Seeking innovation in D&C contracts

A qualitative comparative analysis of innovation in Dutch water related infrastructure development

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Master thesis

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July 2019

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Double Degree Master thesis:

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Abstract

This thesis identifies factors that could explain the presence of technical product and process innovation in the context of water related infrastructure development delivered through D&C contracts. Innovation is an increasingly sought after feature in water related infrastructure development as it is of high practical relevance to keep up with the contemporary contextual change, and due to its contribution to well-being, economic progress, and sustainable development needed to meet the requirements of current and future global challenges. In this research, the QCA method was applied as an umbrella approach in which literature study, interviews, and a questionnaire were put to use as a means to gain data on the four input conditions used in this thesis: Best Value Procurement, competition between bidders, risk transfer, and penalties against the private sector. The research identified no necessary or sufficient conditions leading to the occurrence or absence of innovation. Two pathways consisting of competition, risk transfer, and penalties lead to innovation, but could not be minimized and are thus complex of nature. Two pathways consisting of two conditions each lead to the absence of innovation. One of the two was explained by going back to the cases, resulting in the finding that the absence of innovation could not be completely accounted to the identified pathway but more to the tender process set up. The second pathway, ~risk*penal → ~innovation, is considered to be the main finding is term of practical usefulness. The findings of this research could have great implications for public organizations in terms of setting up new D&C contracts when seeking for innovation.

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Chapter 1: Introduction

In this chapter the topics most relevant to this thesis, the research question, and the research design will be introduced. Chapter 1.1 presents background information on the topic. In part 1.2, the choice to focus on D&C contracts is elaborated. In parts 1.3 and 1.4 the scientific and practical relevance are presented. The research question, research design, and reading guide can be found in parts 1.5, 1.6, and 1.7. The research design is discussed further in the Methodology chapter. The relevant topics, including the input and output conditions of this research, will be explained more in depth in chapter 2.

1.1 Background

In order to add legitimacy to the choice to research innovation in water related infrastructure development, it is important to point out the changing context in which these projects are implemented. Climate change induced uncertainties such as sea level rise and increasingly extreme precipitation are likely to put extra stress on the water infrastructure system (Pahl-Wostl, 2006). Despite these challenges, water management sectors in general seem to act rather slow in adapting to them (ibid.). Galaz (2005) argues that water management institutions to some extent ignore the increasing uncertainty and complexity of the water system and that learning activities to increase adaptation are not always encouraged.

The latter results in water sectors being poorly prepared for coming environmental changes which, according to Galaz (2005), is based on a dependence on familiar techniques and a lack of innovation. The link between the capacity to adapt and innovation is made by Rodima-Taylor et al. (2012) by arguing that innovation is required to effectively respond to climate change. Thus, in order to adequately adapt to the future climate change induced contextual changes innovation, amongst other things, is needed. This statement was also underlined by a high ranked director of Rijkswaterstaat by saying that the innovation rate has to increase, both within Rijkswaterstaat and market parties (cobouw.nl, 2018). The identified gap between the current situation in the public water sector and what is needed to cope with future changes is what makes innovation in this sector a highly relevant topic for research.

The reason for holding on to familiar techniques and the lack of innovation may be explained by what Maylor et al. (2006) refer to as the control paradox. The paradox explains that a certain degree of control can help to monitor activities and progress of projects while still being open enough to allow new ideas and knowledge sharing. However, beyond a certain point of control most flexibility is lost and excessive bureaucracy and control take over, losing the ability to learn, innovate, and function in a complex environment (Edelenbos and Klijn, 2009). On the contrary, when too little control is maintained, the project can quickly be considered as 'out of control', which is why managers of projects often prefer adequate mechanisms of control to keep the outcomes predictable (Bourne and Walker, 2005).

The reason for the existence of the control paradox is that the exact tip-over point between control and flexibility is 'located' somewhere in a grey area and is considered as being dynamic (Bourne and Walker, 2005). Thus, in short, it is difficult to predict when the boundary between too much and too little control is reached with the consequence that project initiators may be anxious to loosen control and thus prefer to take low flexibility for granted, resulting in the earlier mentioned loss of ability to learn and innovate.

Using public private partnerships (PPPs) in its variety of forms allow market parties to different degrees to be flexible, learn from each other, and innovate (Priemus, 2009). Put differently, PPPs could help in creating flexibility that subsequently increase the ability to innovate. The main goal of this thesis is to test various configurations project conditions that may explain the existence of innovation in water related infrastructure projects using a collaboration between public and private parties in the form of Design & Construct (D&C) contracts. Debate exists whether or not the D&C contract should be considered a PPP. In this thesis, D&C is assumed to be a PPP contract from, for which explanation is given in chapter 1.2. Chapter 1.2 also describes why D&C contracts are an interesting research focus regarding innovation.

This thesis aims to add to the existing literature by focusing on innovation in these partnerships. Rather than focusing on all PPP forms, this research focuses on the widely used D&C contract in the context of water related infrastructure development. Four conditions have been derived from earlier research and practical relevance to research if they are associated with innovation: Best Value Procurement, the numbers of bidders, type of risk assumed by the private parties, and penalties on performance. The latter three input conditions are chosen based on a research by Rangel and Galende (2010). Best Value Procurement was later added as an input condition based on the wishes of Rijkswaterstaat to gain more insight in the effects of this procurement method on innovation.

1.2 Design and Construct contracts

Public Private Partnerships can take on many forms, depending on the degree of involvement of the private contractors and the integration of project phases (Lenferink et al., 2013). Traditionally, similar to many other western countries, the executive department of the Dutch Ministry of Infrastructure and the Environment (Rijkswaterstaat) was responsible for agenda-setting, plan-making, building, and maintenance of infrastructure projects. This method was operational until the late 1990s, with Rijkswaterstaat providing detailed solutions to spatial problems, based on which private contractors could calculate their price in an attempt to be awarded to contract.

Following the neoliberal turn in the Netherlands, a new approach was adopted for the construction of new infrastructure. Opposed to the traditional detailed solutions provided by Rijkswaterstaat, contractors were now responsible for the technical details of the solution proposed by Rijkswaterstaat. In these Engineering & Construct (E&C) contracts, the client still provided the contractor with a detailed design and outcome, but no longer interfered with the technical details to achieve the sought after outcome (Lenferink et al., 2013).

The next step in the integration of project phases and involvement of contractors in available contract forms was the Design & Construct (D&C) contract, which was designed on the basis of positive experiences with the abovementioned E&C contract (Lenferink et al., 2019). In the D&C contract, no specified design is provided by the client, only a desired outcome is presented. This allows contractors to include more creativity in their proposed tender bids, as they can propose their own design to achieve the desired result. D&C contracts are often used in Dutch infrastructure projects, compared to other contract forms (Koenen, 2019). In this thesis, the scope with respect to contracts is limited to the D&C contract.

Noteworthy is that contracts listed as D&C in practice look like E&C contracts (Lenferink et al., 2013). In the procurement phase a desired outcome is formulated by the client. However, contractors tend to already work out detailed designs in the procurement phase to get a better judgement of, for instance, potential risks. This information is then used to prepare an accurate and competitive bid. Put differently, contractors in practice do a significant part of the design activities before the contracting, which means that design activities after contracting are limited. So, the contract then looks similar to E&C contracts where a technical specification is made on basis of an already selected and worked out design. However, as this thesis is written from a public perspective, the project cases are delivered through contract that are listed as D&C by Rijkswaterstaat.

