et al., 2005). At the micro level, risks are also endogenous but related to stakeholder relationships and contract management. This risk type can occur because the public sector has a social responsibility, while the private sector is driven by profit (Bing et al., 2005).

There are different ways to allocate risks among the parties. Risks can be transferred from the public to the private party. In this way, the private party takes a certain amount of risks from the public party. Risks can be shared between the public and private party. And risks can also be allocated among the consortium of private parties. What do other authors say about risk allocation for each category of risks identified in Bing et al. (2005)?

Political and governmental policy risks should be allocated to the public party (Bing et al., 2005; Palma et al., 2009). Also, site availability, which is part of the project selection should be allocated to the public party according to Bing et al. (2005). Relationship risks, force majeure risks and legislation changes risks should be shared by both parties; and the majority of the remaining risks (especially at the meso level) should be allocated to the private partner. Four factors are difficult to allocate, therefore these should be handled on a case-by-case basis: level of public support, project approval and permits, contract variation, and lack of experience (Bing et al., 2005). Project related risks such as financial, construction and residual value risk should be mainly allocated to the SPV (Burke & Demirag, 2017). Operation risks should be allocated to the SPV in in PPPs, and to the public sector in conventional procurement (Bing et al., 2005). In this research operation risks, and project finance risks will be preferably allocated to the SPV in the case of procurement with a DBFM contract and to the public sector in the case of procurement with a D&C contract. Table 2.2 provides an overview of the suggested risk allocation based on Bing et al. (2005).

Table 2.2: Risk categories and allocation overview (based on Bing et al., 2005).		
Risk level	Risk factor category	Allocation
Macro level risks	Political and government policy	Public party
	Macro-economic / financial market	Private
	Legal	Shared
	Social	Case-by-case
	Natural	Private
Meso level risks	Project selection	Public party
	Project finance	Private (DBFM) Public (D&C)
	Residual risk	Private (DBFM) Shared (D&C)
	Design	Private
	Construction	Private
	Operation	Private (DBFM) Public (D&C)
Micro level risks	Relationship	Shared / case-by-case
	Third party	Private

Risk propensity is defined by Wang et al. (2015). as "an individual's current tendency to take or avoid risks and considered as an individual trait which can change over time as a result of experience". Risk propensity is related to the risk perception of a project manager, since risks can be perceived subjectively. For instance, an unexperienced manager high risk-taking manager may perceive risks different than an experienced risk averse manager. The risk perception of a project manager is relevant since, the project manager can judge whether the risks were allocated properly.

Concluding, a proper risk allocation is expected to have a positive influence on cost underrun. The risk allocation according to the model of Bing et al. (2005) is used to decide whether a case has a proper risk allocation compared to the literature. Contract type also plays a role in the risk allocation, since projects with a DBFM contract have a high risk transfer to the private party. Also, the risk perception of the project manager is considered relevant, since there might be project specific reasons why a certain risk allocation was used, that deviates from the 'standard' risk allocation.

2.5 Project size

Empirical studies show different underlying reasons on the relation between project size and cost overrun (Jørgensen et al., 2012). Also (Cantarelli, Van Wee, et al., 2012) argue that there is no consensus of the impact of project size on cost overrun in infrastructure projects. Project size in this research will be defined as the estimated cost of a project (not the actual construction cost). This definition has been used in other studies on cost overrun (Cantarelli et al., 2012c; Flyvbjerg, Holm, & Buhl, 2004). The estimated cost of the project is further specified in this research as the initial contract worth.

Research about the effect of project size on cost overrun have different outcomes. Mahamid (2013) finds that projects size has a correlation to cost deviation, and argues that large projects are more likely to have success. This might have to do with the fact that large projects have more experienced project management. Odeck (2004) in (Cantarelli et al., 2012c) argues that larger projects most probably have

better management compared to smaller projects, this might be an explanation for the relative high cost overruns among smaller projects. Therefore, it is interesting to research if there is a relation between project size and the type stakeholder management. As already argued, projects with a higher degree of uncertainty are better off with process management. Often larger projects have more uncertainty and complexity, and therefore it seems logical that process management is likely to be more often used in larger projects.
Flyvbjerg et al. (2004) argue that project size only is relevant for bridges and tunnels, in these cases larger projects have larger cost escalations than smaller projects. A factor that might play a role is the increasing complexity of projects for bridges and tunnels. There are higher design and construction risks in such projects compared to 'normal' infrastructure.
A Dutch study shows that cost overrun is the highest for small projects, but project size does not significantly influence cost overrun (Cantarelli et al., 2012c). A reason for the high cost overrun for small projects is related to contract changes which leads to additional costs (Verweij, van Meerkerk, & Korthagen, 2015). They argue that DBFM contracts have lower contract change costs, because of the long range of these contracts they may be better able to deal with changing project conditions which should lead to lower contract changes (Verweij et al., 2015).

Also, the contract type can play a role in cost overrun for large sized projects. A study in Australia shows that traditional procurement resulted in faster completion for smaller projects, while this resulted in statistically significant increased time overrun for projects with increased size (Raisbeck et al., 2010). Also Anastasopoulos et al. (2014) argue that large-sized projects are generally more likely to have cost overrun. As also described in paragraph 2.2, project size and contract type seem to have a relationship with each other. Smaller projects seem to be better off with a D&C like contract, and larger projects perform better with a DBFM contract.

Cantarelli et al. (2012c) provided a classification for the size of infrastructure projects based on cost limits by the MIRT (table 2.3). The MIRT (Meerjarenprogramma Infrastructuur Ruimte en Transport) is the implementation programme for infrastructure projects in the Netherlands.

Table 2.3: Project size classification (Cantarelli et al., 2012c)

Small	< €50 million
Medium	€50 < €112.5 million
Large	€112.5 million < €225 million
Very large	> €225 million

Smaller project have more frequently cost overrun compared to larger projects, however the impact of cost overrun with larger projects is more severe (Cantarelli et al., 2012c).

All in all, it is expected that smaller project have a higher tendency to end up with higher cost overruns compared to larger projects. So project size seems to have an impact on cost overrun. Also, the contract type in combination with project size has a probable relation with cost overrun. Smaller projects with a D&C contract are expected to lead to cost underrun, and large projects with a DBFM contract are expected to lead to cost underrun. Small projects often have a low complexity, while large projects are more likely to have a higher complexity. So, small projects may be better served with a project oriented type of stakeholder management, while large projects might benefit more from a process oriented type of stakeholder management.

2.6 Conceptual model

Figure 2.4 shows the conceptual model of this research. The theoretical framework has provided expected relations between the individual conditions and cost overrun. For the condition contract type it is expected that the DBFM contract has a negative relation with cost overrun (so it is expected that the DBFM contract leads to cost underrun). For the condition stakeholder management there was no clear individual relation identified with cost overrun. For the condition proper risk allocation there was a negative relation found with cost overrun. And for the condition project size there also was a negative relation found with cost overrun. The QCA will be used for the configuration effect of the conditions on cost overrun.

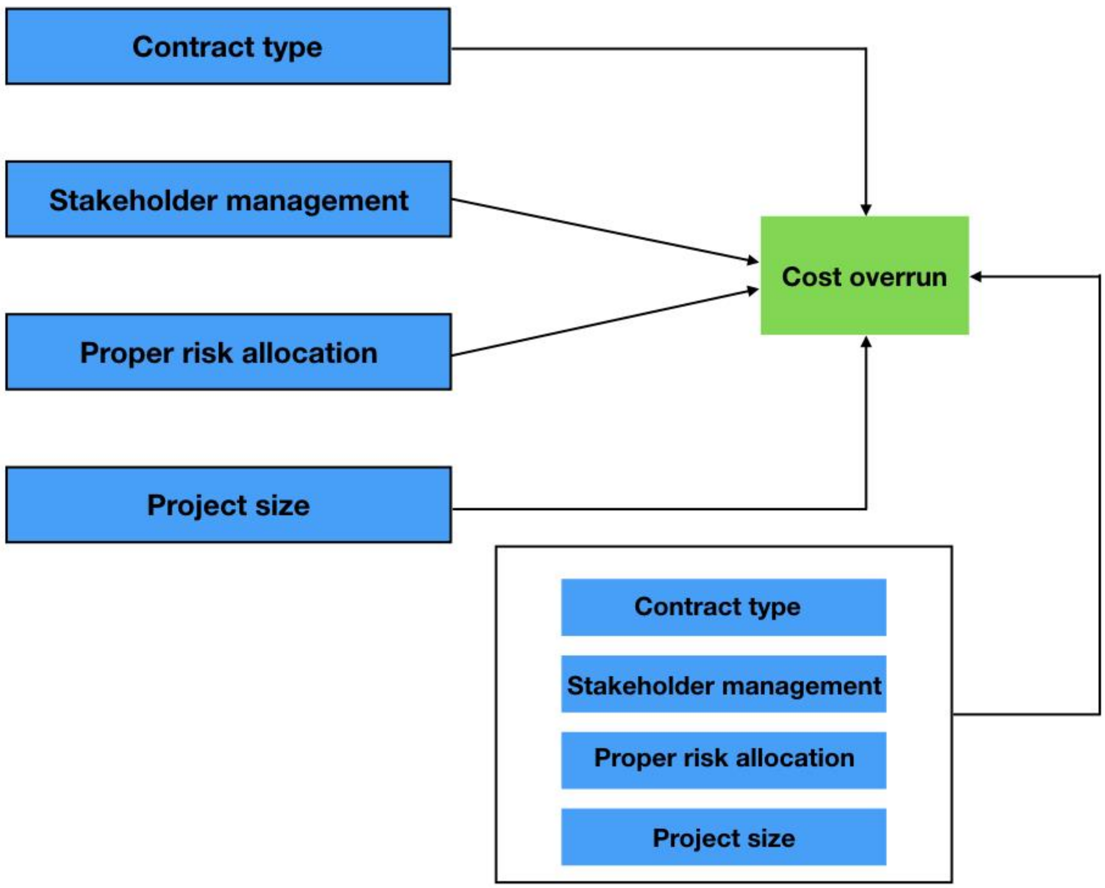


Figure 2.4: Conceptual model

3. Methodology

In this chapter, the methods of the research will be explained and justified. The following elements will be discussed: The QCA research method, the case selection, operationalization and calibration of each condition and the outcome (cost overrun), and ethical considerations.

3.1 QCA

The research method in this thesis is a qualitative comparative analysis (QCA). QCA is chosen as a research method because of the advantages compared to a qualitative or quantitative approach. QCA is suitable for this research because of the systematic comparison of cases, and the configurational aspect of the method. This will be explained further in this chapter.

To explain QCA, first a distinction has to be made between a case-based approach and a variable-based approach. A case-based approach is an in-depth approach into a few cases with a focus on interpretative, inductive, and (often) qualitative analysis. While a variable-based approach is a broader approach of many cases, it is also more analytical, deductive, and (often) uses quantitative analysis. QCA is a combination between a case-based approach and a variable based approach (Gerrits & Verweij, 2018). As Ragin (1987) in Rihoux (2006) puts it: a 'synthetic strategy' which aims to 'integrate the best features of the case-based approach with the best features of the variable-oriented approach'. However this statement has been criticized, especially by researchers with a quantitative orientation, QCA is the technique that has been most widely applied in the field of systematic comparative case study analysis (Rihoux, 2006).

Firstly, this method is suitable to study a moderate amount of cases in a systematic way. In this research, ten cases are analyzed. A qualitative approach would take more time, since the researcher would have to do ten case studies in order to compare the cases to each other. QCA is a systematic approach, because it focuses on the set-memberships of conditions in the cases, and the outcome. A condition can be present or absent in a case, and thus get a score assigned of 0 (not in a set) or 1 (in a set), or a score in between (which will be touched upon in 3.4). The rationale behind this research method for this thesis is the structured comparison of multiple cases on four conditions.
Secondly, an important characteristic of QCA is the focus on set theory. This allows the researcher to see the cases as configurations of conditions which (together) explain cost overrun or cost underrun. Within QCA, cases are constructed as configurations of conditions (Berg-Schlosser et al., 2009; Rihoux and Ragin, 2009b, in Gerrits & Verweij, 2018). These configurations of conditions lead to certain outcomes. It is possible that different configurations of conditions lead to the same outcome (Gerrits & Verweij, 2018). Berg-Schlosser et al. (2009) describe this as "multiple conjunctural causation". Since it views causality as context and conjuncture specific, QCA rejects any form of permanent causality (Berg-Schlosser et al., 2009). QCA identifies necessary and sufficient conditions for the desired outcome. Following the definitions of Gerrits & Verweij (2018) p.p.87, a condition is necessary "for the occurrence of the outcome if the outcome cannot be achieved without that particular condition". And a condition is sufficient "if it can produce the outcome all by itself".
The conditions that are chosen are: contract type, stakeholder management, risk allocation, and project size. Since QCA allows for different types of data (both qualitative and quantitative) collection, this method is useful for this thesis. So, both interviews can be conducted and databases can be analyzed. The interview data, however needs to be categorized in order to be calibrated and analyzed within QCA.

3.2 Case selection

The cases were selected from the main project database of Rijkswaterstaat (Projectendatabase). In order to make a good comparison, there needs to be an area of homogeneity. A well-argued case selection implies that the cases are alike enough to permit comparison. The area of homogeneity of this research is the following. This research only focuses on road infrastructure projects. Water and rail infrastructure is excluded from this research in order to make the selected cases more similar. Also, rail infrastructure differs in cost overrun than road infrastructure (Cantarelli et al., 2012c; Flyvbjerg et al., 2004). Since this research focuses on PPPs, only the contract types Design & Construct (D&C) and DBFM were included. DBFM contracts are clearly recognized as PPP contracts, but D&C contracts have less PPP characteristics. However, in the definition of PPPs used in this research, also used by Verweij et al. (2017) there is a wider adoption of PPPs. Also in a D&C contract, both partners bring resources to the partnerships, and risks are allocated between the partners and/or shared. Therefore, both contract types can be seen as a form of a PPP, but DBFM contracts are more integrated and have more private responsibility. Projects procured with a DBFM contract are generally larger projects. Large projects can be quite different from small projects in management strategy (Edelenbos & Klijn, 2009), stakeholder management (Mok et al., 2015), complexity (Mok et al., 2015), contract changes (Verweij et al., 2015), and cost overruns (Odeck, 2004; Odeck et al., 2015; Cantarelli et al., 2012c; Flyvbjerg et al., 2004). So, only D&C projects were selected from the same project size category as the DBFM projects in the project database. And finally, the project phase of the cases that was analyzed is the implementation phase. This is the focus of this research.

So, the selection criteria were the following: it has to be a road infrastructure project; either a Design & Construct contract or a DBFM contract; tendered as a public-private partnership; the size of the smallest DBFM is the minimum size of the cases; the cases should be at least in the implementation phase.