D&C as a PPP form

In this thesis the D&C contract in considered as being a form of PPP, even though discussion exists whether or not this is the case. Weihe (2008) argues that both broad and narrow definitions of the term PPP are present in the literature. The narrow definition only includes partnerships where finance is private, and where design, construction, operation and/or maintenance are bundled together in one contract. In a broader sense of the term, not all project phases have to be included in one contract, which would also mean that D&C can be considered a PPP. According to Hueskens (2019), it is questionable whether or not these 'lighter' contract forms must be considered PPP. However, she also states that these contracts show great dissimilarities with the more traditional contract forms and at the same time share various characteristics with contract forms that fit the narrow description of PPP (such as DBFMO). Further, in Verweij (2015) a D&C project is considered a (using the broad understanding of PPP) PPP in which, opposed to traditional public procurement, the private party is responsible for both the design and the construction of the project. Also in Lenferink et al. (2012) the D&C contract is mentioned alongside the DBFM contract as being an integrated contract form that includes more actors and interaction over a longer period of time, and thus hints to a situation where D&C is considered a PPP.

Also when applying the definition of Carbonara and Pellegrino (2018), who wrote about innovation in PPP, the D&C contract can be considered a PPP. They state that a PPP is any partnership between public and private parties that cooperate to achieve a common goal, involving risk and responsibility sharing between the parties. This fits the D&C contract as it is an arrangement between the public client and the private contractors (partnership), where the client defines a desired outcome for the contractor to realize in a way they think seems fit (common goal), where risks and thus responsibilities are divided between the parties.

D&C contracts and innovation

In general, the (infrastructure) construction industry is not often characterised as being highly innovative (Gann, 2000; Priemus, 2009). In more integrated contracts as the D&C contract, however, the strict separation of design and construction faded (Priemus, 2009) which means that the contractor is responsible for both the design and the construction. Statements by Konings and Lourens (2004) and Priemus (2009) claim that this contract form offers enough design freedom to the contractors to allow them to apply product and process innovations.

Further, with the non-existence of the strict separation between the design and construction phase in the D&C contract form, opposed to less integrated contracts, contractors were given room to apply their own creativity to achieve the desired outcome, which was seen as positive for the occurrence of innovation (Priemus, 2009). On the other hand, compared to the bigger (financial and scope-wise) DFBM contracts, contractors do not have to carry to burden of large financial loans with banks which can result in being more careful and standardized, instead of seeking innovative solutions. Furthermore, with banks being part of the equation, an additional stakeholder with a big financial interest is included. With this inclusion, the financial lender may have a voice in how contractors approach the project. This being said, it is not very likely that banks support innovative solutions as it increases the risk of failure and thus enlarges the possibility that the contractors cannot return the loan.

Another finding that makes D&C contracts an interesting topic for research regarding innovation, is that contactors have expressed their worries about the bigger DBFM contracts (Koenen, 2019). The huge projects that are delivered through the DBFM contract can become to risky, resulting in major financial problems for the private parties. This statement is underlined by findings of Verweij et al. (2019) that suggest that smaller contracts, in contrast to the big DBFM contracts, could attract smaller contractors that are highly motivated to innovate.

To conclude this section, the paragraphs above show that the D&C contract has the potential to lead to more innovation in the construction sector, which makes it an interesting contract form to research when looking for factors explaining the occurrence of innovation within a project.

1.3 The scientific debate

Innovation related research in PPP projects has not been untouched in the past decade. However, as many different variables are present in these projects, not all researches look alike in terms of context, area of homogeneity, and researched input conditions. For instance, Rangel and Galende (2010) researched the relation between four conditions (risk transfer, penalties, competition between bidders, and design responsibility) and innovation activities in Spanish highway projects. In their research, they used a multiple regression method to identify these relations. The results showed that a significant positive relation was found between three out of the four conditions (risk transfer, penalties, and competition between bidders) and innovation activities. Noteworthy is that this research only took into account the relations between single conditions and innovation. One of the main recommendations resulting from the research was that "*it would be interesting to test the consistency of the results by analysing other types of contracts.*" (Rangel and Galende, 2010, p. 54). In this thesis, the consistency of the results found by Rangel and Galende (2010) is tested: the three conditions that proved to have a positive relation with innovation in the Spanish highway projects are tested in the context of Dutch water related infrastructure projects. To add to this, configurations of conditions are taken into account in this thesis, whereas Rangel and Galende (2010) only focused on single conditions.

Another, more recent, research by Verweij et al. (2019) did take into account the relation between configurations of conditions and innovation, by using the QCA method. This research looked into three input conditions (deployment of public management, procurement result, and consortium composition) to investigate if they are associated with the occurrence of innovation in Dutch infrastructure projects. The results showed that the occurrence of innovation in the cases was associated with various nonexclusive configurations of the three conditions, with the special finding that a consortium consisting of few firms is in particular related to innovation. A recommendation for future research was to also include other PPP types to investigate innovation to see of these types are more favourable for innovation. This recommendation is in line with Van den Hurk and Verweij (2017), who argue that the majority of PPP research focuses on DBFM(O) projects. In this thesis, the focus in terms of PPP contract form is on the D&C contract.

Another characteristic of research in PPP is that the majority used traditional qualitative case studies as a method, which limits the generalizability of the outcomes of these studies (Van den Hurk and Verweij, 2017). Quantitative and comparative methods are barely used in this field and Van den Hurk and Verweij (2017) argue that researchers should get out of their comfort zone and apply these methods in order to generate generalizable results. This thesis uses QCA so that various cases can be compared and thus honours the call for PPP research using comparative methods.

Finally, Rijkswaterstaat stated that clear data on the link between Best Value Procurement (BVP) and innovation is not yet available. This thesis seeks to fill the knowledge gap by including BVP as a input condition, alongside the three conditions derived from Rangel and Galende (2010).

In conclusion, this thesis adds to the existing literature by adopting the recommendation for future research by Rangel and Galende, by testing the consistency of their results in a different context, that is Dutch water related infrastructure projects. Further, the focus on D&C contracts was a response to the recommendation of Verweij et al. (2019) that other PPP forms should be included when researching innovation in PPP projects, a call that was underlined by Van den Hurk and Verweij (2017). Also, the use of QCA in this thesis fulfils the call for PPP research using other methods than the traditional case studies, so that cases become comparable. Lastly, BVP is included as an input condition to fill the knowledge gap on the relation between BVP and innovation, identified by Rijkswaterstaat.

1.4 Innovation in water infrastructure

Partnerships between various public and private parties can be a tool for innovation to be implemented (Priemus, 2009). Especially in complex and ever changing systems, such as the (water) infrastructure system, stimulating innovation is key (OECD, 2007). However, as mentioned before, innovation does not always seem to have priority in water management related projects due to the control paradox (Pahl-Wostl, 2006) and thus adaptations to increasing uncertainty and complexity are happening in a slow pace (Galaz, 2005). Below some quotes from various international players in water management and infrastructure development are listed, indicating the importance of innovation in these sectors.

> *"The innovation rate really has to increase. Within market parties, but also within Rijkswaterstaat."* (Rijkswaterstaat, 2018)

This quote stresses the practical relevance of innovation, stated by the executive agency of the Ministry of Infrastructure and Water Management in the Netherlands. The context of the quote further implies that innovation in the infrastructure sector is crucial in order to keep up with the contemporary contextual changes, mainly expressed as climate change and its consequences for water management.

> *"Undoubtedly the capability to innovate and to bring innovation successfully to market will be a crucial determinant of the global competitiveness of nations over the coming decade. There is a growing awareness among policymakers that innovative activity is the main driver of economic progress and well-being as well as a potential factor in meeting global challenges in domains such as the environment and health."* (OECD, 2007, p.3)

> *"Investment in infrastructure and innovation are crucial drivers of economic growth and development. With over half the world population now living in cities (…) Technological progress is also key to finding lasting solutions to both economic and environmental challenges, such as providing new jobs and promoting energy efficiency. Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development."* (UNDP, 2015)

> *"The more we invest in innovation and infrastructure, the better off we'll all be. Bridging the digital divide, promoting sustainable industries, and investing in scientific research and innovation are all important ways to facilitate sustainable development."* (UNDP, 2015, p.11)

The three quotes mentioned above, all by international organisations, state the importance of innovation in regards to well-being, economic progress, and sustainable development: all leading to meeting the requirements of global challenges. Based on these statements it seems evident that innovation is a crucial part of keeping up with the future climate change induced challenges. In order to conduct this research properly, innovation as a term has to be defined adequately. And moreover, innovation in water related infrastructure has to be defined. OECD defines innovation as follows:

> *''The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations''* (OECD, 2005, p.46).