Following these selection criteria resulted in a selection of 19 cases. One of these cases had a sort of alliance contract, so this case was excluded of this research because it is outside the research scope. Also, one case was implemented more around 15 years ago, so there was no project management anymore. A previous project manager was contacted but due to a lack of time and of memory of the project, data collection was not possible for this project. So, 17 cases are left over for data collection in this research. With permission of Rijkswaterstaat, the initial case selection is presented in table 3.1. Two of these cases have a project size over €1 billion. Of these 17 cases, data was collected from 10 cases. These cases are analyzed in this research. The main reasons for not collecting the data from the other cases were: busy schedules of project managers; the project was implemented too long ago, and there was a lack of time of the (project) managers to look up the required information of the projects.

Table 3.1: initial case selection
NN NM RW33, Assen - Zuidbroek
A12 Ede-Grijsoord
DHN: Omlegging A9 Badhoevedorp
MN A2 Holendrecht-Oudenrijn
A50 Ewijk - Valburg
NB A2 ZSM Den Bosch - Eindhoven
NN NM A31 Leeuwarden (haak om)
A10 Tweede Coentunnel / A5 Westrandweg
N18 Varsseveld-Enschede
ZH RW4 Burgerveen-Leiden
MN A27/A1 Utrecht N-Eemnes
SAA: A6 Almere
NN NV 2e fase Zuid. Ringw. Gron’

MN A1/A28 knooppunt Hoevelaken
UT A12 Lunetten - Veenendaal
ZH RW15 Maasvlakte-Vaanplein (UPR)
SAA: A1/A6

3.3 Data collection

3.3.1. Questionnaires and semi-structured interviews

For the conditions stakeholder management and risk transfer, questionnaires were sent to the main project managers. The project managers were invited to do an interview with the questions of the questionnaires as a basis, or fill in the questionnaires by themselves. The option for an interview or the questionnaire was given in order to get a high response rate. 19 projects were selected initially, so 19 questionnaires were sent to project managers. The choice to send the questionnaires to the main project managers was made with the idea that the main project managers has some knowledge of all aspects of the project, and therefore is most likely to fill in both part of the questionnaire. And if the main project managers would not be able to fill in the questionnaire, he or she could ask a more specialized manager to fill in the questions. For some projects, the main project manager did not have time or was not able to answer the questions. So, also other managers were interviewed or filled in the questionnaires. Mostly, this was the risk manager (manager projectbeheersing), or the stakeholder manager (omgevingsmanager).

The questionnaires contain a short introduction with information where the data will be used for. This also contains the confidentiality part that the data will be used with confidentiality, and the analysis will only be published.

The option to do an interview was the preferred way of data collection by the researcher, because this allows the project manager to explain the answers that will be given. Also, this gives the researcher the possibility to make notes about the context of the project and the answers that are given by the interviewee. Gathering the information via interviews can result in more accurate data since the interviewee takes more effort to provide the data. Three project managers are interviewed, two are interviewed by phone and one is interviewed personally. The interviews were semi-structured. The other data was collected via the questionnaires. Also one explorative interview was done before sending the questionnaires.

Interviews bring up perceptions by the researcher which can result in subjectivity.

3.3.2. Quantitative data

Rijkswaterstaat has a project database with quantitative information about their projects. This database is be used for this thesis to derive information from the selected projects. Also, access has been given to a dataset (created by dr. S. Verweij) where a large selection of data from infrastructure projects of the project database has been ordered in an insightful way. The data from the conditions ‘contract type’ and ‘project size’ were derived from this database/dataset. Also, the outcome (cost overrun) was derived from this database/dataset. This dataset has been useful, since the researcher was able to use this dataset for case selection as well. Also, the researcher did not have to create a dataset from the scratch based on data from the project database.

The dataset had a selection of cases reduced to road infrastructure projects, connected to the main road network. The dataset has information about some characteristics of these projects, including: contract type; duration of implementation; estimated costs and initial contract value; cost overrun for each category.

Also, in the project database, there was contact information of the project managers for each project. This information was used to select the project managers for the selected cases. So, email addresses and phone numbers from the project managers were available for the researcher. This was helpful, because some project managers did not respond initially to the mail that was send. When calling the project managers there was a better and faster response.

3.4 Operationalization and calibration

In order to make a comparison between the cases the data needs to be calibrated. Gerrits & Verweij (2018) argue that calibration creates standards against which data measurements become interpretable. These standards range between the value 0 and 1. So the raw (qualitative) case data are transformed into scores between 0 and 1 (Gerrits and Verweij, 2018). For each of the conditions, and the outcome, calibration is needed.

There are three principal types of calibration within QCA: crisp-sets, fuzzy-sets, and multi-value. Crisp-set QCA (csQCA) only has the values 0 or 1, so a condition is either 'present' or 'absent'. Fuzzy-set QCA (fcQCA) allows degrees of membership scores, so a case can also have a degree of membership. For example, four-value fuzzy-set membership will be used to be more precise in the membership of the condition, so a condition can also have a value 0.33 or 0.67 to indicate that the condition is 'more in than out', or 'more out than in' for example. Finally, multi-value QCA (mvQCA) allows for multinomial conditions and discrete values of a certain category. For example, different types of contracts can have a different value. Since mvQCA cannot be combined in one QCA with fsQCA (Gerrits & Verweij, 2018), mvQCA will not be used in this thesis.

3.4.1. Cost overrun

Definition

Cost overrun in this thesis is defined as the difference between the actual costs and the estimated costs. Where the estimated costs are measured at the moment of contracting. In the project database, the estimated costs which is used in this research is the initial contract value. The initial contract value is the baseline against which cost overrun will be measured. The actual costs are the estimated costs plus the total of the cost overrun. So, cost overrun is measured from the initial contract value, and the total of cost overrun will be included in this definition of cost overrun. In the dataset, cost overrun is distinguished as cost overrun in 'construction contracts' and 'other' cost overrun. 'Other' cost overrun is made up of actually all sorts of contracts that are outside the main construction contract(s). For example, P16 has 73 contracts outside of the main construction contract. The main construction contract has a cost overrun of €94 million, while the 73 other contracts have a total cost overrun of €677.000, this is less than one percent of the cost overrun. So, the analysis will focus only on cost overrun in 'construction contracts', since this is the most important contract of the project. Cost overrun is measured relative to the project size (initial contract value).

Subcategories (indicators)

In the project database, different categories of cost overrun are distinguished, which add up to the total cost overrun. This classification was also used in a previous study by Verweij et al. (2015). The following types of cost overrun are categorized in the project database with the definitions used in Verweij et al. (2015):

Table 3.2: Definition and abbreviations of the outcome conditions (Verweij et al., 2015)	
Scope change (SC)	Here the scope of the contracted work is extended with the purpose to achieve e.g. a faster completion of the project, cost advantages, reducing traffic obstructions and logistic advantages.
Omission (OM)	Omissions are changes that have to be made in/to the contract because the contract appeared incomplete, unclear, or contained incorrect or conflicting contract terms.
Technical necessity (TN)	Technical necessities are changes in the physical and/or technical conditions under which the project is being implemented.
Laws and regulation (LR)	This concerns changes that occur in laws and regulations that require stricter requirements, so that the contract may have to be changed to meet these requirements.
Total cost overrun (TCO)	This is the sum of the above described categories.

Initially, these types of cost overrun were also meant to be part of the QCA. Because it would give a better understanding of the configurational effect of the conditions on controllable and uncontrollable types of cost overrun. However due to limited variation of the types of cost overrun, no sufficient configurations of conditions were found. Therefore, the types of cost overrun were not analyzed using QCA.
It has to be noticed that no strong conclusions can be drawn for the types of cost overrun (table 3.2 and table 3.3), since the data in these categories are not of the highest accuracy.

Calibration
For cost overrun, there are multiple possible outcomes. Satisfactory outcomes can be cost underrun or no cost overrun. Unsatisfactory outcomes are cost overrun. For this condition, a four-set fsQCA will be used since it allows for a more precise calibration with the values: 0; 0.33; 0.67; 1. So, a distinction can be made in the amounts of cost overrun. Table 3.3 gives an overview of the categories of cost overrun for each case. Cost overrun is calculated as the cost overrun (for each category, and in total) divided by the project size, and then converted to percentages. So P1 has a total cost overrun of 15.89% of the project size.

Table 3.3: Overview cost overrun for each case					
Case ID	SC	OM	TN	LR	TCO
P1	6,12%	0,51%	8,21%	1,05%	15,89%
P2	2,92%	0,00%	2,87%	0,00%	5,79%
P5	9,84%	0,06%	33,09%	0,55%	43,53%
P7	20,49%	0,23%	11,56%	0,00%	32,29%
P9	0,01%	5,47%	1,57%	0,00%	7,05%
P10	2,86%	0,01%	0,39%	0,05%	3,30%
P11	40,05%	0,81%	0,00%	0,00%	40,87%
P16	6,49%	0,00%	0,00%	0,00%	6,49%

P17	0,73%	0,00%	0,00%	0,00%	0,73%
P18	69,07%	0,00%	2,71%	0,00%	71,78%

For example, P1 has the following raw data available for cost overrun (table 3.4). In the second row, each category is presented as a percentage of project size. This is done for each project in table 3.3.

Table 3.4: Cost overrun example P1					
Project size	SC	OM	TN	LR	TCO
€188.556.000	€11.538.000	€971.000	€15.476.000	€1.984.000	€29.969.000
100%	6.12%	0.51%	8.21%	1.05%	15.89%

In order to calibrate the outcomes, the clusters of contract changes (or cost overrun as defined in this research) of the article of Verweij et al. (2015) are used. These clusters are based on 45 road infrastructure projects in the Netherlands. Because of the relative large sample with a good representation of the road infrastructure projects in the Netherlands, these clusters are valid for this research. Only one case (P5) is outside the range of these clusters. So the range of the third cluster is adjusted. The clusters are presented in table 3.5. These are the clusters and calibration for the outcome TCO.

Table 3.5: Clusters and calibration total cost overrun (TCO), adapted from Verweij et al. (2015).			
Cluster	Relative cost overrun	N	Calibration score
1. Low	0 - 7.47%	5	0
2. Medium	9.85 - 22.66%	1	0.33
3. High	29.29 - 43.53%	3	0.67
4. Very high	60.34 - 118.23%	1	1

For the other categories of cost overrun, no clusters were found in external sources. Therefore, clusters were made by the researcher based on a Q-Q plot. 62 projects were included in this cluster analyses. These projects were derived from the dataset (see 3.2.2). The dataset was checked for errors, and some minor changes needed to be made in order to do a right cluster analysis. These clusters are the following (table 3.6):

Table 3.6: Cluster analysis and calibration categories of cost overrun				
Cost overrun in % of initial contract value	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Calibration	0	0.33	0.67	1
Scope change %	0 - 14.67 *(N=47)* **(N=7)**	19.33 - 21.15 *(N=4)* **(N=1)**	25.73 - 41.55 *(N=9)* **(N=1)**	69.07 - 84.11 *(N=2)* **(N=1)**
Omission %	0 - 2.90 *(N=52)* **(N=9)**	4.81 - 5.88 *(N=5)* **(N=1)**	8.56 - 15.29 *(N=3)* **(N=0)**	24.43 - 24.48 *(N=2)* **(N=0)**
Technical necessity %	0 - 3.88 *(N= 36)* **(N=7)**	5.62 - 15.40 *(N=17)* **(N=2)**	20.28 - 24.98 *(N=5)* **(N=0)**	29.30 - 46.30 *(N=4)* **(N=1)**
Laws and regulation %	0 - 2.46 *(N=60)* **(N=10)**	-	-	7.35 - 11.93 *(N=2)* **(N=0)**

To clarify, when we take the row 'scope change', in the first cluster there are 47 cases of the 62 cases with a range between 0 and 14.67 percent. There are 7 cases from the case selection of this research in the first cluster. The cases in the first cluster will get a calibration score of 0.

It has to be noticed that only a few cases produce the outcome in the categories of cost overrun (table 3.7). This is the result from the cluster analyses with a larger sample of cases (N=62). With this calibration, there was no row in the truth table of the QCA analysis with a high consistency. Only the outcome 'TCO' had sufficient configurations of conditions to produce the outcome, so a QCA analysis was done with the outcome 'TCO' and '~TCO'. Negation (~) means that a case has a set-membership of $0.0 \leq x < 0.5$ in a set (Gerrits & Verweij, 2018).

Table 3.7: Calibration of types of cost overrun

Case ID	Cost overrun Scope change (SC)	Cost overrun Omission (OM)	Cost overrun Technical necessity (TN)	Cost overrun Laws and regulation (LR)	Cost overrun total construction contracts (TCO)
P1	0	0	0.33	0.33	0.33
P2	0	0	0	0	0
P5	0	0	1	0	0.67
P7	0.33	0	0.33	0	0.67
P9	0	0.33	0	0	0
P10	0	0	0	0	0
P11	0.67	0	0	0	0.67
P16	0	0	0	0	0
P17	0	0	0	0	0
P18	1	0	0	0	1

3.4.2. Contract type

Definition and calibration

Two types of contracts are used in this thesis: D&C and DBFM contracts. For this condition a csQCA is sufficient because there are only two values needed. It is expected that a DBFM contract will reduce cost overrun and that thus has a negative relation with cost overrun, and a positive relation with cost underrun. It is expected that a D&C contract will not reduce cost overrun and therefore has a positive relation with cost overrun. Therefore, a D&C contract will have the value 1 and a DBFM contract will have the value 0. Table 3.8 gives an overview of the contract types for the projects of this research. There are six projects that are procured with a D&C contract, and four projects are procured with a DBFM contract.

Table 3.8: Raw data contract type and calibration

Case ID	Contract type	Calibration
P1	D&C	1
P2	DBFM	0
P5	D&C	1
P7	D&C	1
P9	D&C	1

P10	DBFM	0
P11	D&C	1
P16	DBFM	0
P17	DBFM	0
P18	D&C	1

3.4.3. Stakeholder management

Definition

The two points of view which are relevant for stakeholder management in this research are project management and process management. Project management can be described as internal-oriented and non-cooperative management. Process management can be described as external-oriented and cooperative management. For the intensity of stakeholder management for a project, the fulltime equivalent (FTE) will be used for both program and process stakeholder management.

Table 3.9: Operationalization stakeholder management

Variable	Sub-variable	Indicators
Type of stakeholder management	1. Project management 2. Process management	1. Internal oriented stakeholder management, focused on predetermined goals, with a DAD communication strategy. 2. External oriented stakeholder management, has an outward orientation, focused on including stakeholders, with a DDD communication strategy.
Capacity of stakeholder management	1. FTE	1. Fulltime equivalent for total stakeholder management.

Calibration

For the calibration a four set fsQCA will be used. Using fsQCA allows for a more precise calibration based on two variables: type of stakeholder management, and capacity of stakeholder management (table 3.8). These two variables will be used to calibrate this condition. It is expected that a project management approach fits the best in relative simple projects with a low complexity. This type of management is more focused on achieving predetermined goals. When an (unexpected) event occurs, this management style is internally oriented, and less concerned in communicating with stakeholders to look for a solution. In complex infrastructure projects, it is expected that this management style has a positive relation with cost overrun.