In this definition, four forms of innovation can be distinguished, that is product innovation, process innovation, marketing innovation, and organizational innovation (OECD, 2005). *Product innovation* entails new or improved goods and services, such as technical components or the use of more sustainable materials. An example in water infrastructure could be the use of a longer lasting and thus more sustainable material in the refurbishment of canal quays. *Process innovation* is similar to product innovation with the difference that it regards production or delivery methods instead of goods and services. Included in this form of innovation could be new techniques or equipment used in the implementation of a project. Sticking to the quay refurbishment example, process innovation could be new techniques of implementation that minimize disturbance to waterway users during implementation. *Marketing innovation* is all about new methods is product promoting, such as product design. Again, in the example of the quays, marketing innovation could be used in the aesthetic design of the quays to make the project more appealing to the local community so public support is increased. The fourth and last form of innovation is *organizational innovation*. With this mode of innovation the organizational structure or method of a project is changed or renewed. The obvious example for the quay issue is the use of a new form of public private partnership in order to increase benefits.

This thesis focuses on two types of innovation, that is product and process innovation, as described by OECD (1996) as Technical product and process innovation (TPP). Reasons for making this decision are given in chapter 2.1.

Klijn and Teisman (2003) argue that is was expected that the occurrence of product innovation and process innovation would be enlarged with the emerge of public private partnerships. However, potential relations between certain PPP conditions and the occurrence of innovation often lack conclusive or non-disputable evidence (Leiringer, 2006). Based on these statements, the relations between public private partnerships, including D&C contracts, and innovation remains an interesting topic for research. In this thesis, this relation is studied specifically for D&C contracts in water related infrastructure development in the Netherlands, focusing on four conditions.

1.5 Research question and expected results

The aim of this study is to assess the effects of four input conditions (of which three proved to stimulate innovation in earlier research on highway projects and one was added later in the research process on request of Rijkswaterstaat) that could stimulate product and process innovation in Dutch water related infrastructure projects. Further, this thesis seeks to find the configurations of these conditions that could explain innovation. The main research question is:

Which conditions or configurations of conditions could explain innovation in D&C water related infrastructure projects in the Netherlands?

With the researched conditions being *(1) type of risk assumed by the private sector (2) provision for penalties against the private sector if the project does not meet the quality requirements specified in the contract, (3) competition between bidders, (4) Best Value Procurement)*

To answer this question in an organized manner, sub questions have been formulated:

1. *How can product and process innovation be defined for water related infrastructure projects specifically and what are conditions that are associated with the occurrence of innovation?*

The conditions mentioned in the first sub question are the four conditions mentioned in the primary research question. These conditions will be further explained in chapter 2. The goal of this question is to find out if and identify what innovation is in water related infra-PPP's and what conditions could be associated with innovation.

2. *What are the expected results of the four conditions on innovation in water related infrastructure projects using D&C in the Netherlands?*

Using a literature study, this question seeks to formulate expectations of the effects of each of the conditions on the occurrence of innovation in water related infrastructure projects in the Netherlands. This is done by reflecting on the current scientific debate on the subject so that the theoretical relation between the input conditions and innovation can be explained.

3. *What configuration(s) of the used input conditions stimulate innovation in water infrastructure related projects using D&C contracts?*

This last sub question goes beyond formulating expectations, but uses the QCA method to research the effects of configurations of conditions on innovation in D&C contracts. The results for this sub question can then be compared to the results of sub question 2 to see if they match.

Expected results

This thesis is expected to generate relevant results for planning practitioners and academia. Firstly, expected will be useful for practitioners to organize future contracts in such a way that innovation is optimally encouraged. As PPPs are partly constructed to increase the occurrence of innovation, it is expected to find a great deal of innovation in the researched cases. Another expectation is that most innovation is initiated by the market.

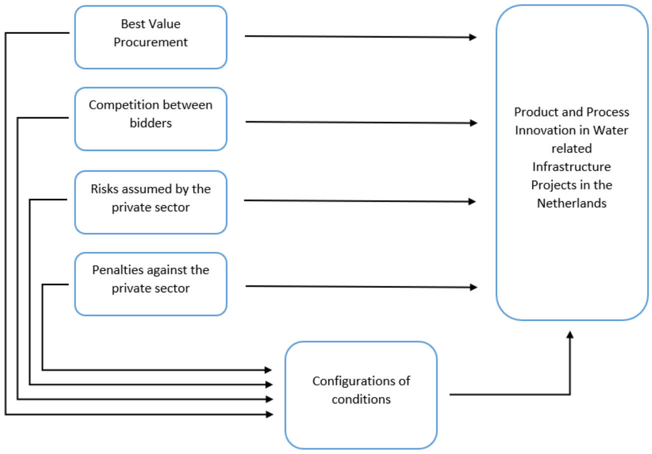
1.6 Research design

Literature research is used to elaborate on the four conditions used in this thesis and to answer sub-question one on innovation in water infrastructure projects and sub-question two: all four conditions and their relations to innovation are assessed individually: expected effects of the conditions on innovation are formulated, based on existing theory on the conditions. The literature is also used as a tool to set boundaries to the thesis and to formulate hypotheses.

After all four conditions are thoroughly elaborated on and calibrated using a literature study, the QCA method is used to analyse the relations between configurations of conditions and product and process innovation in PPP regarding water infrastructure related projects.

In order to answer the main and secondary research questions, a literature study and a Qualitative Comparison Analysis (QCA) were used. The literature will be used to provide background, set boundaries and definitions and create a hypothesis that will be tested using the QCA. QCA is chosen because (as in the article by Verweij et al. (2013)) the goal of this thesis is assessing individual and combined effects of multiple conditions, in this case the BVP method, competition between bidders, assumed risk by the private sector, and penalties for underperformance. A QCA method provides opportunities to do this, while being able to conduct a more systematic analysis compared to in-depth case study research. A more detailed explanation of the research design and methods is given in chapter 3.

Figure 1.1 shows a schematic view of the research design. As said, operationalizing the explanatory and outcome conditions is an important step and will be further specified in the next chapters.



1.7 Reading guide

Chapter 1 gave a general introduction to the topic and formulated the research questions. In chapter two, sub question 1 is answered and a theoretical framework is set up as a tool to conduct the further research. Chapter 3 presents the methodology, including research methods, operationalization, and calibration. The results of the data collection and truth table analyses are given in chapter 4, after which the findings are discussed in chapter 5. In chapter 6 conclusions and recommendations are discussed

Chapter 2: Theoretical framework

The goal of this chapter is to construct a theoretical framework and set boundaries within which this thesis is conducted. Firstly, innovation in PPPs is described as this is the outcome condition. Thereafter, in this sequence, Best Value Procurement, competition between bidders, assumed risks by the private sector, and penalties against the private sector are described as input conditions. Not only will the conditions be described, but hypotheses on the relation between the input conditions and the occurrence of innovation in PPPs will be formulated.

2.1 Innovation in public private partnerships.

Theory

In order to successfully conduct research on innovation as an outcome condition, thorough understanding of the term is crucial. In a policy document by the OECD (2007) it is argued that infrastructure innovation and the ability to implement it in the market is key for competitiveness, economic progress, well-being, and meeting global challenges, a statement which is also underlined by UNDP (2015). On a smaller organizational scale, innovation has the potential to bring advantages to those who innovate, including but not limited to cost reductions (Tawiah and Russel, 2008). However, the broad usage of the term makes it hard to define and *"is in many ways ambiguous and its wide applicability has resulted in a plethora of definitions used to describe phenomena in a variety of contexts"* (Leiringer, 2006, p.6).