Process management is a management style that is focused on involving and collaborating with the (external) stakeholders. This management style is associated with projects with a complexity. When an event occurs, process management is focused on involving stakeholders to try to look for solutions. In infrastructure projects, it is expected that process management will reduce cost overrun, so it has a negative relation with cost overrun.

Figure 3.1 shows the possible calibrations for this condition. The management style has a higher weight than the management capacity, a case with process management scores below 0.5 and a case with project management scores above 0.5. The reason for this decision is that the management style influences the outcome according to literature (see paragraph 2.3). The FTE deployment is relevant, but the orientation (or quality) of the management approach for a project has a higher relevance. For example, if a project with a very high complexity has a high FTE deployment has a project management style, the expected outcome is that the issues that will occur probably will not be managed properly. Therefore, the management style has a higher weight than the management capacity.

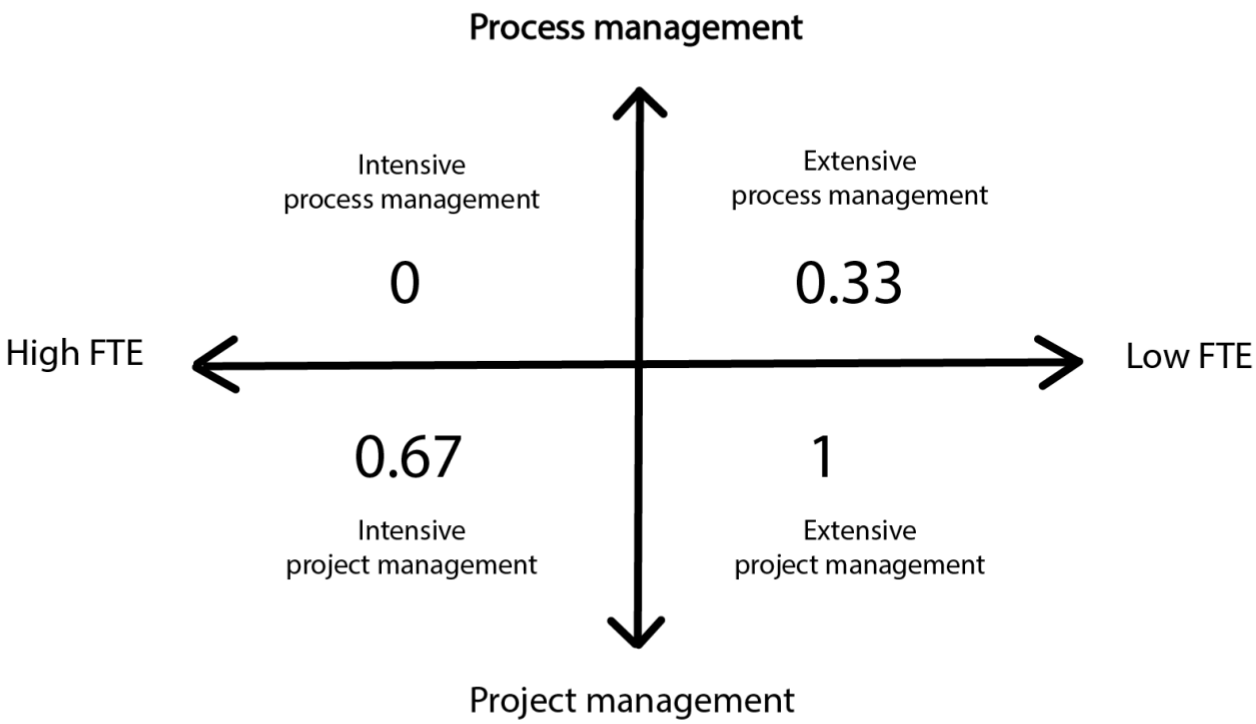


Figure 3.1: Calibration type of stakeholder management (Created by author)

Qualitative data was gathered via questionnaires and a few additional phone interviews for some elucidation. Questions were asked about the orientation of the management style, the communication strategy, the capacity for internal and external stakeholder management, and the approach for the external stakeholders. During the phone interviews, the questionnaires were filled in by the researcher. The data of the questionnaires was coded in an excel document under the above described categories. The data overview showed that most projects had a management style that was tending towards process management. Table 3.9 gives an overview of the data that was collected, and the calibration that was applied to this condition. Because most cases had an external management orientation (8 out of 10), and a DDD communication approach (9 out of 10) the researcher looked at the combination of all categories in order to decide whether a case would be labelled as project or process management.

Initially, a case is labelled as process management if the orientation was external, with a DDD communication strategy, and if there is collaboration with the stakeholders. Looking at the data (table 3.9), the communication strategy is for 9 out of 10 cases a DDD communication strategy, and the case with a DAD communication strategy has 'inform' as approach for the external stakeholders. Therefore this case was assigned a project management style. For the other cases therefore, the communication strategy was the same and therefore has no further influence on the calibration. When looking at the orientation of stakeholder management, the researcher also included the allocation, and ratio of FTE between internal and external stakeholder management. The average ratio (1.52 FTE) means that a project has 1.52 more external than internal FTE deployment. If a project scores high on all aspects of process management, but has a low ratio than the ratio is no determining factor. Only if a project has not clearly a project or process management style the ratio gives more clarity. P10, for example has an external oriented management with a DDD communication strategy, but the approach towards the external stakeholders is 'involve', here the FTE average ratio is included. The ratio is 0.2, and thus below the average ratio. Here a project management style is assigned. P10 has a FTE deployment, and therefore is assigned a calibration score of 0.67: intensive project management. If a case is labelled as external oriented, but without a DDD communication strategy or collaboration with stakeholders, the case is labelled as project management. Otherwise almost all cases would have process management as the type of stakeholder management.

For the capacity of stakeholder management there were two projects with a relative high deployment of FTE (P9; P10). This questions the reliability of the data of the FTE of stakeholder management. Some projects (which are not included in the analyses) had no data for the capacity of stakeholder management, so it might be that there is no consistent data of the capacity for stakeholder management. The amount of FTE for stakeholder management varies quite among the cases. However many project managers recalled the capacity from their memory. Therefore, in line with Verweij et al. (2019) the capacity will be distinguished only between a high and low deployment of FTE. For this variable, no distinction is made between the FTE for internal and external stakeholder management, only the total FTE for stakeholder management is included. The distinction between the FTE deployment allocated for internal and external stakeholder management was only used for the choice for project or process management. The total FTE deployment was divided by the project size to correct the absolute FTE and make it relative FTE deployment. The average relative FTE (3.78) was used to allocate cases to a low and high FTE deployment. Because two cases had a relative high FTE deployment, the average might be too high. One case just below the average (P5) is therefore still allocated to a high FTE deployment. So, the crossover point for high/low deployment of FTE is the score of P5 (3.59). Also, it is expected that more FTE will decrease cost overrun. So, a project management approach combined with a low FTE is expected to result in cost overrun. And a process management approach combined with a high FTE is expected to result in cost underrun.

To clarify table 3.10 with the raw data, an example will be given for one case how the calibration works. For P1, the orientation is external with a DDD strategy, with 1 internal FTE and 3 external FTE, this leaves a FTE ratio (FTE external / FTE internal)of 3:1 = 3. The approach for the external stakeholders is inform, involve, collaborate. These things combined give this case a process management style. The total FTE is 4. The relative FTE ((FTE/project size)*100000) gives a score of 2.12. This is below the crossover point 3.59, and therefore scores a low FTE deployment. So, a process management style and a low FTE brings the calibration for P1 to 0.33, which is an extensive process management style.

Table 3.10: Raw data stakeholder management.

Case ID	Orientation	Communication strategy	FTE Internal	FTE external	FTE ratio	Approach external stakeholders	Management style	Total FTE	Relative total FTE	Allocation low/high	Calibration score
P1	External	DDD	1	3	3	Inform, involve and collaborate	Process	4	2.12	Low	0.33
P2	External	DDD	1	3	3	Inform, involve and collaborate	Process	4	1.95	Low	0.33

P5	Internal	DDD	2	4	2	Inform, involve and collaborate	Process	6	3.59	High	0
P7	External	DAD	1.5	1.5	1	Inform	Project	3	2.39	Low	1
P9	Internal	DDD	20	10	0.5	Inform, involve	Project	30	12.16	High	0.67
P10	External	DDD	30	6	0.2	Involve	Project	36	7.32	High	0.67
P11	Internal and External	DDD	2	3	1.5	Collaborate	Process	5	2.02	Low	0.33
P16	Internal and External	DDD	3	3	1	Inform, involve and collaborate	Process	6	0.41	Low	0.33
P17	Internal and External	DDD	2	3	1.5	Inform, involve and collaborate	Process	5	1.69	Low	0.33
P18	External	DDD	2	3	1.5	Involve	Project	5	4.09	High	0.67

3.4.4. Proper risk allocation

Definition

A proper risk allocation is based on the conformity with the theoretical suggestion for risk allocation. Bing et al. (2005) provides a suggestion for risk allocation between the public and the private partner. In table 2.2 an overview is gives for a right risk allocation between the public and private partner, including the differences for a DBFM and a D&C contract type.

The project manager is close to the project and has good knowledge about the risks of the project. The opinion of the project manager can also be a good indication for a proper risk allocation. Therefore, a proper risk allocation will be defined as the conformity with the theoretical suggestion for risk allocation, and the project managers' perception of the risk allocation (table 3.11).

Table 3.11: Operationalization proper risk allocation	
Variable	**Indicators**
Type of risks allocated between public and private party.	1. Macro risks 2. Meso risks 3. Micro risks
Perception of risk allocation by project manager.	1. Satisfaction with this risk allocation 2. Different risk allocation

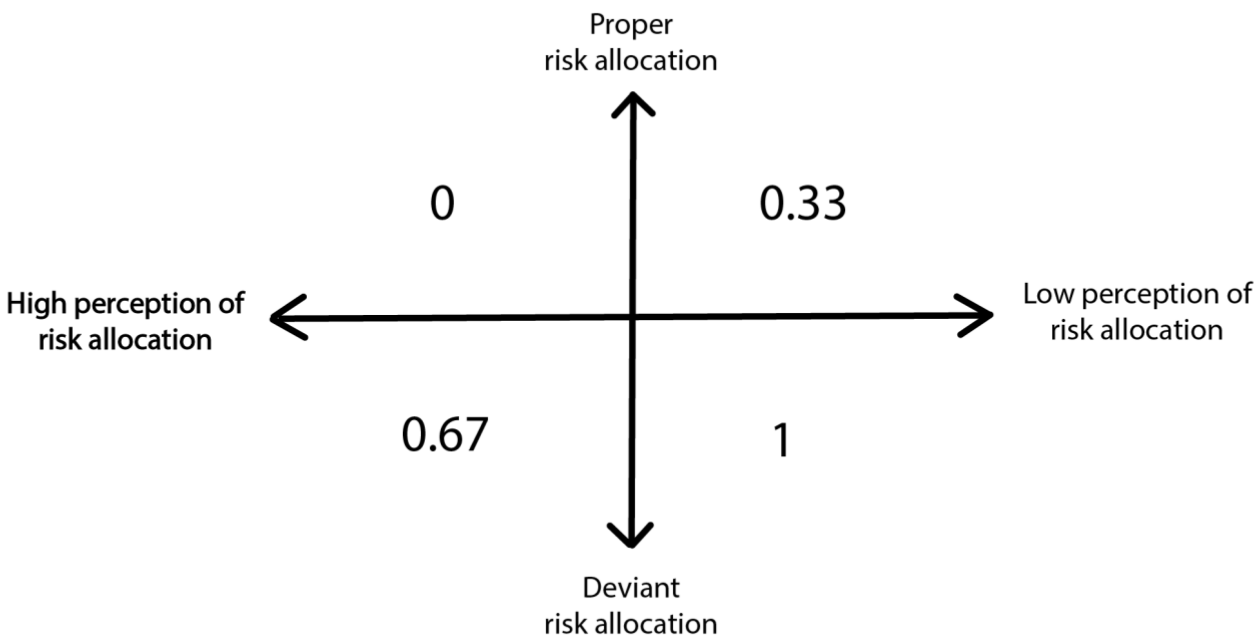


Figure 3.2: Calibration of proper risk allocation

Calibration

Risk allocation will be indicated with risks for each risk level and category allocated according to the model of Bing et al. (2005). It is expected that a risk allocation conform the theoretical suggestion will reduce cost overrun. So, for each type of risk that is allocated to the right party according to literature a score of 1 will be given, with a total of 12 points and a minimum of 0 points. When risks are shared when they should have been transferred, a half point is given. The average score is 8.14. Four cases are above the average score, and six cases below the average. Since the four cases above the average score range between 10.5 and 11, they have a maximum deviation of 1.5 from the maximum score. Therefore these four cases will be assigned a risk allocation conform the theory.

The perception of the risk allocation by the project manager had a more homogeneous result. Almost all project managers thought the risk allocation was quite good (for that specific contract type). For project P9 it was indicated the risks were allocated good, but some risks additional could have been transferred to the market. Therefore, project P9 is given a 'no' in the category of the perception of risks by the project manager. Three project managers (P1; P2; P18) stated the insight in the risks was not sufficient, or the risks were underestimated. This is not included in the calibration score, since this data was not collected for all the cases. But this information can be useful when going back to the cases.

In figure 3.2, the calibration of this condition is provided. As one can see, the risk allocation according to the theory has a higher weight than the perception of the project manager. It seems counterintuitive, but a calibration score of 1 indicates that this condition contributes to cost overrun, and therefore a calibration score of 0 contributes to cost underrun. So, a risk allocation according to the theoretical suggestion gives a score between 0 and 0.33, and therefore contributes to cost underrun. The reason that a risk allocation according to the theoretical suggestion has a higher weight compared to the perception of the project manager is the expectation that a proper risk allocation leads to better outcomes in a PPP, and also is a key performance indicator (see 2.4).

Table 3.12: Raw data and calibration proper risk allocation.

Case ID	Risk allocation score	Risk allocation conform theory	Right risk allocation perceived by project manager	Sufficient insight in the risks	Calibration score
P1	6	No	Yes	No	0.67
P2	11	Yes	Yes	No	0
P5	7	No	Yes	Yes	0.67
P7	6	No	Yes	Yes	0.67
P9	5.5	No	No	Yes	1
P10	11	Yes	No	Yes	0.33
P11	8	No	Yes	Yes	0.67
P16	10.5	Yes	Yes	-	0
P17	10.5	Yes	Yes	-	0
P18	8	No	Yes	No	0.67

3.4.5. Project size

Project size, in this research, is defined as the initial contract value of the main construction contract. This condition was categorized in previous research in four categories (Cantarelli et al., 2012c; Verweij et al., 2015). which are visible in table 3.12. So, a distinction was made between relative small projects, relative large projects, and the projects in between. The cases that were selected in this research, range between the categories 'large' and 'very large', since the smallest project has a project size of over €120 million. The project size of the case selection in this research is higher than the project size categories in literature. The cases in the initial case selection range between approximately €120 million and €1.4 billion.

Table 3.12: Project size clusters.