Based on the above statements by the OECD and the UNDP, a distinction between incentives can already be made (Tidd and Bessant, 2009). The first incentive evolves on a higher scale, namely the (inter)national governments. This incentive entails meeting global challenges and thus is desired by governments. The second incentive can be found on the firm level: advantages to the companies that innovate in order to stay ahead of competition. These incentives also mean that innovation can be driven by the market or by the public party. This thesis includes both as the practical relevance of innovation in water related infrastructure is to cope with future climate change impacts. Thus in this case it is not relevant who initiates innovation, but that innovation occurs in the first place. However, to get a clear view of the innovation that occurred in the researched cases in this thesis, a distinction was made between private or public driven innovation during data collection.

The process of defining innovation in the scientific debate can be considered incomplete, which is plausible since, also based on the latter paragraphs, the term has a broad scope (Duffield, 2013). Duffield (2013) argues that three issues have to be taken into account when evaluating innovation. Firstly, innovation cannot be referred to as solely research and development or applying high end technology. This meaning to innovation is too limited and does not honour the broad nature of the term. Two highlighted features that are included amongst others in the scope of innovation are products and processes, on which this thesis has its focus. Secondly, innovation has four main features: newness, capability of making change, possibility of being used in the market, and that it creates value. Lastly, as already mentioned in chapter 1, innovation does not necessarily has to be radical of nature. Or in other words: innovation does not always entails a complete change in product or process, but can also refer to an incremental process of improvements with positive results.

Based on the finding that innovation as a general term is too broad to grasp due to its ambiguous nature and the fact that in this thesis innovation is only used in regard to one specific sector, a focus is needed. Based on OECD (2005) we can distinguish between four forms of innovation: product innovation, process innovation, marketing or financial innovation, and organizational innovation: these different forms of innovation have been discussed in chapter 1.4. In this thesis product and process innovation are considered outcome conditions. Technical product and process (TPP) innovation is defined by OECD (1996, p.31) as follows:

'Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation)…" (OECD, 1996, p.31)

So, in this thesis the choice is made to focus on product and process innovation, also known as technical product and process innovation (TPP) (OECD, 1996). This decision was made for several reasons. Firstly, the OECD provides a clear definition that makes the term understandable and easy to grasp. Secondly, marketing innovation is excluded as it is considered not to significantly contribute to the practical challenge at hand, that is coping with the future climate change induced impacts, as it deals with aesthetic features of the project. A comment that could be made here is that marketing innovation could increase public acceptance of the projects, which streamlines the process of implementation of innovation (Taiwah and Russel, 2008). However, this form of innovation is still considered to contribute significantly less to meeting the standards for future challenges than product and process innovation. Also, as marketing innovation increases public acceptance for technical measures, its contribution to solving the issue is paving the way for TPP (Leiringer, 2006). This means that one could say that the effect of TPP also includes the effects of marketing innovation, and thus marketing innovation does not have to be researched separately. Thirdly, organizational innovation is part of the area of homogeneity, as PPP and its different forms are considered being organizational innovation.

Organizational innovation can, based on the latter paragraph, thus be seen as a 'tool' to increase TPP, as a change in organization (such as the introduction of PPP) could have TPP as a goal. This is also why PPP, and D&C in particular, is a topic of research and part of the area of homogeneity in this thesis: it could possibly increase innovation. Further, when taking into account the explanations of Taiwah and Russel (2008) and Leiringer (2006) on marketing innovation, it seems like this form of innovation could have the purpose to create or increase public acceptance for TPP to be implemented. In other words, both organizational and marketing innovation are, in this thesis, considered as helpful instruments to increase the output condition: the occurrence and implementation of TPP. This also means that they are not included in the outcome condition. The figure below illustrates the relations between the four forms of innovation, based on Taiwah and Russel (2008) and Leiringer (2006).

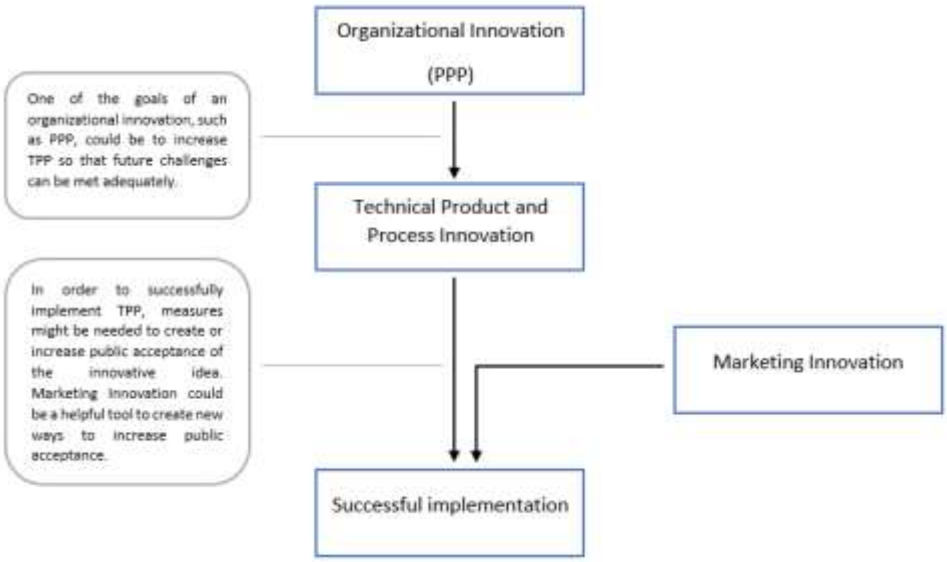


Figure 2.1: schematic presentation of the assumed relations between the different forms of innovation. Source: authors's own, based on Taiwah and Russel (2008) and Leiringer (2006).

Defining innovation in water related infrastructure projects

To adequately grasp what is meant by innovation in this thesis, an interpretation of the term is produced and subsequently process and product innovation are made tangible. In the process of defining the meaning of innovation for this thesis, different definitions (OECD, 2005; UNDP, 2017; Rijkswaterstaat, 2014; EPA, no date) are analysed and combined.

UNDP (2017) defines innovation for development as something that is about "*identifying new and more effective solutions that add value for the people affected by development changes.*" Compared to the definition given by OECD (2005) in chapter 1.4, this definition adds a clear focus on the added value for the users of a certain product. Considering future environmental change as the main incentive for water infrastructure innovation, as mentioned by Galaz (2005), adding the end users of innovated products to the definition seems the rational thing to do as they will be the ones benefitting from it. However, as the output condition in this thesis is only technical product and process innovation and not the degree to which it adds value, the addition of "*adding value for the people affected by development changes*" is not included in the definition.

Rijkswaterstaat (2014) defines innovation as the development and application of new product, technologies, processes, and services. On its own, this definition does not significantly add power to the previous definitions. However, Rijkswaterstaat states that every innovation can be found somewhere on a spectrum between incremental innovation and radical innovation. Incremental innovation stands for improvements of already existing technologies, products, or processes. Radical innovations are completely new technologies, products or services, mainly based on scientific findings. Opposed to incremental innovation, radical innovation may require drastic changes.

The three definitions of innovation in the previous paragraphs all have strong aspects. Combining the three definitions published by OECD, UNDP, and Rijkswaterstaat, with a focus on product and process innovation would lead to a general definition of innovation. From this new definition for innovation as a general term, further narrowing down of the definition is needed to focus specifically on water infrastructure. EPA (no date) has defined water innovation in a very similar way as OECD (2005) defined the general term of innovation, with a small addition on water related goals. The definition also embraces innovation as new, forward-thinking solutions to achieve certain goals, such as new processes and products.

Combining the mentioned explanations of the term innovation in this sub-chapter, with the addition of a focus on water related infrastructure, resulted in a definition of innovation that is used in this thesis. Put differently, from the general definitions given by the various organizations mentioned above, the relevant aspects for this thesis are adopted. For instance, the Rijkswaterstaat definition added the distinction between radical and incremental innovation, and the definition by OECD was used for the distinction made between product and process innovation. Below, the definition of innovation used in this thesis is given, and the figure below shows a schematic presentation of the scope of this definition.