Cluster	Categories literature
1 Small	< €50 million (N=0)
2 Medium	€50 < €112.5 million (N=0)
3 Large	€112.5 < €225 million (N=5)
4 Very large	> €225 million (N=5)

Table 3.13: Calibration project size

Case ID	Project size cluster	Calibration score
P1	Large	0.33
P2	Large	0.33
P5	Large	0.33

P7	Large	0.33
P9	Very large	0
P10	Very large	0
P11	Very large	0
P16	Very large	0
P17	Very large	0
P18	Large	0.33

The calibration in table 3.13 only has cases with a calibration between 0 and 0.5. This calibration was chosen for the first analysis, because this calibration stays close the project size categories in the literature. Also, a calibration with more variety in the calibration, so also cases with scores of 1 and 0.67 might give too much weight to project size. For example P1 has a project size of €188 million, and thus belongs in the third group 'large'. With this calibration (table 3.13), P1 has a calibration score of 0.33. But compared to the cases that are selected in this research, P1 is a small project. As we saw in paragraph 2.5, it was expected that small projects had a higher chance to result in cost overrun, and thus it would be also a logical choice to calibrate P1 with a score of 1, which indicates a full membership of this condition on the outcome cost overrun. Therefore, project size is calibrated twice. The first calibration (table 3.13) stays close to the literature, and the projects only have membership in the categories 'large' and 'very large'. The second calibration (table 3.15), is based on project clusters of the initial case selection of this research (N=18), see table 3.13. Table 3.15 shows that with this calibration most of the cases have a calibration score between 0.5 and 1.

Table 3.14: Project size clusters 2		
Cluster	Project size	Calibration score
1 (N=5)	€120 million < €210 million	1
2 (N=3)	€210 million < €410 million	0.67
3 (N=1)	€410 million < €500 million	0.33
4 (N=1)	€1.300 million < 1.400 million	0

Table 3.15: Second calibration project size		
Case ID	Cluster	Calibration score
P1	1	1
P2	1	1
P5	1	1
P7	1	1
P9	2	0.67
P10	3	0.33
P11	2	0.67
P16	4	0
P17	2	0.67
P18	1	1

3.5 Ethical considerations

The data of Rijkswaterstaat is highly classified since it contains (financial) strategic information about projects. Therefore, it is important that the data will be anonymized in this thesis so that it cannot be

linked to individual projects. Also, during the thesis, the researcher has to be careful with the confidential information. The researcher has to comply with the confidentiality agreement (vertrouwensverklaring) between the University of Groningen and Rijkswaterstaat. Part of this agreement is the approval of Rijkswaterstaat before publishing the article, and sharing the data with the University of Groningen.
The interviews also have to be taking into consideration on the area of privacy. The interviews were made anonymously.

4. Results and analysis

In this chapter, the results of the QCA will be presented and interpreted. First, the analyses with the outcome ‘cost overrun’ (TCO) and ‘cost underrun’ (~TCO) will be done with the first calibration of project size (table 3.13). The second analyses will be done with the same outcomes, but the second calibration of project size (table 3.15).
The analyses with the categories of cost overrun was not possible. As is visible in table 3.5, the categories of cost overrun had too few cases that produced the outcome. The truth tables that were produced, therefore had a too low consistency (below 0.75) to be included in this research. Also, defining cost overrun based on the cost estimations before the tender process did not lead to more diverse results. So, only the outcome ‘total cost overrun’ (and cost underrun) is analyzed in this chapter.

The analysis was done with the QCA software fsQCA (Ragin & Davey, 2016). After the construction of the truth table, a “standard analysis” was done. This was recommended over “specify analysis” (Ragin, 2010), because the “standard analysis” is the only way to generate the “intermediate” solution. So the “standard analysis” provides all three types of solutions: complex; parsimonious, and intermediate. The intermediate solution includes only logical remainders, whereas the complex solution (no logical remainders), and the parsimonious solution (all logical remainders without any evaluation of the plausibility) (Ragin, 2009). For example, when a case has a full membership in all the conditions, but it does not produce the outcome, it not logical. In this research, the complex solution will be used. Gerrits & Verweij (2018) p.p. 109, argue that the complex solution “stays the closest to the case-based nature of QCA and to the empirical reality under investigation”. The algorithm that was used is the Quine-McCluskey algorithm (Ragin & Davey, 2016).

4.1 Cost overrun and cost underrun with first calibration of project size

4.1.1 Total cost overrun

First, an analysis of necessary conditions was done with ‘total cost overrun’ as the outcome. This analysis indicates the relation between the individual conditions and the outcome. A necessary condition is “a condition that must be present for the outcome to occur, but its presence does not guarantee that occurrence” (Ragin, 2009). A condition is considered necessary if the consistency score is at least 0.9 (Schneider & Wagemann, 2012 in Verweij et al., 2019). The analysis of necessary conditions showed that the condition ‘Contract Type’ had a consistency of 1.0, and the condition ‘proper risk allocation has a consistency of 0.901198, and thus are necessary conditions (table 4.1). However, the coverage is 0.556667 for CT and 0.643162 for PRA, this indicates the empirical relevance. Contract type is a necessary condition, because the four cases that have the score 0 for CT, also have the score 0 for TCO, and the other cases that have the score 1 for CT have mostly the score 0.67 or 1 for TCO. This explains the high score for necessity and thus a relation between contract type and cost overrun. Also for the condition PRA, the cases with a score of 0 or 0.33 for PRA also score a 0 for TCO, and most cases that score a 0.67 or a 1 also score a 0.67 or 1 for TCO. Only P9, is different because it scores a 1 for both CT and PRA, and the outcome (TCO) is 0. This will be reflected upon in the discussion.
The coverage for the necessary conditions is not really high. This can be explained due to the low amount of cases of the analysis. The other conditions have a low score on consistency, and are thus no necessary conditions.

Table 4.1: Analysis of necessary conditions for outcome ‘Total cost overrun’.

Condition	Consistency	Coverage

CT	1	0.556667
SM	0.598802	0.429185
PRA	0.901198	0.643162
PS	0.395210	0.800000

In the data matrix (table 4.2) the cases are shown as configuration of conditions and the outcome, in this case the 'total cost overrun' (TCO). As already mentioned, the score of the conditions indicate the membership of the condition. So, P1 has a full membership in contract type (CT), more out than in membership in type of stakeholder management (SM), more in than out membership in proper risk allocation (PRA), and a more out than in membership in project size (PS), and this results in a more out than in membership in the outcome TCO.

Table 4.2: Data matrix with outcome 'total cost overrun'.

Case ID	CT	SM	PRA	PS	Outcome TCO
P1	1	0.33	0.67	0.33	0.33
P2	0	0.33	0	0.33	0
P5	1	0	0.67	0.33	0.67
P7	1	1	0.67	0.33	0.67
P9	1	0.67	1	0	0
P10	0	0.67	0.33	0	0
P11	1	0.33	0.67	0	0.67
P16	0	0.33	0	0	0
P17	0	0.33	0	0	0
P18	1	0.67	0.67	0.33	1

The truth table (table 4.3) shows 4 rows of configurations of conditions which are empirically present in the cases of this research. In total there are 16 (2^4) configurations of conditions possible. The rows without cases present are removed from the truth table, since these are irrelevant for the analysis. Rows with a consistency below 0.75 may indicate inconsistencies. The first two rows have a consistency just below 0.75. Since these two rows have the highest consistency of the truth table, and they are just below the threshold of the cutoff point, they have been assigned an outcome score of 1. The other rows are considered inconsistent and therefore score a 0 on the outcome.

Table 4.3 : Truth table with total cost overrun as outcome

Case ID	CT	SM	PRA	PS	Outcome	RAW consist.	PRI consist.	SYM consist.
P1; P5; P11	1	0	1	0	1	0.749064	0.601191	0.601191
P7; P9; P18	1	1	1	0	1	0.749064	0.601191	0.601191
P2; P16; P17	0	0	0	0	0	0	0	0
P10	0	1	0	0	0	0	0	0

The (complex) solution that results from the standard analysis is shown in table 4.4. The solution is based on the first two rows of the truth table, since these rows produce the outcome. The cutoff point is 0.749064. There is one solution that leads to cost overrun: CT*PRA*~PS. This configuration is sufficient, there are no sufficient conditions found. The raw coverage measures for the proportion of membership in the outcome explained by each term of the solution (Ragin, 2010). The consistency measures the degree to which membership in each solution is a subset of the outcome (Ragin, 2010). For this solution, the consistency is around 0.69, and the coverage is around 0.9. The solution coverage gives an indication of the explanatory value of the solution. And the solution consistency measures the degree to which membership of the whole solution is a subset of membership in the outcome. In this case, there is only one solution, so both the solution coverage and consistency are equal to the raw coverage and consistency of the solution row. The solution is found in six cases that produce the outcome (cost overrun).

Table 4.4: Results for outcome 'total cost overrun'.				
Results	Raw coverage	Unique coverage	Consistency	Cases
CT*PRA*~PS	0.901197	0.901197	0.691954	P11; P5; P7; P18
Solution coverage			0.901197	
Solution consistency			0.691954	

Interpretation
The solution indicates that cases with a D&C contract, combined with a deviation of proper risk allocation, and a high project size result in cost overrun. As already mentioned, contract type and proper risk allocation were necessary conditions. This means that contract type has to be part of the solution. No sufficient conditions were found, only a sufficient configuration.

4.1.2 Negated total cost overrun
The negated cost overrun, or low cost overrun was also analyzed. Negation indicates a set-membership of $0.0 \leq x < 0.5$. So cases that have cost overrun between 0.0 and 0.5 belong to the negated total cost overrun. The analysis of necessary conditions shows no necessary conditions (table 4.5), since there are no conditions with a consistency above 0.9.

Table 4.5: Analysis of necessary conditions with ~total cost overrun as outcome		
Condition	Consistency	Coverage
CT	0.399399	0.443333
SM	0.498498	0.712446
PRA	0.448949	0.638889
PS	0.198198	0.800000

The truth table (table 4.6) shows four rows of configurations of conditions which are empirically present in cases of this research. The first two rows produce the outcome, with a consistency of 1.

Table 4.6: Truth table with ~total cost overrun as outcome.								
Case ID	CT	SM	PRA	PS	~Outcome	Raw consist.	PRI consist.	SYM consist.
P2; P16; P17	0	0	0	0	1	1	1	1
P10	0	1	0	0	1	1	1	1
P1; P5; P11	1	0	1	0	0	0.621723	0.398809	0.398809
P7; P9; P18	1	1	1	0	0	0.621723	0.398809	0.398809

The results in table 4.7 show one solution which lead to low cost overrun, based on the first two rows of the truth table. The solution coverage is around 0.5 and the consistency is 1. In the results, there are no sufficient conditions found, only a sufficient configuration. The cases that are present in this solution are P16; P17; P2; P10.

Table 4.7: Results for the outcome ~total cost overrun.				
Results	Raw coverage	Unique coverage	Consistency	Cases
~CT*~PRA*~PS	0.501502	0.501502	1	P16; P17; P2; P10
Solution coverage		0.501502		
Solution consistency		1		

Interpretation
This solution formula indicates that cases with a DBFM contracts, and a proper risk allocation, and a large project size result in cost underrun.

4.2 Analyses of cost overrun and cost underrun with second calibration of project size

In this second analysis, project size is calibrated with a smaller sample of cases (N=18) as presented in table 3.14 and table 3.15. The smaller case sample was the initial case selection for this research. This resulted in most of the cases having a full set-membership or 'more in than out' instead of all the cases being 'more out than in' or having no set-membership for the condition 'project size'.

4.2.1 Total cost overrun
The analysis of necessary conditions now shows that project size is a necessary condition as well. Table 4.9 shows that the two cases (P10; P16) with a membership between 0 and 0.5 for PS also score a 0 on TCO. Further, four cases also confirm a positive relation between PS and TCO, these are P5; P7; P11; P18. So, in total six out of 10 cases support the individual relation between PS and TCO, this explains the low coverage of the analysis of necessary conditions for PS.
Therefore, with this analysis, there are three necessary conditions for the outcome to occur: contract type, proper risk allocation, and project size. The data matrix gives an overview of the calibrated data (table 4.9).

Table 4.8: Analysis of necessary conditions with 'total cost overrun' as outcome.		
Condition	Consistency	Coverage
CT	1	0.556667
SM	0.598802	0.429185
PRA	0.901198	0.643162
PS	1	0.455041

Table 4.9: Data matrix with outcome 'total cost overrun'.					
Case ID	CT	SM	PRA	PS	Outcome TCO
P1	1	0.33	0.67	1	0.33
P2	0	0.33	0	1	0
P5	1	0	0.67	1	0.67

P7	1	1	0.67	1	0.67
P9	1	0.67	1	0.67	0
P10	0	0.67	0.33	0.33	0
P11	1	0.33	0.67	0.67	0.67
P16	0	0.33	0	0	0
P17	0	0.33	0	0.67	0
P18	1	0.67	0.67	1	1

The truth table (table 4.10) has five rows which are empirically present in the cases. The first two rows have a consistency of just below 0.75. According to Gerrits & Verweij (2018), a score of below 0.75 may indicate sever inconsistencies, however it is important to revisit the cases. Also gaps between the consistency scores can indicate valuable information Ragin (2009). Therefore, these configurations are assigned a score of 1.

Table 4.10: Truth table with total cost overrun as outcome.

Case ID	CT	SM	PRA	PS	Outcome (TCO)	Raw consist.	PRI consist.	SYM consist.
P1; P5; P11	1	0	1	1	1	0.749064	0.601191	0.601191
P7; P9; P18	1	1	1	1	1	0.749064	0.601191	0.601191
P2; P17	0	0	0	1	0	0	0	0
P16	0	0	0	0	0	0	0	0
P10	0	1	0	0	0	0	0	0

There is one solution in this analysis for cost overrun: CT*PRA*PS (table 4.11). Cases with a D&C contract, and a deviation of proper risk allocation, and a relative small project size are more likely to have cost overrun. This solution has a coverage of around 0.9, and a consistency around 0.75. Again, there are no sufficient conditions found, only one sufficient configuration. The difference with the previous analysis of total cost overrun is the condition 'project size'. In the previous analysis, project size was negated, in this analysis project size is not negated. This can be explained to the different calibration of the condition 'project size'. The first calibration of project size only shows cases that are below 0.5, and therefore that calibration is less useful for the analyses. P1 and P9 is examples of a logic contradiction. These cases have the same configuration of conditions as the first two rows, however the outcome is different. P1 was in the first row together with P5 and P11, but was removed because P1 has cost underrun instead of cost overrun. P9 used to be in the same row with P7 and P18. However P9 has a different outcome with the same configuration. P9 has cost underrun as the outcome. Therefore P9 was removed from the truth table. P1 and P9 will be addressed in the discussion since it is interesting to find out why there is a logical contradiction, and why these cases have different results than theoretically expected.

Table 4.11: Results with total cost overrun as outcome.