> *''The implementation of a radically or incrementally improved product (good or service), or process in water related infrastructure.''*

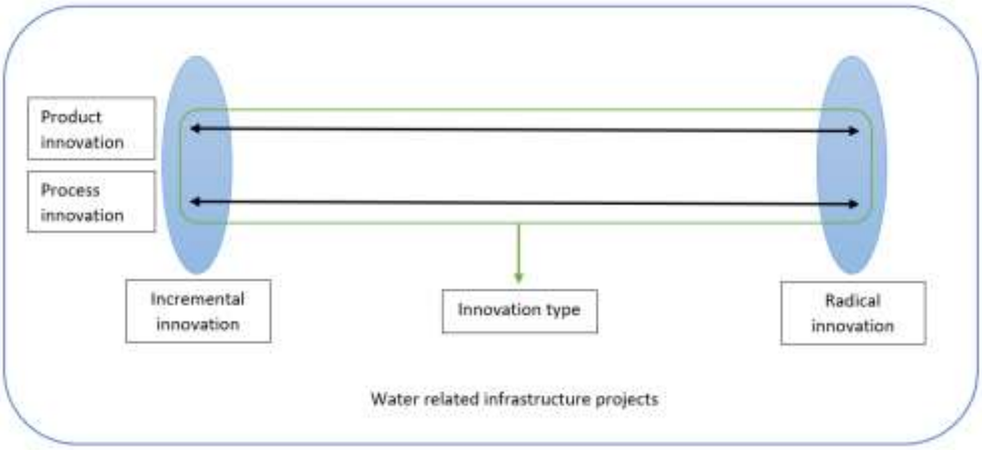


Figure 2.2: the area within the green box represents the innovation this thesis focuses on: product or process innovation somewhere on the spectrum between incremental and radical innovation, with a focus on water related infrastructure projects. Source: Author's own (2019).

Earlier in this thesis it was clarified that the focus will be on product and process innovation. However, TPP innovations can roughly be divided in four categories with four different outcomes, based on the type of innovation and the degree of change (Rijkswaterstaat, 2014; OECD, 2007), which is also clear from the definition for innovation that is used in this thesis. Firstly, a TPP innovation can be either a product innovation or a process innovation. Secondly, an innovation can either be a new product or process (radical innovation) or an improved product or process (incremental innovation) (Rijkswaterstaat 2017; OECD, 2007). Incremental innovation stands for improvements of already existing products, or processes, while radical innovations are completely new products or processes, mainly based on scientific findings. Taiwah and Russel (2008), based on Pavitt (1971) and Freeman (1982), identify a third type of innovation: revolutionary innovation. This type of innovation changes an entire system and its characteristics but because of its large timespan it is not considered relevant for this thesis: it should be considered as a kind of paradigm shift in a particular field (e.g. planning) and thus does not occur in a single project. The figure below shows the four possible outcomes of the relevant innovation types considered in this thesis.

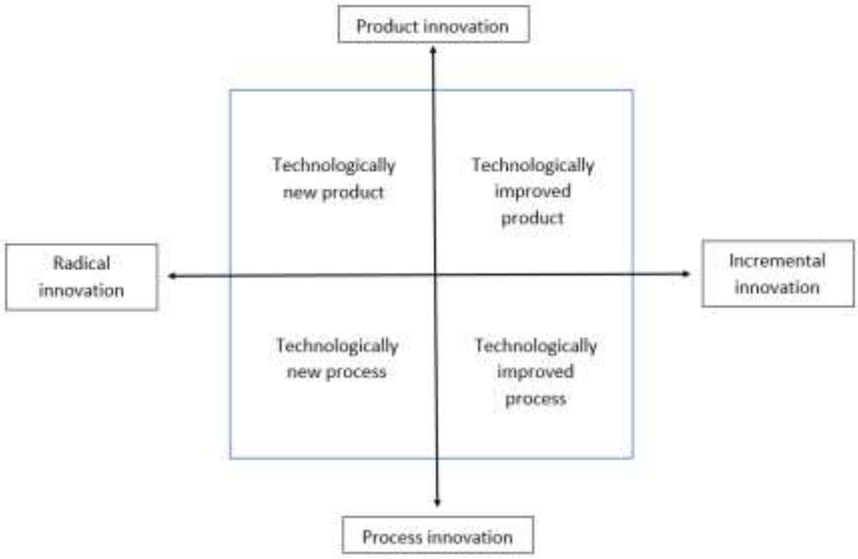


Figure 2.3: Four outcomes of product and process innovation based on nature of innovation. Source: Author's own (2019)

After identifying the possible innovation outcomes when dealing with TPP, the next step is to make them tangible by clarifying what this exactly entails. This is done by combining findings on product and process innovation by Taiwah and Russel (2008). Due to the fact that their definition of innovation does not take the degree of novelty into account, findings of Rijkswaterstaat (2014) and OECD (2007) are added to make it suitable for incremental innovation and radical innovation. In tables 2.1 and 2.2 is listed what is perceived by product innovation and process innovation, including both the incremental and radical nature an innovation can have.

Table 2.1: types of product innovation. Based on Tawiah and Russel (2008), Rijkswaterstaat (2014), and OECD (2007)
Product innovation
New or improved advanced construction products (components, materials etc.) and their assemblies
New or improved designs and concepts
Use of new or improved advanced technology and systems in the operating and maintenance phase

Table 2.2: types of process innovation. Based on Tawiah and Russel (2008), Rijkswaterstaat (2014), and OECD (2007)
Process innovation
Use of new or improved advanced construction technologies/methods, measuring, lifting, and assembling devices
Off-site fabrication and new or improved construction methods leading to reduced off-site activities
New or improved methods of pacing and/or sequencing of construction activities leading to compressed project/programme schedules
New or improved creative service delivery methods

2.2 Best Value Procurement (BVP)

Theory

The Best Value Procurement (BVP) method has been added as an input condition on request of the Rijkswaterstaat department where this research was conducted. Rijkswaterstaat has been using the BVP method for approximately ten years at the time of writing. Rijkswaterstaat states on its website that the method has proven its value by successfully achieving promising results. However, clear data on the link between the BVP method and the presence of innovation in a project has not been investigated so far within Rijkswaterstaat. This thesis seeks to fill this knowledge gap.

For a long period of time the traditional low-bid approach was the procurement method used for the majority of construction projects, where project clients select contractors based on the lowest price (Hasnain and Thaheem, 2016). The low-bid procurement approach more than once led to risky decision making on the contractors' side resulting in misunderstandings, reactive attitudes, low quality products, and mistrust (Kashiwagi et al., 2010). Opposed to the traditional low-bid approach, the BVP method selects the contractor based on verifiable performance data, to ensure quality of the end product (Abdelrahman et al., 2008).

The BVP method is considered to be effective and efficient, creating a win-win situation for both the contractor and the client: highest possible value or quality for the lowest cost (Hasnain and Thaheem, 2016). For the contractor this means a high profit and for the client this entails limited cost and time deviations (Kashiwagi et al., 2012). This is done by examining the features of a contractor or contractors' proposal to safeguard the projects' long term performance (Chan et al., 2004). One important part of the procurement process is the contractor's ability to show that they have high performances on earlier comparable projects (Hasnain and Thaheem, 2016). Further, decision making in BVP is simplified by clear up-front agreements, which reduces transaction costs for both parties.

The BVP method, according to Hasnain and Thaheem (2016) contains three stages: competitive selection phase, clarification phase, and the execution phase. This is in line with the stages that are distinguished by Rijkswaterstaat, with the difference that Rijkswaterstaat adds a preparation stage, which is the first stage.

In the preparation phase (voorbereidingsfase), the client prepares the procurement trajectory. Project goals are defined and Quality criteria are formulated. In the competitive stage (beoordelingsfase) contractors are asked to hand in their plans for the project. Further, interviews are held with two contractor officials. Based on the proposed plan and the interviews, the client choses a provisory candidate for the contract. The clarification phase (onderbouwingsfase) allows the potential contractor to elaborate their plans by giving more details and explaining how the process is going to look like. After this phase is has been completed successfully, the contractor is awarded the contract. In the execution phase (uitvoeringsfase) the contractor constantly measures their own performance and that of the client. Using a weekly report the contractor gives insight in the risk management and their performances.