Results	Raw coverage	Unique coverage	Consistency	Cases
CT*PRA*PS	0.901198	0.901198	0.748756	P5; P7; P11; P18
Solution coverage			0.901198	
Solution consistency			0.748756	

Frequency cutoff: 1
Consistency cutoff: 0.748756

Interpretation
This solution (CT*PRA*PS) is represented by four cases (P5; P7; P11; P18). This solution indicates that a D&C contract with a deviating or 'improper' risk allocation and a relative small project size result in cost overrun.

4.2.2 Negated total cost overrun
The analysis of necessary conditions shows no necessary conditions (table 4.12).

Table 4.12: Analysis of necessary conditions with ~total cost overrun as outcome.		
Conditions	Consistency	Coverage
CT	0.399399	0.443333
SM	0.498498	0.712446
PRA	0.448949	0.638889
PS	0.650150	0.589918

The truth table (table 4.13) shows five rows with configurations that produce cost underrun. The first three rows are consistent with a consistency of 1. The data matrix (table 4.9) shows that there are six cases that produce cost underrun. P1 and P9 also produce cost underrun, but as already mentioned these cases are logical contradictions because they have the same configuration as other cases that lead to cost overrun.

Table 4.13: Truth table with ~TCO as outcome								
Case ID	CT	SM	PRA	PS	Outcome (~TCO)	Raw consist.	PRI consist.	SYM consist.
P2; P17	0	0	0	1	1	1	1	1
P16	0	0	0	0	1	1	1	1
P10	0	1	0	0	1	1	1	1
P1; P5; P11	1	0	1	1	0	0.621723	0.398809	0.398809
P7; P9; P18	1	1	1	1	0	0.621723	0.398809	0.398809

The results of the analysis are two solutions, presented in table 4.14. The frequency cutoff and the consistency cutoff are both 1. So, the solution includes the first three rows of the truth table. Four cases are present in the two solutions (P2; P10; P16; P17). There are no sufficient conditions identified, only two sufficient configurations. The consistency of the solution is 1 and the coverage is 0.451952.

Table 4.14: Results with ~TCO as outcome				
Results	Raw coverage	Unique coverage	Consistency	Cases
~CT*~PRA*~PS	0.3003	0.100601	1	P16; P10
~CT*~SM*~PRA	0.351351	0.151652	1	P2; P16; P17
Solution coverage		0.451952		
Solution consistency		1		

Interpretation

In the first solution ~CT*~PRA~PS, two cases are present (P16; P10). This solution indicates that projects tendered with a DBFM contract, has a proper risk allocation according to the theory, and belongs to the category 'very large' projects, result in cost underrun.

In the second solution ~CT*~SM*~PRA, three cases are present (P2; P16; P17). This solution indicates that projects tendered with a DBFM contract, a process oriented type of stakeholder management, and a proper risk allocation lead to negated cost overrun. So this configuration of conditions also lead to cost underrun.

5. Discussion and conclusion

In this chapter the results of the data analyses will be discussed. First, the main findings will be related to some of the cases. Then, the results will be related to the theoretical expectations. After that, the research questions will be answered. Then, the practical and theoretical relevance will be discussed, and finally, the limitations of this research will be addressed.

5.1 Main findings and relation to the cases

First of all, the two analyses with the different calibration for the condition project size will be discussed. The analyses with the outcome 'cost overrun' both have a solution that includes the conditions 'contract type', 'proper risk allocation', and 'project size'. The first two conditions remain the same in both solution formulas, however the condition 'project size' changes from 'negation' to 'normal'. So, the formula changes from CT*PRA*~PS to CT*PRA*PS. The first formula CT*PRA*~PS → cost overrun means that projects with a D&C contract, and an improper risk allocation and a large project size result in cost overrun. In the second formula, the condition 'project size' (PS) changes from a large project size to a relative small project size. This means that the calibration of 'project size' influences the role of the condition 'project size' in the solution formula. In the analyses with the outcome 'cost underrun' the solution formula from the first analysis (~CT*~PRA*~PS) stays also in the second analysis (table 4.7; table 4.14). And an additional solution term appears in the second analysis: ~CT*~SM*~PRA. The first solution term means that projects with a DBFM contract, and a proper risk allocation, and a large project size lead to cost underrun. The second solution term means that projects with a DBFM contract, and a process management style, and a proper risk allocation also lead to cost underrun. As the data matrix for the second analyses shows (table 4.9), only two cases belong to the category 0 - 0.5 for the condition 'project size' instead of all the cases. As a result, the negated project size has a lesser influence on the outcomes.

Second, the first calibration of the condition 'project size' had little variation among the cases. The cases only had a set-membership between 0 and 0.5 for the condition 'project size' (table 3.13). Therefore, there was no variation for the condition 'project size' (PS) in the truth table (table 4.3). In order to resolve the issue of limited diversity a second calibration of the condition 'project size' was done. The second calibration of the condition 'project size' has more variation and contains cases for all the project size categories. This calibration is based on the project size of the cases that were selected for this research, while the first calibration of the condition 'project size' was based on a larger sample of cases out of the dataset of Rijkswaterstaat. This large sample includes many cases that belong in the category 'small' cases. Since the cases that were selected for this research only include large cases, the first calibration has no cases in the categories 'small' and 'medium' (table 3.12). The second calibration of 'project size' had cases in all the clusters since the clusters were based on the case selection for this research. However, it has to be noticed that cases with a score of 1 (which means a relative small project) are by no means small projects. The smallest group of projects in the case selection for this research belong in the category 'large' in the groups in other research (Cantarelli et al., 2012c; Verweij et al., 2015).

When looking at the cases in the data matrices and truth tables, two cases are logical contradictions. This means that the cases P1 and P9 both have a configuration of conditions that leads to cost overrun (table 4.10), however these cases have cost underrun. Looking at the characteristics of the contradictory cases, P1 has a D&C contract, a process management style with a low FTE deployment (table 3.10), an improper risk allocation according to the theory, but the project manager perceived a right risk allocation, and a relative small project size, the outcome is a medium cost overrun of 15.89% (table 3.3), labelled as cost underrun in this research. P1 has the same configuration of conditions as the cases P5 and P11, however these cases result in cost overrun (P5, 43.53%; P11, 40.87%). The biggest cause of cost overrun in P1 is mostly technical necessity (8.21%) and scope changes (6.12%), in P5 it is technical necessity (33.09%), and for P11, the biggest cause is allocated to scope changes (40.05%). P5 is the only case that has a process management style and a high FTE deployment, which is expected to contribute to cost underrun. However, this management style is associated with cases that have a high complexity. High complexity is associated with many external stakeholders, and often a large project size. Projects with a high complexity need to be managed in such a way that the external stakeholders are collaborating when issues arise, and there is an emphasis on interaction with the societal environment. Looking at the project size, P5 has a relative low project size, which is often associated with a (relative) low complexity. P11 also has a process management style, but with a low FTE deployment. P11 falls in the category 'medium' project size, which is still relative low.

P9 has the same configuration of conditions as the cases P7 and P18, which is a D&C contract, a project management style, an improper risk allocation and a relative small project size, the outcome is cost underrun for P9 (7.05%) and cost overrun for P7 (32.29%) and P18 (71.78%). Looking at table 3.2, cost overrun in P7 is caused by scope changes for a large part (20.49%) and technical necessity also accounts for a large part of cost overrun (11.56%). For P9, the largest part of cost overrun is caused by omission (5.47%). And for P18, scope changes are by far the largest cause of cost overrun (69.07%).

Since there is was not an in depth study done of all the cases, the findings cannot be linked to more qualitative aspects of these cases. To really be able to explain why these cases are deviants, these cases have to be included in further research as well.

5.2 Relation between the findings and theory

First, the analysis of necessary conditions and the solution formula for the outcome 'cost overrun' will be discussed. The analysis of necessary conditions for the outcome 'cost underrun' showed no necessary conditions. The analysis of necessary conditions for 'cost overrun' showed three necessary conditions (table 4.8). The necessity of a condition indicate the individual relation between a condition and the outcome. In QCA it is not that common that necessary conditions occur. An explanation for the appearance of these three necessary conditions can be that there is little variation among the cases. This had to do with the results of the data collection. The limitations of the data and the analyses will be discussed in paragraph 5.6.
It is expected based on the theory that contract type can have an impact on cost overrun (see 2.2). Also contract types are associated with project size. This might explain the necessity of the condition 'contract type' on 'cost overrun'. Also the condition 'proper risk allocation' is a necessary condition. A proper risk allocation also belongs to the mostly identified Critical Success Factors (CSF) for PPPs. And lastly, project size also is a necessary condition. According to literature, project size seems to have an impact on cost overrun.

5.2.1 Contract type

The condition 'contract type' was present in all three solution terms. The solution formula for cost overrun is: CT*PRA*PS. So, CT*PRA*PS → cost overrun. Projects with a D&C contract, an improper risk allocation and a relative small project size result in cost overrun according to this solution formula. The first solution term for cost underrun is: ~CT*~PRA*~PS. So, ~CT*~PRA*~PS → cost underrun. This means that projects with a DBFM contract, a proper risk allocation and a large project size lead to cost underrun. The other solution term for cost underrun is: ~CT*~SM*~PRA. So, ~CT*~SM*~PRA → cost underrun. The first conclusion is that D&C contracts are part of the configuration that leads to cost overrun, and DBFM contracts are part of the configuration that leads to cost underrun. The analysis of necessary conditions shows that the condition ‘contract type’ (CT) is a necessary conditions, and thus has a relation with cost overrun. Why is it expected that D&C contracts contribute to cost overrun and DBFM contracts contribute to cost underrun? D&C contracts are not financed privately, and therefore lack an additional incentive to reduce cost overrun. When a project is financed with privately, there might arise problems to get additional resources in case of cost overrun (Verweij & van Meerkerk, 2018). This stimulates contractors to reduce cost overrun. Also, the bundling of project phases stimulates contractors to be efficient, since the maintenance is included in the contract (Ng & Loosemore, 2007). Due to private finance, and the payment for availability of the road (or a fine when the road is not available), the private partner has an incentive to reduce cost overrun. And in order to get a loan, the risk management of the private partner has to be of high quality. Therefore, D&C contracts don’t have an expected positive relation with cost underrun. And it is in line with the literature that D&C contracts contribute to cost overrun.

5.2.2 Type of stakeholder management

The condition ‘type of stakeholder management’ only occurs in the solution term for cost underrun. The type of stakeholder management that contributes to cost underrun is process management. The management of a PPP is regarded important to ensure successful outcomes (Klijn et al., 2008; Verweij, 2015), which can be associated with cost underrun. Edelenbos & Klijn (2009) argue that process management is more suited for projects with a higher complexity, and that smaller projects with a low complexity might be better off with a project management style. Large projects are more likely to have more complex stakeholders interrelationships and conflicting interests, a higher project uncertainty, and more public attention and controversies (Mok et al., 2015). Therefore in this research, project size is expected to have a positive relation with complexity. Projects with a DBFM contract are generally very large projects, that therefore are also likely to have a quite high complexity. In the solution term ~CT*~SM*~PRA → cost underrun, a DBFM contract, with a process management style and a proper risk allocation contribute to cost underrun. This solution term is in line with the theoretical expectations. The combination of a DBFM contract and a process management style has a positive relation with cost underrun.

5.2.3 A proper risk allocation

According to the literature, a proper risk allocation is really important for a successful infrastructure project (Ng & Loosemore, 2007; Osei-Kyei & Chan, 2015). Risks need to be allocated to the party that is best able or has an incentive to manage these risk effectively (Ng & Loosemore, 2007; Burke & Demirag, 2017). Since, projects with a DBFM contract have an incentive to reduce cost overrun, DBFM contracts have a higher risk transfer compared to D&C contracts. Since a proper risk allocation is among the mostly identified critical success factors (CFS) for PPPs (Osei-Kyei & Chan, 2015) it seems logical that an improper risk allocation contributes to cost overrun. The findings also indicate that an improper risk allocation contributes to cost overrun, and a proper risk allocation contributes to cost underrun. So, a risk allocation in accordance with the theory (Bing et al., 2005), has a positive relation with cost underrun.

5.2.4 Project size

The condition ‘project size’ is less straightforward to interpret than the previous conditions. This has to do with the fact that ‘project size’ was calibrated twice based on different clusters in order to be used properly in the QCA. Therefore, two analyses with different calibrations of ‘project size’ were done. The first calibration (table 3.13) was done based on cluster identified in literature (Cantarelli et al., 2012c; Verweij et al., 2015). The second calibration (table 3.15) was done based on clusters within the initial case

selection of this research, which included only large cases (> €120 million). So, a 'small' project in this research is only relative small since these 'small' projects are still quite large.
Various authors state the large projects are more likely to perform better (Mahamid, 2013; Odeck, 2004; Cantarelli et al., 2012c; Verweij et al., 2015). This may have to do with a better project management (Odeck, 2004) e.g. more experienced managers, or the type of stakeholder management (Edelenbos & Klijn, 2009). However, Anastasopoulos et al. (2014) argues that large projects are generally more likely to have cost overrun. And Flyvbjerg et al. (2004) argues that larger projects only have cost escalations for bridges and tunnels. The definition of cost overrun according to Flyvbjerg however includes also the decision-making process, unlike the definition of cost overrun in this research.
The results differ with regard to the project size. In the first analysis, project size occurs in both solution formulas as ~PS, which means a large project size. So, this means that a large project size contributes both to cost overrun as to cost underrun. However, in the second analysis project size occurs in the solution formula for cost overrun as relative small project size, and in the solution formula for cost underrun as large project size. This nuance in the second calibration of project size indicate that a very large project size (between €420 million and €1.400 million) contribute to cost underrun, but that a relative small project size (between €120 million and €410 million) contribute to cost overrun. However, the project size has to be seen as part of the solution.

The other conditions of the formula are expected individually to contribute to cost overrun, however they seem to fit together. Smaller projects are better off with a simpler (D&C) contract than a complicated DBFM contract. However, small projects in this context are relatively large. What can be concluded is that projects within the categories between €120 million and €410 million combined with a D&C contract and an improper risk allocation lead to cost overrun. This solution is supported by four cases, however the consistency is just below the threshold of being consistent (table 4.11).

So, this solution is also much in accordance with the literature. However, of the projects that are representing this solution (P2; P16; P17), only P16 has a high project size, the other projects score a 1 and a 0.67 on the condition 'project size'. Still, this is in line with literature, since these projects can be labelled as quite large projects. This solution, therefore also contributes to the literature on cost overrun in infrastructure projects.

There are two solution formulas for cost underrun. In literature, integrated contracts like DBFM are expected to more efficient than traditional contracts. Also, studies showed that projects with a DBFM contract in the Netherlands had less cost overrun compared to projects with a D&C contract. As already mentioned, a proper risk allocation is a CSF for PPPs. So, it seems to be a logical part of the solution for cost underrun. And also the large project size is in accordance with the theory in relation with cost underrun. It was expected that projects with a DBFM contract and a large project size resulted in cost underrun, so this solution supports the theoretical expectation of the combined effect of contract type with project size on cost underrun. This solution is supported by two cases (table 4.14).

5.3 Research questions

In order to answer the primary research question of this thesis, first the secondary research questions will be addressed.
The first research question regards the relation between contract types and cost overrun. Based on the theory, (paragraph 2.2) it is expected that integrated contracts such as DBFM contracts do perform better than less integrated contracts (D&C) or traditional contracts (Ng & Loosemore, 2007; Engel et al., 2011). Empirically, there also seems to be a relation between contract type and cost overrun. The analysis of

necessary conditions shows that the condition 'contract type' is a necessary condition. However, as already mentioned, the reliability of the analysis of necessary conditions is questioned, since it is rare that three conditions are considered necessary. The results of the QCA are about configurations of conditions that lead to cost overrun and cost underrun. But to answer the research question, based on the findings in this research D&C contracts seem to contribute to cost overrun, and DBFM contracts seem to contribute to cost underrun.
Contract type is also part of both solutions which lead to cost overrun and cost underrun. The solutions indicate that projects with a D&C contract in combination with an improper risk allocation and a relative small project size (which is still quite large), are related to cost overrun. And projects with a DBFM contracts in combination with a proper risk allocation, and a large project size, and projects with a DBFM contract, and a process management style, and a proper risk allocation are related to cost underrun. The results indicate that DBFM contracts are part of the solution to cost underrun, and D&C contracts are part of the solution to cost overrun. The configurational parts of the solution will be addressed later in this paragraph.

The second research question is about the relation between stakeholder management and cost overrun. Based on the theory, there is not a clear individual relation between type of stakeholder management and cost overrun. But, the type of stakeholder management in relation with the complexity of a project seem to have a relation on cost overrun. Process management is more suited for projects with a higher complexity, and project management fits better to projects with a lower complexity. It is expected that stakeholder management has an impact on satisfactory outcomes, in this case cost overrun. However, the configuration with other conditions such as project size and contract type has stronger theoretical expectations than the individual relation of stakeholder management on cost overrun. Empirically, the condition' type of stakeholder management' is no necessary condition, so there is no strong relation of the individual relation with cost overrun. Looking at the solutions, the type of stakeholder management is present in one of the three solutions: ~CT*~SM*~PRA. So, a process management type, with a DBFM contract, and a proper risk allocation leads to cost underrun. This solution is supported by three cases (table 4.14). Adding more cases might give more insight in the influence of the condition 'type of stakeholder management'.

The third research question regards the relation between a proper risk allocation and cost overrun. According to the theory, a proper risk allocation is relevant for a successful outcome. So, a proper risk allocation has a relation on cost overrun. This means that a DBFM contract also implies a higher risk transfer to the private party compared to a D&C contract. Empirically, the conditions 'proper risk allocation' was also a necessary condition. This means that there was an individual relation found between a proper risk allocation and cost overrun. This condition is present in all the three solutions, and indicate that an improper risk allocation as part of a configuration of conditions contribute to cost overrun and a proper risk allocation as part of a configuration of conditions contribute to cost underrun.
The fourth research question is about the relation between project size on cost overrun in PPPs. According to the literature, there are suggestions that project size has a positive relation with cost overrun. Empirically, project size was also a necessary condition for cost overrun to occur. The four projects with cost overrun were relative small projects. However, no hard conclusions of a positive relation between project size and cost overrun can be drawn from this finding. Project size is also part of two out of the three solutions. The results may indicate that relative small projects contribute to cost overrun and relative large projects contribute to cost underrun.
The last secondary question is about which configurations of conditions will lead to cost overrun in infrastructure PPPs. This was already addressed in paragraph 5.2. To sum up, there was one solution formula which leads to cost overrun:

CT*PRA*PS

And two solution provide the outcome cost underrun:

~CT*~PRA*~PS
~CT*~SM*~PRA

The primary research question can now be answered.

"How do contract types, type of stakeholder management, a proper risk allocation, and the project size influence cost overrun of road infrastructure tendered as a public-private partnership?"

Based on theoretical and empirical findings (which are quite in line with each other), it is expected that projects with a combination of a D&C contract, an improper risk allocation compared to the risk allocation of Bing et al. (2005), and a relative small project size, lead to cost overrun. Since a relative small project size still can be regarded as large, this finding also contributes to the expectation that large projects which are procured with a contract different than a DBFM like contract are more likely to result in cost overrun (Anastasopoulos et al., 2014).
There are also two solution formulas that lead to cost underrun. This brings the expectation that projects with a DBFM contract, a proper risk allocation and a high project size lead to cost underrun. The results regarding the DBFM contract are in line with the article of Anastasopoulos et al. (2014) that large projects with a DBFM like contract are less likely to result in cost overrun. Also, it is expected that projects with a combination of a DBFM contract, a 'proper risk allocation' and a large project size have a positive relation on cost overrun. This solution is in line with theoretical expectations, since a DBFM contract, a proper risk allocation, and a large project size also were expected to have a positive relation with cost overrun based on the theory.
Projects with a combination of a DBFM contract, a process management type, and a proper risk allocation lead to cost underrun as well. It was expected that process management was suited for projects with a high complexity. As already argued, large projects and DBFM contracts are associated with a high complexity. So, this finding is also in line with the theoretical expectations.

5.4 Practical relevance

The first relevant finding is that four out of the ten cases in this research result in cost overrun. The types of cost overrun were not included in the QCA analyses because there was too little variation, however most of the cost overrun is found in the category 'scope changes'.

Also, one solution is found that leads to cost overrun: the combination of a D&C contract with an improper risk allocation, and a relative small project size. Since this research had its limitations (see 5.5), further research is needed to get more insight in the effects of conditions on cost overrun.
Since both the solution terms to cost underrun includes the DBFM contract type, it is advised to keep using the DBFM contract for large projects with the proper risk allocation according to the literature. Also, the combination of the DBFM contract with process management and a proper risk allocation leads to cost underrun. So, it is also advised to combine the DBFM contract with a process management style.

Finally, it is recommended to facilitate research in this topic by storing relevant data of previous research in way that future researchers can easily pick up this topic. Also, keeping track of relevant data of current projects (such as the FTE deployment for internal/external stakeholder management, or risk data) would help researching this topic (and other topics) since this data was hard (for some projects not) to derive.

5.5 Theoretical relevance

The results of this research contribute to academia since there was a research gap into the effects of configurations of conditions on cost overrun. Most of the conditions had expected individual relations on cost overrun. These relations were researched and put together in the theoretical framework. Also, briefly some relations between the conditions were found, but due to the limited amount of time this was not done for all the combinations of conditions. But the results give insight in the configurational effects on cost overrun and cost underrun. These result confirmed theoretically suggested relations between the conditions with positive effects on cost underrun for 'DBFM contract' and 'process management', 'DBFM contract' and 'large project size'. There are no really deviating results in these configurations, since they are quite in line with theoretical expectations. However, two cases are deviating. It would be interesting to research why these cases have cost underrun with a configuration that leads to cost overrun.

As a suggestion for further research, it might be interesting to study more or different conditions on cost overrun like the composition of the private consortium (see Verweij et al., 2019), the procurement result (Verweij et al., 2015), or the occurrence of innovation. It may be interesting to see what the configurational effect of the conditions on cost overrun are.

5.6 Limitations and reflection of the research

First, most of the literature regarding cost overrun addressed the single relation between the conditions and cost overrun. The theoretical framework therefore was designed to build up theoretical expectations for the relation between the single conditions on cost overrun. Also, not for all the conditions clear relations were found with cost overrun. For example, for the condition 'type of stakeholder management' there were some indications that process management would lead to satisfactory outcomes. This could be linked to cost overrun, but this was not explicitly mentioned in the articles. Also, only four conditions were included in this research. The decision for four conditions was also influenced by the characteristics of the QCA method. Adding too many conditions for a few cases can cause a limited diversity to occur (Berg-Schlosser & De Meur, 2009). Then a large part of the possible combinations of conditions would not be filled with cases that are empirically present.

Second, the initial case selection included 18 cases. Finally, only data was collected from 10 cases, either because the project manager did not have time to look up the required information in order fill in the questionnaires, or the project was implemented too long ago and the data was not easily available. In some cases, the current (project) manager was not the project manager in the implementation phase, and therefore was not able to answer the questions. Sometimes contact was initiated with other managers from the IPM model such as contract managers or risk managers. Due to a lack of time, and the interference of the summer vacation, the researcher had to stop the data collection at 10 cases. If more cases were added, maybe more solution term were identified. Also, probably there would be more variation among the cases which could improve the outcomes of the QCA.

Third, due to a lack of variety in the outcomes of different categories of cost overrun (table 3.7), the analyses were only done with the outcome 'total cost overrun' and 'total cost underrun'. This has influenced this research to be less comprehensive since the types of cost overrun were excluded of the QCA. I tried to calibrate the different types of cost overrun based on different clusters, but there were no sufficient configurations found for each of the different types of cost overrun.

Last, the data that was collected is for most cases based on the results of the questionnaires. When sending out the questionnaires, there was given an invitation to do an interview in order to give an elucidation of the data. The decision to give the option for an interview or questionnaire was made to get a high response rate keeping in mind that most project managers were busy. So, most project managers filled in the questionnaire. For most of the cases, I spoke to one or two managers (depending on the data still needed). A higher amount of managers might improve the data was collected. Also, the data on stakeholder management was quite homogeneous. Almost all the answers indicated a process management style. For further research, it would be good do interviews in order to get a better indication on this condition.

6. References

Anastasopoulos, P. C., Haddock, J. E., & Peeta, S. (2014). Cost Overrun in Public-Private Partnerships: Toward Sustainable Highway Maintenance and Rehabilitation. *Journal of Construction Engineering and Management*, *140*(6), 04014018. https://doi.org/10.1061/(asce)co.1943-7862.0000854

Berg-Schlosser, D. & Meur, G. (2009). Comparative research design: case and variable selection. In Rihoux, B., & Ragin, C. C. *Applied Social Research Methods: Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques* (Vol. 51, pp. 19-32). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781452226569

Berg-Schlosser, D., Meur, G., Rihoux, B. & Ragin, C. (2009). Qualitative comparative analysis (qca) as an approach. In Rihoux, B., & Ragin, C. C. (2012) *Applied Social Research Methods: Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques* (Vol. 51, pp. 1-18). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781452226569

Bing, L., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005). The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of Project Management*, *23*(1), 25–35. https://doi.org/10.1016/j.ijproman.2004.04.006

Brown, K. (2007). Are Public–Private Transactions the Future of Infrastructure Finance? *Public Works Management & Policy*, *12*(1), 320–324. https://doi.org/10.1177/1087724X07303680

Burke, R., & Demirag, I. (2017). Risk transfer and stakeholder relationships in Public Private Partnerships. *Accounting Forum*, *41*(1), 28–43. https://doi.org/10.1016/j.accfor.2016.06.004

Cantarelli, C. C., Flyvbjerg, B., & Buhl, S. L. (2012a). Geographical variation in project cost performance: the Netherlands versus worldwide. *Journal of Transport Geography*, *24*, 324–331. https://doi.org/10.1016/j.jtrangeo.2012.03.014

Cantarelli, C. C., Molin, E. J. E., Van Wee, B., & Flyvbjerg, B. (2012b). Characteristics of cost overruns for Dutch transport infrastructure projects and the importance of the decision to build and project phases. *Transport Policy*, *22*, 49–56. https://doi.org/10.1016/j.tranpol.2012.04.001

Cantarelli, C. C., Van Wee, B., Molin, E. J. E., & Flyvbjerg, B. (2012c). Different cost performance: Different determinants?. The case of cost overruns in Dutch transport infrastructure projects. *Transport Policy*, *22*, 88–95. https://doi.org/10.1016/j.tranpol.2012.04.002

Cantarelli, C. C, Flyvbjerg, B., Molin, E. J. E., & Van Wee, B. (2011). Cost Overruns in Large-scale Transportation Infrastructure Projects: Explanations and Their Theoretical Embeddedness. *European Journal of Transport and Infrastructure Research*, *10*(1), 5–18. https://doi.org/10.18757/ejtir.2010.10.1.2864

Cantarelli, Chantal C., Flyvbjerg, B., van Wee, B., & Molin, E. J. E. (2010). Lock-in and its influence on the project performance of large-scale transportation infrastructure projects: Investigating the way in which lock-in can emerge and affect cost overruns. *Environment and Planning B: Planning and Design*, *37*(5), 792–807. https://doi.org/10.1068/b36017

Cavalieri, M., Cristaudo, R., & Guccio, C. (2019). On the magnitude of cost overruns throughout the project life-cycle: An assessment for the Italian transport infrastructure projects. Transport Policy, 79(January), 21–36. https://doi.org/10.1016/j.tranpol.2019.04.001

CBS (2018). *Rijk; uitgaven en ontvangsten begrotingshoofdstukken.* Retrieved on 5 February, 2019 from: https://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=60050

Chasey, A. D., Maddex, W. E., & Bansal, A. (2012). Comparison of Public–Private Partnerships and Traditional Procurement Methods in North American Highway Construction. *Transportation Research Record: Journal of the Transportation Research Board*, *2268*(1), 26–32. https://doi.org/10.3141/2268-04

Cruz, N. F. da, & Marques, R. C. (2012). Delivering Local Infrastructure through PPPs: Evidence from the

School Sector. *Journal of Construction Engineering and Management*, *138*(12), 1433–1443. https://doi.org/10.1061/(asce)co.1943-7862.0000558

De Bruijn, H., Heuvelhof, E., & Veld, R. (2010). *Process management: Why project management fails in complex decision making processes*. *Process Management: Why Project Management Fails in Complex Decision Making Processes* (Second). Springer. https://doi.org/10.1007/978-3-642-13941-3

De Schepper, S., Dooms, M., & Haezendonck, E. (2014). Stakeholder dynamics and responsibilities in Public-Private Partnerships: A mixed experience. *International Journal of Project Management*, *32*(7), 1210–1222. https://doi.org/10.1016/j.ijproman.2014.01.006

Edelenbos, J., & Klijn, E.-H. (2007). Trust in Complex Decision-Making Networks. *Administration & Society*, *39*(1), 25–50. https://doi.org/10.1177/0095399706294460

Edelenbos, J., & Klijn, E. H. (2009). Project versus process management in public-private partnership: Relation between management style and outcomes. *International Public Management Journal*, *12*(3), 310–331. https://doi.org/10.1080/10967490903094350

Edelenbos, J., & Teisman, G. R. (2008). Public-private partnership: On the edge of project and process management. Insights from Dutch practice: The Sijtwende spatial development project. *Environment and Planning C: Government and Policy*, *26*(3), 614–626. https://doi.org/10.1068/c66m

El-Gohary, N. M., Osman, H., & El-Diraby, T. E. (2006). Stakeholder management for public private partnerships. *International Journal of Project Management*, *24*(7), 595–604. https://doi.org/10.1016/j.ijproman.2006.07.009

Engel, E., Fischer, R., & Galetovic, A. (2011). Public-Private Partnerships to Revamp U.S. Infrastructure. *The Hamilton Project*, (February), 1–26. Retrieved from http://www.brookings.edu/papers/2011/02_partnerships_engel_fischer_galetovic.aspx

Flyvbjerg, B., Ansar, A., Budzier, A., Buhl, S., Cantarelli, C., Garbuio, M., … van Wee, B. (2018). Five things you should know about cost overrun. *Transportation Research Part A: Policy and Practice*, *118*(2), 174–190. https://doi.org/10.1016/j.tra.2018.07.013

Flyvbjerg, B., Holm, M. K. S., & Buhl, S. L. (2004). What Causes Cost Overrun in Transport Infrastructure Projects? *Transport Reviews*, *24*(1), 3–18. https://doi.org/10.1080/0144164032000080494a

Gerrits, L., & Verweij, S. (2018). *The Evaluation of Complex Infrastructure Projects : A Guide to Qualitative Comparative Analysis*. Cheltenham, UK: Edward Elgar Publishing. Retrieved from http://search.ebscohost.com.proxy-ub.rug.nl/login.aspx?direct=true&db=nlebk&AN=1830942&site=ehost-live&scope=site

Grimsey, D., & Lewis, M. (2005). Are Public Private Partnerships value for money?. *Accounting Forum*, *29*(4), 345-378. doi: 10.1016/j.accfor.2005.01.001

Hodge, G. A., & Greve, C. (2017). On Public–Private Partnership Performance: A Contemporary Review. *Public Works Management and Policy*, *22*(1), 55–78. https://doi.org/10.1177/1087724X16657830

Jørgensen, M., Halkjelsvik, T., & Kitchenham, B. (2012). How does project size affect cost estimation error? Statistical artifacts and methodological challenges. *International Journal of Project Management*, *30*(7), 839–849. https://doi.org/10.1016/j.ijproman.2012.01.007

Klijn, E.-H. (2009). Public – Private P U B L I C – P R I VAT E PA R T N E R S H I P S I N T H E N E T H E R L A N D S : P O L I C Y , PROJECTS AND LESSONS. *Economic Affairs*.