Best Value Procurement and innovation

The scientific debate has not yet properly covered the link between BVP and the occurrence of innovation in infrastructure projects. This is also the reason why Rijkswaterstaat wishes to get more insight on this topic and thus why BVP was added as an input condition to this thesis. A statement on

BVP by Hasnain and Thaheem (2016) that could be linked to innovation elaborates the importance of striving for highest quality by the contractor in order to achieve client satisfaction. This could possibly imply that new product or processes are implemented to achieve higher quality.

Personal correspondence with a Rijkswaterstaat expert (interview transcript added as appendix C and D) reveals that the BVP method is designed to encourage innovation in infrastructure projects. Client and contractor work together to strive for the highest quality, of which implementing innovation is considered part of. However, due to the nature of the BVP method it is most likely that innovation in BVP projects only entails incremental innovation, as contractors have to prove competency in the form of previous performance in similar projects, using similar solutions.

2.3 Competition between bidders

Theory

The second input condition is competition. In other words, this condition refers to the amount of bidders participating in the procurement process, which is the main indicator of competition in tender processes, according to Hong and Shum (2002). The secondary indicator of competition in procurement auctions is style of bidding, which is partly related to the first indicator (Hong and Shum, 2002). This secondary indicator suggests that more aggressive bidding, partly due to a higher amount of competitors, increases competition.

This input condition is based on the economic market mechanism which emerges when a number of competitors bid for a contract (Rangel and Galende, 2010). The basic idea behind competitive tender processes is for the client to gain better value for money due to competing private parties (Iossa et al., 2007). A high degree of competition between bidders could be an incentive for market parties in striving for higher cost efficiency and thus higher value for money, which on its turn could possibly lead to innovation.

In a tender process different market parties bid against each other with the goal to be awarded the contract. Two main features on which the clients base their selection are competency in providing quality and the lowest costs (Grimsey and Lewis, 2005). The condition of competition between bidders, in this thesis, is based on the two indicators mentioned earlier, that is the number of bidders and price competition (Hong and Shum, 2002).

Competition between bidders and innovation

In the scientific debate it is argued that the procurement phase can have a significant influence on innovation, through competition between bidders (Hueskens, 2019; Edler and Uyarra, 2013). However, Edler and Uyarra (2013) argue that the exact mechanism that helps competition influence innovation has not been identified yet, and Hueskens (2019) underlines this statement in het recently published work.

Multiple empirical studies underline the positive relation between competition and innovation in PPPs (Hueskens, 2019). For instance, Rangel and Galende (2010) found that competition is positively associated with innovation. Their explanation is that innovation gives contractors a competitive advantage over other contractors. They further state that product and process innovation could be a means to achieve higher cost efficiency, which on its turn can give a competitive advantage over other market parties participating in the tender process. Of course, cost efficiency is not innovation, but innovation could very well be a tool to achieve cost efficiency. Additionally Akintoye et al. (2003) state in their empirical study that attempting to keep costs low in order to come up with a competitive bid forces contractors to think of and apply innovative measures to excel competition.

Based on the reasoning in the latter paragraph, it seems likely that a high degree of competition could potentially lead to innovation. With competition driving market parties to lower their prices in order to stay ahead of competitors, only those who see opportunities to increase efficiency would be able to be awarded the contract. As mentioned before, this does not imply product or process innovation, but it could be an indication as product or process innovation are potentially tools to gain efficiency.

It has to be kept in mind, however, that innovation automatically brings along risks, especially when dealing with radical innovation, which is in line with empirical findings by Barlow and Köberle-Gaiser (2008, 2009). In their research, focused on projects in the UK, they argue that too much competition could lead to risk adverse conduct resulting in the use of familiar methods and product. This does not immediately imply that no innovation occurs, but rather that innovation is likely to be incremental of nature.

Obviously, the statement made in the latter paragraph in dependent on the procurement method. In the Netherlands, where Rijkswaterstaat is the main client for infrastructure projects, the Economic Most Profitable Tender method (EMVI, Dutch for Economisch Meest Voordelige Inschrijving) is the starting point for procurement, according to the 'Aanbestedingswet 2012' (Rijkswaterstaat, 2017). The EMVI method focuses on the price-quality ratio of the received bids, which presents bidders with the opportunity to distinguish themselves from the rest based on added value (Rijkswaterstaat, 2014). Using this method, the assessment of the bids goes in twofold: first, the quality is taken into account, without looking at the price, only after this first phase the tender price is assessed. Then, Rijkswaterstaat looks at the added value of each bid during and after the construction phase. The added value is expressed in fictive monetary value, which indicates what Rijkswaterstaat is willing to spend on the added value of the bidders. This monetary value makes is transparent for the bidders how much there is to spend on added value, something which could help the occurrence of innovation. this could, contrary to the latter paragraph, also concern radical innovation as the extra room for added value could make the risks of innovating worthwhile.

The second feature that clients take into account when awarding the contract to a private party, aside from price, is quality (Grimsey and Lewis, 2005). This entails the competence of a market party to deliver a high quality product in a timely manner. Applying the same market mechanism which is seen during the abovementioned 'price wars' on the quality of proposed solutions or projects ideas, it could mean that competition may force market parties to innovate in order to provide better quality solutions (Rangel and Galende, 2010).

However, quality may suffer when being subject to a high degree of competition (Grimsey and Lewis, 2005; Iossa et al., 2007; Gelderman and Laeven, 2005). The financial competition can cause private parties to become solely focused on offering the best price, that other features such as product quality suffered under it. This phenomenon is referred to a 'war of the cents' (Iossa et al., 2007. p.10). At Rijkswaterstaat this phenomenon is minimized by paying additional attention to quality, as explained earlier: EMVI is the starting point. Also, when using the BVP method quality is a main focus point. 75 per cent of the choice for the contractor is based on quality and past performance ensuring future quality and only 25 per cent is based on price (Rijkswaterstaat, 2015).

Based on the statement by Grimsey and Lewis (2005) and Rijkswaterstaat (2015) that clients take into account not only the lowest price but also quality, it could be assumed that both factors are closely monitored during the tender process and that the chance of a so-called 'war of the cents' and its effects on quality is minimal. Add to this that EMVI is the starting point in Dutch infrastructure project, which stimulates added value in projects. However, price competition cannot be denied when looking at competition between bidders, so in this thesis competition between bidders entails both the number of bidders participating in the tender process and price competition.

The hypothesis for this condition states that, based on Rangel and Galende (2010) and the presence of EMVI, competition between bidders in the form of a high number of bidders and subsequent price competition could lead to more occurrence of innovation, through an increased efficiency and added value. Moreover, as the QCA method also takes configurations of conditions into account, even more innovation is expected when a high degree of competition is combined with the use of the BVP method.

2.4 Risk transfer to the private sector

In project management risks can never be completely abolished (Zhang et al., 2016). Risk transfer is the process in which identified risks are divided between the client (public) and the contractor of consortium (private) (ibid.).

Theory

In public private partnerships risks are divided between the client and the private parties, which is considered one of the advantages of PPP (Rangel and Galende, 2010). Risks can be seen as potential future events that have negative effects on the projects and its stakeholders. Smith (1996) defines risk as probability multiplied by loss, in which probability is the potential threat and loss is the damage that results from the threat. Parker and Hardley (2003) argue that the allocation of risks to the private parties may be a driving force in maximizing efficiency, leading to innovation.

Iossa et al. (2007, p.3) argue that the allocation of risks between the client and the private consortium should be based on two concepts:

1. given partners with similar risk-aversion, the risk should be allocated to the party that is responsible or has relatively more control over the risk factor
2. given partners with similar responsibility or control over the risk factor, the risk should be allocated to the party that is more able to bear it, i.e. the less risk-averse party.