Klijn, E.-H., & van Twist, M. J. W. (2007). Publiek-private samenwerking in Nederland - Overzicht van Theorie en Praktijk. *M&O*, *3/4*(January), 156–170.

Klijn, E. H., Edelenbos, J., Kort, M., & van Twist, M. (2008). Facing management choices: An analysis of managerial choices in 18 complex environmental public-private partnership projects. *International Review of Administrative Sciences*, *74*(2), 251–282. https://doi.org/10.1177/0020852308089905

Koppenjan, J. (2005). The Formation of Public-Private Partnerships: Lessons from Nine Transport Infrastructure Projects in The Netherlands. *Public Administration*, 83(1), pp.135-157.

Kort, I. M., Verweij, S., & Klijn, E. H. (2016). In search for effective public-private partnerships: An assessment of the impact of organizational form and managerial strategies in urban regeneration partnerships using fsQCA. *Environment and Planning C: Government and Policy*, *34*(5), 777–794. https://doi.org/10.1177/0263774X15614674

Lenferink, S., Tillema, T., & Arts, J. (2013). Towards sustainable infrastructure development through integrated contracts: Experiences with inclusiveness in Dutch infrastructure projects. *International Journal of Project Management*, *31*(4), 615–627. https://doi.org/10.1016/j.ijproman.2012.09.014

Mahamid, I. (2013). Effects of project ' s physical characteristics on cost deviation in road construction. *Journal of King Saud University - Engineering Sciences*, *25*(1), 81–88. https://doi.org/10.1016/j.jksues.2012.04.001

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of who and What Really Counts. *Academy of Management Review*, *22*(4), 853–886. https://doi.org/10.5465/AMR.1997.9711022105

Mok, K. Y., Shen, G. Q., & Yang, J. (2015). Stakeholder management studies in mega construction projects: A review and future directions. *International Journal of Project Management*, *33*(2), 446–457. https://doi.org/10.1016/j.ijproman.2014.08.007

Ng, A., & Loosemore, M. (2007). Risk allocation in the private provision of public infrastructure. *International Journal of Project Management*, *25*(1), 66–76. https://doi.org/10.1016/j.ijproman.2006.06.005

Odeck, J. (2004). Cost overruns in road construction - what are their sizesand determinants? *Transport Policy*, *11*(1), 43–53. https://doi.org/10.1016/S0967-070X(03)00017-9

Odeck, J., Welde, M., & Volden, G. H. (2015). The impact of external quality assurance of costs estimates on cost overruns: Empirical evidence from the norwegian road sector. *European Journal of Transport and Infrastructure Research*, *15*(3), 286–303.

Osei-Kyei, R., & Chan, A. P. C. (2015). Review of studies on the critical success factors for public-private partnership (PPP) projects from 1990 to 2013. *International Journal of Project Management*, *33*(6), 1335–1346. https://doi.org/10.1016/j.ijproman.2015.02.008

O'shea, C., Palcic, D., & Reeves, E. (2019). Comparing Ppp With Traditional Procurement: the Case of Schools Procurement in Ireland. *Annals of Public and Cooperative Economics*, *90*(2), 245–267. https://doi.org/10.1111/apce.12236

Palma, A. de, Leruth, L., & Prunier, G. (2009). Towards a Principal-agent based typology of risks in PPPs. IMF Working Paper, 09(177), 1–24.

Ragin (2009). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In Rihoux, B. & Ragin, C. C. (2012), *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques.* (pp. 87-122). Thousand Oaks: SAGE Publications, Inc.

Ragin, Charles C. 2010. *User's Guide to Fuzzy-Set/Qualitative Comparative Analysis 2.0*. Irvine, California: Department of Sociology, University of California.

Ragin, Charles C. & Sean Davey. 2016. *Fuzzy-Set/Qualitative Comparative Analysis 3.0*. Irvine, California: Department of Sociology, University of California.

Raisbeck, P., Duffield, C., & Xu, M. (2010). Comparative performance of PPPs and traditional procurement in australia. *Construction Management and Economics*, *28*(4), 345–359. https://doi.org/10.1080/01446190903582731

Rhodes, R. (1996). The new governance. *Public Manage. Crit. Perspect*, *44*, 208. Retrieved from https://books.google.com/books?hl=en&lr=&id=Hq5_Co-9S5EC&oi=fnd&pg=PA208&dq=%22manner,+method+or+system+by+which+a+particular+society%22+%22of+British+government+but+the+term+is+not+in+the+index+nor+defined+in+the+text:+it+is%22+&ots=pnBOFHSXw-&sig=--bMIH

Rihoux, B. (2006). Qualitative Comparative Analysis (QCA) and Related Systematic Comparative Methods.

International Sociology, *21*(5), 679–706. https://doi.org/10.1177/0268580906067836
Rijkswaterstaat (2015). *Minder transactiekosten bij DBFM-contracten.* Retrieved on 13 March, 2019 from: https://www.magazinesrijkswaterstaat.nl/zakelijkeninnovatie/2015/02/minder-transactiekosten-bij-dbfm-contracten
Rijkswaterstaat (2019). *Publiek-Private Samenwerking.* Retrieved on 12 March, 2019 from: https://www.rijkswaterstaat.nl/zakelijk/zakendoen-met-rijkswaterstaat/publiek-private-samenwerking/index.aspx
Rijkswaterstaat. (2019). *Toekomstige Opgave Rijkswaterstaat: Perspectief op de uitdagingen en verbetermogelijkheden in de GWW-sector*.
Sager, T. (2011). Neo-liberal urban planning policies: A literature survey 1990-2010. *Progress in Planning*, *76*(4), 147–199. https://doi.org/10.1016/j.progress.2011.09.001
Smyth, H., & Edkins, A. (2007). PROJECT Relationship management in the management of PFI / PPP projects in the UK, *25*, 232–240. https://doi.org/10.1016/j.ijproman.2006.08.003
Verweij, S. (2015). Achieving satisfaction when implementing PPP transportation infrastructure projects: A qualitative comparative analysis of the A15 highway DBFM project. *International Journal of Project Management*, *33*(1), 189–200. https://doi.org/10.1016/j.ijproman.2014.05.004
Verweij, S. (2018). MEERWAARDE DOOR PPS. WELKE MEERWAARDE? *Agora*, *3*, 34–37.
Verweij, S., Loomans, O., & Leendertse, W. (2019). The Role of the Public Partner in Innovation in Transport Infrastructure PPPs: A Qualitative Comparative Analysis of Nine Dutch DBFM Projects. *Public Works Management & Policy*, 1087724X1984721. https://doi.org/10.1177/1087724x19847215
Verweij, S., & van Meerkerk, I. (2018). Publiek-Private Samenwerking in de Transportinfrastructuur Resulteert in Betere Uitkomsten: Wens of Waarheid? (pp. 1–14).
Verweij, S., van Meerkerk, I., & Korthagen, I. A. (2015). Reasons for contract changes in implementing dutch transportation infrastructure projects: An empirical exploration. *Transport Policy*, *37*, 195–202. https://doi.org/10.1016/j.tranpol.2014.11.004
Verweij, S., Teisman, G. R., & Gerrits, L. M. (2017). Implementing Public–Private Partnerships: How Management Responses to Events Produce (Un) Satisfactory Outcomes. *Public Works Management and Policy*, *22*(2), 119–139. https://doi.org/10.1177/1087724X16672949
Wang, H., Xiong, W., Wu, G., & Zhu, D. (2018). Public–private partnership in Public Administration discipline: a literature review. *Public Management Review*, *20*(2), 293–316. https://doi.org/10.1080/14719037.2017.1313445
Warsen, R., Nederhand, J., Klijn, E. H., Grotenbreg, S., & Koppenjan, J. (2018). What makes public-private partnerships work? Survey research into the outcomes and the quality of cooperation in PPPs. *Public Management Review*, *20*(8), 1165–1185. https://doi.org/10.1080/14719037.2018.1428415
van Wee, B. (2007). Large infrastructure projects: A review of the quality of demand forecasts and cost estimations. *Environment and Planning B: Planning and Design*, *34*(4), 611–625. https://doi.org/10.1068/b32110
Yescombe, E. R. (2007). *Public-private partnerships: Principles for policy and finance*. Burlington, VT: Butterworth-Heinemann.
Zhang, X. (2005). Critical Success Factors for Public–Private Partnerships in Infrastructure Development. *Journal of Construction Engineering and Management*, 131(1), pp.3-14.
Zietlow, G. (2005). “Cutting costs and improving quality through performance-based road management and maintenance contracts— The Latin American and OECD experiences.” *Proc., Senior Road Executives Programme, Restructuring Road Management,*. Univ. of Birmingham, Birmingham, United Kingdom.

7. Appendices

Appendix 1. Questionnaire stakeholder management and risk transfer

Deze enquête is opgesteld als onderdeel van mijn afstudeeronderzoek over meerwerk in weginfrastructuurprojecten. Ik loop momenteel stage voor mijn afstudeeronderzoek op de afdeling ICG onder begeleiding van Danny Zwerk, en Stefan Verweij van de RUG. Ik zou het zeer op prijs stellen als u deze enquête wilt invullen zodat ik een complete dataverzameling kan krijgen voor mijn onderzoek.
Het doel van mijn onderzoek is om inzicht te krijgen in het effect van de volgende condities: (1) contract type, (2) stakeholder management, (3) risico transfer, en (4) project omvang, op meerwerk in weginfrastructuurprojecten. Meerwerk wordt in dit onderzoek gedefinieerd als het verschil tussen de actuele projectomvang en de initiële contractomvang.
Mijn onderzoeksvraag is: "*How do contract types, type of stakeholder management, risk transfer, and the project size influence cost overrun of road infrastructure tendered as a public-private partnership?*" Dit onderzoek is relevant voor Rijkswaterstaat aangezien de resultaten meer inzicht zullen geven in het effect van configuraties van bovenstaande condities op meerwerk.
De resultaten van de enquête zullen worden gebruikt voor een (QCA) analyse welke de geselecteerde projecten vergelijkt, en onderzoekt welke configuraties van condities leiden tot meerwerk.

Naam deelnemer:
Functie deelnemer:
Projectnaam:
Projectnummer:
Hoofdzaaknummer:

☐ Ik wil graag op de hoogte blijven van de resultaten van dit onderzoek

Emailadres: ………………………………………………………………………………….

Gegevens onderzoeker
Naam: Joël Goodijk
Studie: Environmental and Infrastructure Planning (Rijksuniversiteit Groningen)
Emailadres: joel.goodijk@rws.nl
Telefoon: 06-36433937

1. Stakeholder management

Stakeholder management wordt vanuit de literatuur benaderd vanuit twee invalshoeken: projectmanagement en procesmanagement. Projectmanagement is primair intern georiënteerd (binnen Rijkswaterstaat) en is gericht op het halen van de gestelde doelen. De communicatiestrategie is DAD (decide, announce, and defend). Procesmanagement is extern georiënteerd (samenwerking met private partij) en gericht op het betrekken van stakeholders, is buitenwaards gericht en heeft een DDD communicatiestrategie (dialogue, decide, and deliver). De onderstaande vragen over stakeholder management gaan over de realisatiefase.

1.1 Onder welke categorie valt het type stakeholder management voor dit project het beste?

- ☐ Intern georiënteerd
- ☐ Extern georiënteerd

1.2 Onder welke communicatiestrategie past de communicatie met de stakeholders het meest?

- ☐ Decide, announce, and defend
- ☐ Dialogue, decide, and deliver

1.3 Hoeveel FTE is er voor intern en extern stakeholder management beschikbaar voor dit project?

- ☐ Intern: ………………..
- ☐ Extern: ………………

1.4 Welke benadering wordt er gebruikt voor externe stakeholders?

- ☐ Informeren
- ☐ Betrekken
- ☐ Samenwerken

1.5 Kunt u een voorbeeld geven van de hiervoor genoemde benadering?

………..

………...

1.6 Bent u van mening dat de oriëntatie (intern of extern) van stakeholder management invloed heeft (gehad) (positief of negatief) op VTW's voor dit project? Kunt u uw antwoord toelichten?

………..

……….

1.7 Bent u van mening dat de hoeveelheid FTE voor intern en/of extern stakeholder management invloed heeft (gehad) (positief of negatief) op VTW's voor dit project? Kunt u uw antwoord toelichten?

…….

…….

…….

2. Risico transfer

2.1 Wat is het totaal aandeel van de risico's als percentage van de initiële contractwaarde?

………

2.2 Wat is hiervan de verdeling tussen de private en de publieke partijen?

- ☐ Percentage privaat:
- ☐ Percentage publiek:

2.3 Hoeveel procent van de risico's zijn in totaal naar de private partij overgedragen? Dit zijn dus afwijkingen op het standaard contract.

……

2.4 In hoeverre denkt u dat een risico transfer naar de private partij een invloed heeft (gehad) op meerwerk in dit project op een schaal van 1 t/m 5?

- ☐ 1. Zeer laag
- ☐ 2. Laag
- ☐ 3. Neutraal
- ☐ 4. Hoog
- ☐ 5. Zeer hoog

1.5 Zijn er ook risico's teruggenomen door Rijkswaterstaat? Zo ja, welke? En wat is het totaalbedrag hiervan?

…….

……

2.6 De volgende vraag heeft als doel om de verdeling van de risico's tussen publiek en private risico's te onderscheiden per risico niveau. Voor de verschillende risiconiveaus zijn risico factor categorieën weergegeven gebaseerd op het model van Bing et al. (2005). Voor elke categorie moet een score worden toebedeeld van 1 t/m 5.

Score waarde:
1: Het risico is volledig naar de private partij overgedragen
2. Het risico is grotendeels naar de private partij overgedragen
3. Het risico is gedeeld tussen de publieke en private partij
4. Het risico is grotendeels voor de publieke partij
5. Het risico is volledig voor de publieke partij

Risico niveau	**Risico factor categorie**	**Score (1 t/m 5)**
Macro risico niveau	Politiek en overheidsbeleid	
	Macro-economisch / financiële markt	
	Juridisch	
	Publieke opinie / sociale weerstand	
	Weersomstandigheden, of natuurlijke oorzaak	
Meso risico niveau	Project selectie (grondverwerving, vraag naar project)	
	Residueel risico	
	Ontwerp	
	Constructie	
	Operatie	
Micro	Relationeel / organisatorisch	
	Derde partij	

2.6 Welke categorie VTW's heeft geleid tot het meeste meerwerk?

- ☐ Omissie
- ☐ Regelgeving
- ☐ Scopewijziging
- ☐ Technisch noodzakelijk

2.7 Had een deel van de VTW's voorkomen kunnen worden? Zo ja, op welke manier?

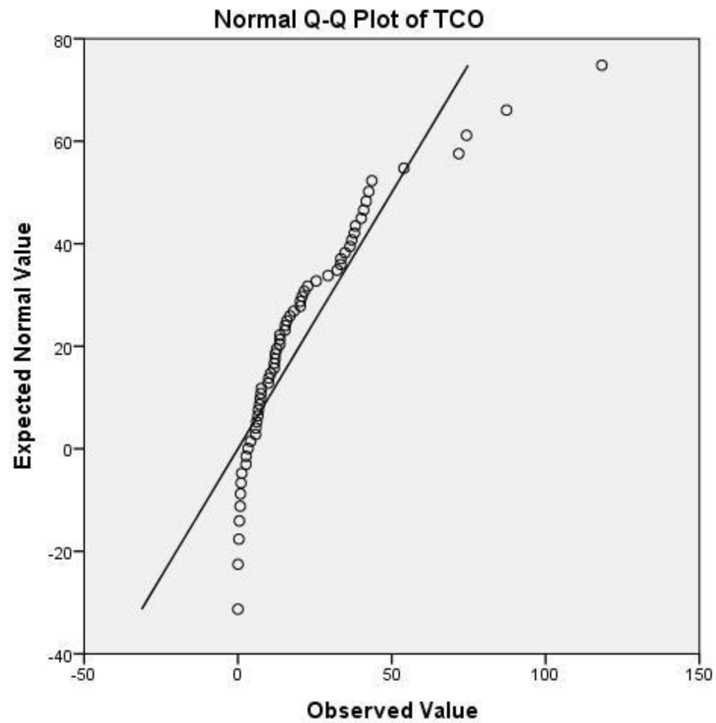
……….

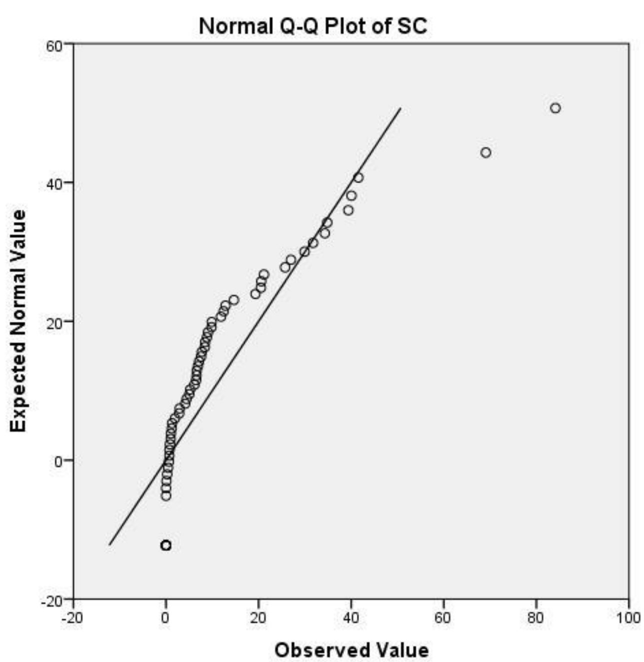
2.8 Welk aandeel van de VTW's in percentage van totaal meerwerk heeft geleid tot een verschuiving van de risicoverdeling? Hoe is de risicoverdeling verandert?

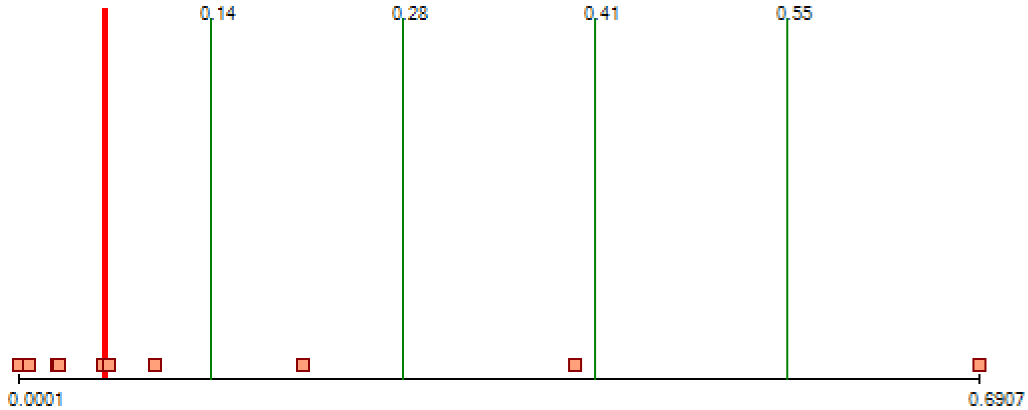
………..

Met het invullen van de enquête verklaart de deelnemer dat de ingevulde gegevens gebruikt mogen worden voor dit onderzoek. De gegevens worden vertrouwelijk gebruikt binnen Rijkswaterstaat. De analyses zullen wel openbaar gemaakt worden, deze zijn niet te herleiden naar het project. Tevens zullen de projectnaam en de gegevens van de deelnemer geanonimiseerd worden. Bij eventuele interviews zullen de namen ook worden geanonimiseerd. Met toestemming van de geïnterviewde zal het interview worden opgenomen om het te kunnen transcriberen en coderen.

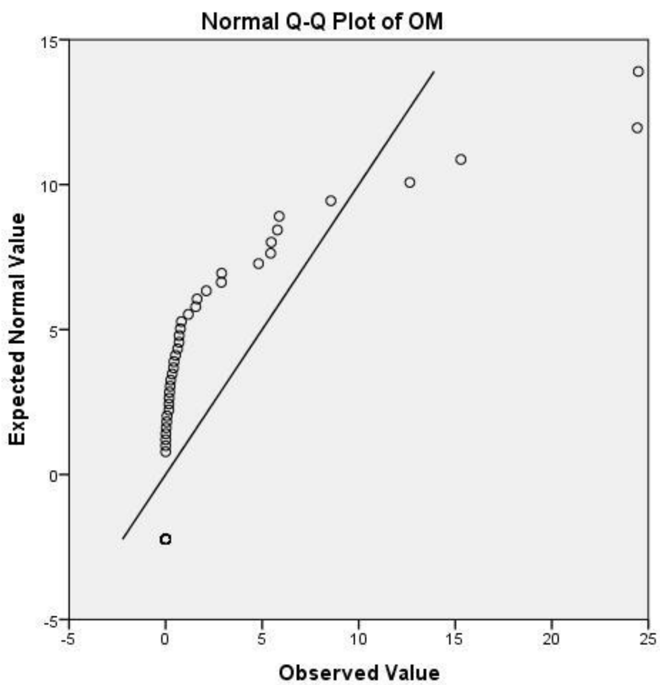
Appendix 2. Clusteranalyses cost overrun

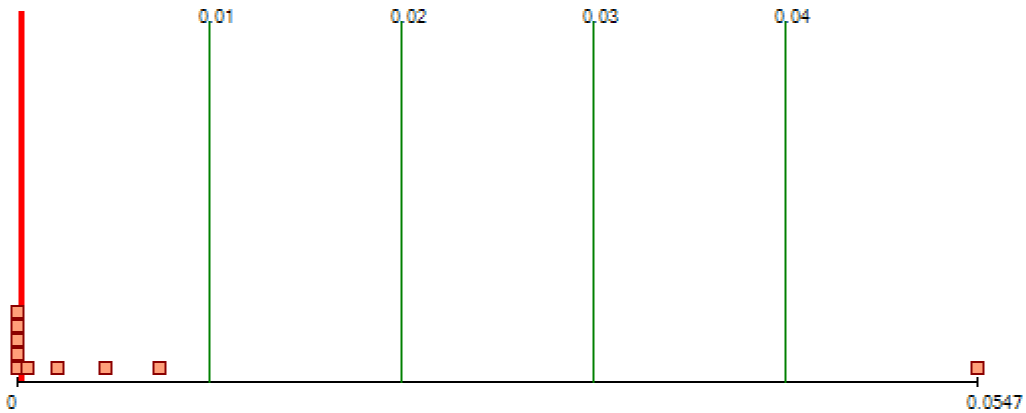




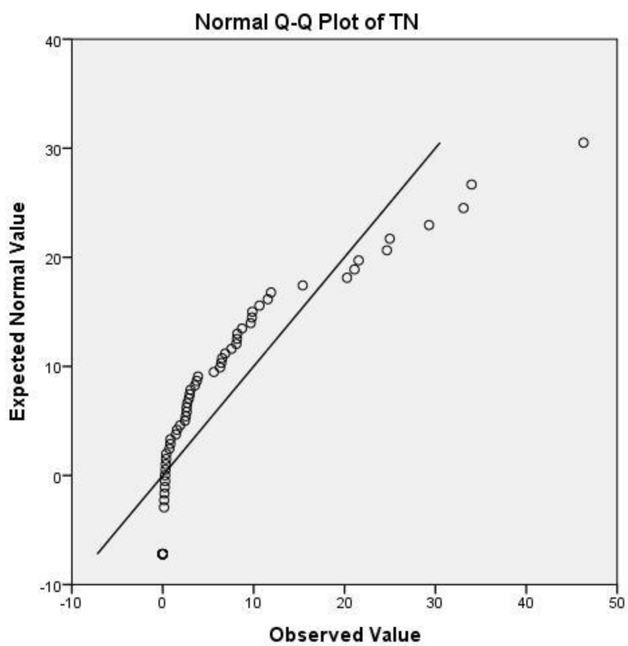


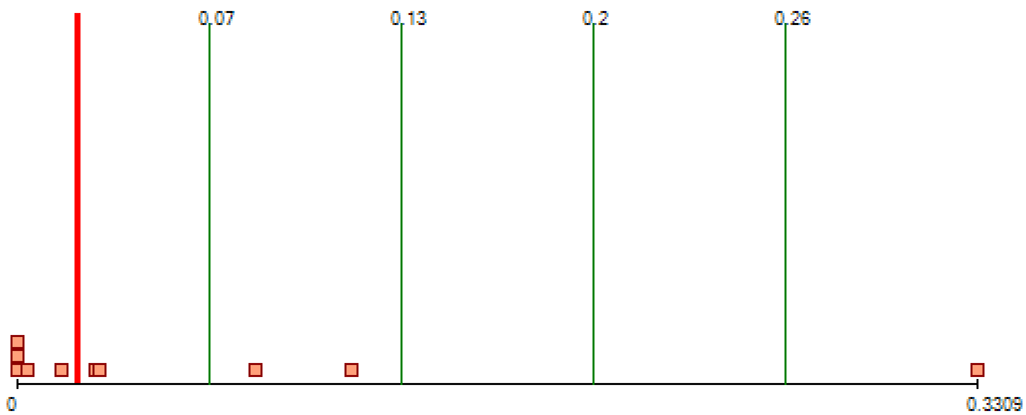
Figuur 1: Clusteranalyse Scope change



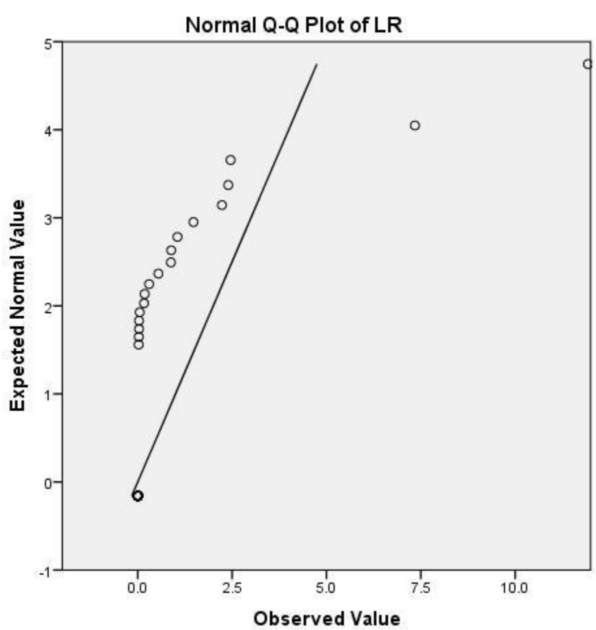


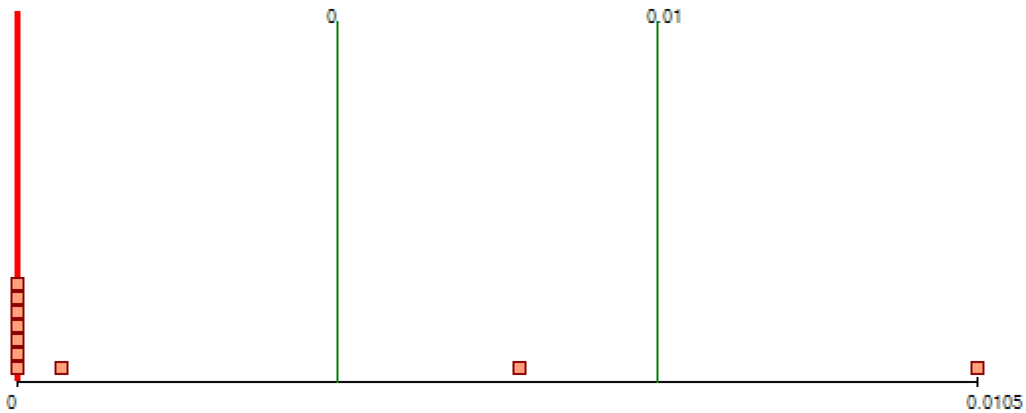
Figuur 2: Clusteranalyse Omission





Figuur 3: Clusteranalyse technical necessity





Figuur 4: Clusteranalyse laws and regulation