Based on the two abovementioned principles the following three criteria for risk allocation can be formulated (Iossa et al., 2007, p.4):

1. The public-sector party should bear risks that the private sector cannot control (or cannot control as well as the public-sector party) either in terms of likelihood of occurrence or in terms of impact.
2. The private-sector party should bear risks that the private sector can control (or can control better than the public-sector party) both in terms of likelihood of occurrence and in terms of impact.
3. The public-sector party and the private-sector party should share risks that the private sector can control in terms of impact but cannot control (or cannot control

as well as the public-sector party) in terms of likelihood of occurrence. Risk sharing may also be appropriate when risk is difficult to forecast and transferring risk to the private-sector party may result in an excessive risk premium (i.e. high cost of capital).

Categorizing risks

Of the three criteria above, two are straightforward and leave minimal room for discussion on who is responsible for certain risks: the public sector adopts the risks the private sector cannot control, and the private sector handles the risks that they can control better than the public party. However, the third criterium entails a grey area. Thus, in terms of the assumed risks by the private sector in water related infrastructure PPP's, the possibility of different forms of risk sharing exists. This means that different contracts have different risk allocations, which may have different effects on the occurrence of product and process innovation in the project, which makes it an interesting input condition.

In water related infrastructure development, different categories and subcategories of risks can be identified. Moreover, in the scientific debate no constant categorization is agreed upon (e.g. Rangel and Galende, 2010; Iossa et al., 2007; Bing et al., 2005; Zhang et al., 2016). Even Within Rijkswaterstaat, no clear categories of risks are distinguished. Instead, the RISMAN method is used, which is a method for risk management in projects (personal correspondence with a Rijkswaterstaat expert, 2019). In this thesis, the risks are categorized based on the articles of Zhang et al. (2016) and Bing et al. (2005) as they use categories that are to a large extent similar. In Bing et al. (2005), the meta-classification by Li (2003) was adopted. This meta-classification was designed especially for the identification for risks in PPPs, and thus is assumed to fit this thesis. The table below presents the categories and subcategories.

Table 2.3: categorization of risks. Based on Zhang et al. (2016) and Bing et al. (2005)
Macro level risks (exogenous/environmental)
Political and government policy
Macroeconomic
Legal
Social
Natural
Meso level risks (endogenous/behavioral)
Project selection
Project finance
Residual risks
Design
Construction
Operation
Micro level risks (stakeholders)
Relationship
Third party

It has to be taken into account that some types of risk are intrinsic to certain contract types. For example, in a DBFM contract, the financial risk lies with the private party as it is an essential part of the contract. As this thesis has its contractual scope limited to D&C contracts, it is very unlikely that the risk subcategory 'project finance' is controlled by the private party, whereas this is plausible in the case of a DFBM contract.

Risk transfer and innovation

After defining risks in the context of this thesis, it is essential to understand why the transfer of risks should be considered an input condition. Hueskens (2019) and Bing et al. (2005) further argue that whether or not increasing risk transfer to the private party encourages innovation is not researched extensively. Also, empirical knowledge lacks regarding the type of risk that should be transferred in order to encourage innovation.

Some researchers argue that risk transfer to the private sector could encourage innovation (e.g. Hueskens, 2019; Rangel and Galende, 2010; Iossa et al., 2007; Bing et al., 2005; Parker and Hardley, 2003). The idea is that more risk to the private sector could possibly increase value for money and this could be associated with innovation. (Hueskens, 2019). Put differently, to reach value for money, increased efficiency and other improvements are necessary that may be established through innovation. Similar to the expected effect of competition on innovation, this input condition does not stimulate innovation directly, but does so by forcing market parties in increase efficiency.

On the contrary, Zhang et al. (2016) argue that more risk transfer to private contractors may lead to lower project performance. It increases exposure of the contractors which might lead to adverse effects such as extra costs. Opposed to the latter paragraph, Zhang et al. (2016) imply that extra costs result in negligence instead of a higher efficiency and innovation. Nasirzadeh et al. (2014) uses the example of a contractor that uses lower quality material to compensate the extra costs of the allocated risks, opposed to innovating, as stated by Rangel and Galende (2010); Iossa et al. (2007); Parker and Hardley (2003).

The negative influence of risk transfer to private contractors is also underlined by an expert at Rijkswaterstaat in personal correspondence (2019). Risk transfer to the private party is always present in PPPs, but increased risk allocation to the private party could make them 'shy' to innovate due to high exposure. The expert argues that a perfect balance has to be found between the contractor and the client, which also implies a balance between changes and risks. The logic behind this statement is that both parties, public and private, want to avoid risks. Further, he mentioned that contractors only have limited financial capacity to deal with risks. This means that transferring more risks to this party, decreases the remaining funds to allocate to innovative solutions. Innovation is mainly listed under risks in the financial accountancy of contractors, as a new product or process possesses the chance to disappoint in performance.

Based on the contrary vision and the lack of knowledge on the effects of risk transfer on the occurrence of innovation, which is also recognized by Hueskens (2019) and Bing et al. (2005), it is hard to formulate expected effects on innovation in water related infrastructure projects. As a result, the hypothesis for this condition is that risk transfer to the private party can have both a positive and a negative effect on innovation, depending on the context of the project.

2.5 Penalties against the private sector

One of the advantages of PPPs mentioned in the literature is that the private sector is motivated to produce quality product in a timely manner because payment will only occur if the contract requirements are met (e.g Rangel and Galende, 2010; Leiringer, 2006). According to Vassallo (2007), the amount of projects that fail to meet the set requirements could be even further minimized by introducing penalties that are issued when contractors deliver inadequate products or fail to deliver timely.

When using a system of penalties in case of underperformance of the contractor, the contract must specifically define underperformance, rectification periods, and the nature of penalties (Iossa et al., 2007). The definition of underperformance must be clearly measurable in order to avoid disagreements. In most cases, underperformance itself is not defined in the contract, but a clear set of requirements is defined, which also functions as indicators for underperformance. In some contracts, rectification periods are included. This gives the contractor the chance to correct any mistakes that are made without being penalized (any further). Lastly, the monetary value of penalties should be described in the contract. When setting up the contract, it is important to take into account that low penalties may not have the motivating effect that is desired, while excessively high penalties might cause the contractor to take unnecessary risks or 'play it safe'.

Penalties and innovation

A penalty system included in a D&C contract is proven to have a positive effect on the percentage of projects that is completed according pre-set quality standards (Vassallo, 2007). This hints to a condition that could be a reason for innovation, but complying to standards is not innovation, unless innovation is defined as a requirement in the contract. Stated differently, innovation that might be driven by the penalties in the contract, is itself not included in any document before the implementation of the contract, but happens during contract duration.

Rangel and Galende (2010) and Iossa et al. (2007) both agree that including penalties in the contract not only result in avoiding underperformance, but also to an increased chance of overperformance. This is considered an extra feature of the penalty system. Whereas the main reason for including penalties in the contract is to avoid underperformance, a secondary result is that the overall quality increases. A possible explanation for the phenomenon could be that contractors create a 'buffer' between the contract quality standards and what they actually deliver (overperformance), in order to avoid penalties. In the case of water related infrastructure projects, overperformance could entail time saving or product quality higher than required. Overperformance caused by extra research and development activities of the companies triggered by the penalty system, could possibly come in the form of product or process innovation. However, this remains a speculation that has to be underpinned by empirical evidence.

In the case of Dutch infrastructure projects, where EMVI is the starting point, penalties could have a more positive effect on innovation. Vassallo (2007) argues that penalties foster the highest possible quality and service and high efficiency, when the project is situated in a encouraging context. As mentioned in the chapter 2.3, the EMVI method does create an encouraging environment for contractors to deliver high quality through added value. Further, also mentioned in chapter 2.3, high quality or added value can be created using innovative solutions. Combining these statements, it seems that, in Dutch infrastructure project tendered with EMVI, penalties could be positively associated with innovation.

In terms of the relation between penalties and innovation, the discussed theory in the sub chapter (Rangel and Galende, 2010; Iossa et al., 2007; Vassallo, 2007) tends to agree upon a positive relation between penalties included in the contract and overperformance. Add to this the encouraging environment in Dutch infrastructure projects combined with the statement by Vassallo (2007) that an encouraging context positively effects the contribution of penalties on innovation through added value, a positive relation between penalties and innovation is expected. These theoretical findings resulted in the formulation of the following hypothesis: penalties included in the contract have a positive effect on the occurrence of innovation.

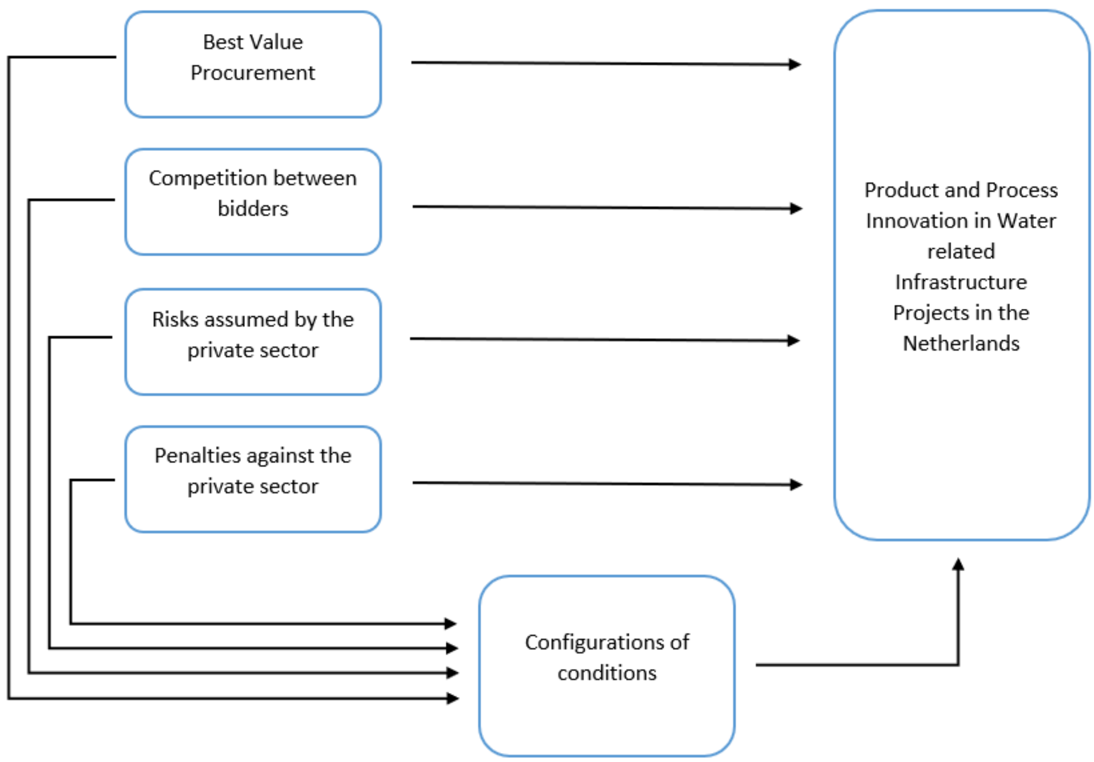
2.6 Performance and innovation

In the previous sections of this chapter literature research was conducted to expose the link between the input conditions and innovation. However, some findings only indirectly link the conditions to innovation, mostly through performance or efficiency. In this section, the link between performance and innovation is discussed, to better understand the relation between the conditions and innovation, with performance as an intermediate step.

Flynn (1994) refers to innovation as a popular strategy to achieve higher performance in order to stay competitive in the market. With innovation being a tool to achieve higher performance, the occurrence of higher performance automatically could be an indication for innovation within a project. However, it is not a guarantee that innovation was the strategy that was used to increase performance.

So, based on the discussed theory in this chapter it is evident that there exists a relation between the input conditions and increased performance. In some cases, this relation can express itself in the form of innovation but this is not always the case. Thus, it has to kept in mind that the described potential relations between the conditions and the occurrence of innovation in this chapter are no certainties is all cases. This means that, based on the theory, no statement can be made that a certain condition will always lead to innovation. The empirical research of this thesis will add to this theory.

2.7 Conceptual model



Chapter 3: Methodology

In this chapter the methodology of this thesis is presented. The primary research strategy of this thesis was Qualitative Comparative Analysis. Under the umbrella of the QCA method, three research methods were used to collect data. First, a literature study was conducted. Secondly, explorative interviews were held with Rijkswaterstaat experts to get a better practical understanding of the conditions used in this thesis. Lastly, Questionnaires were spread among contract managers of the selected cases.

This chapter starts by discussing the case selection process in section 3.1. Next, in section 3.2, the input and output conditions are operationalized and section 3.3 elaborates on the methods of data collection that were used in this thesis. Calibration of conditions and the method of data analysis are discussed in respectively section 3.4 and 3.5.

3.1 Case selection

While cases will never be exactly similar, it is crucial that the selected cases are comparable to some degree. This is called the area of homogeneity (Gerrits and Verweij, 2018), which is discussed in section 3.1.1. Section 3.1.2 explains the different steps taken in the case selection process, in which the different components of the area of homogeneity are represented.

3.1.1 Area of homogeneity

The goal of this thesis is to systematically analyze the effects of (configurations of) four input conditions on the occurrence of radical or incremental product and process innovation. In order to reach this goal successfully, an area of homogeneity is created to ensure that the cases are comparable. The area of homogeneity are the features of the selected cases that are similar between the researched cases. In this thesis, the features that are similar in all cases are the client and the network, the time scope and project phase, and the contractual scope.

Client and network

The first feature all cases have in common is that Rijkswaterstaat was the public party or the client. The reason for this is that this thesis was written at Rijkswaterstaat and data provided by Rijkswaterstaat was used. This means that all data provided were automatically of projects where Rijkswaterstaat was the client. Further, all cases are part of the water related infrastructure network. This can range from lifting groynes to building a bridge. The reasoning for focusing on the water network was explained in chapter 1.

Scope of research with respect to the contract type

Initially the focus of this thesis was on public private partnerships in general. However, many forms of partnership options exist, all with different degrees of private involvement. After Rijkswaterstaat declared their wish to include BVP as an input condition, some PPP options were no longer useful as the dataset provided by Rijkswaterstaat showed that BVP was barely used in other contract types. Thus, the decision was made to focus on one specific contract type, that is D&C. Further scientific relevance of focusing on the D&C contracts with respect to innovation were presented in chapter 1.2. Based on this information, the focus of this thesis eventually shifted to D&C (or Design & Build) contracts

Time scope and project phase

Of all cases the tender process opened in the last ten years. This time scope was chosen to ensure that interviewees and respondents should be able to remember certain aspects of the projects. Further, the moment of measurement in terms of innovation in this thesis is after delivery of the project. This means that all cases that are included in this research were already finished at the time of research.

The reason for this measurement moment is that it gives the most complete overview of the implemented innovations in a project.

3.1.2 Case selection process

The area of homogeneity is based on both theoretical grounds and empirical grounds. Firstly, all selected cases should be found in the database delivered by Rijkswaterstaat. Secondly, all cases should be water related infrastructure projects in the Netherlands (referred to in the Rijkswaterstaat database as ‘waterbouw’). In order to get the right selection of cases, a dataset of all tendered projects was provided by Rijkswaterstaat, which was then filtered on ‘waterbouw’ or water related projects in the past ten years. After this filter, the dataset contained 332 cases.

The next step in the case selection process was to filter the remaining cases based on contract type. In this thesis, the focus is on Design & Construct contracts. After selecting all the D&C contracts, 81 cases were found.

Because the dataset also contained cases which were stopped along the way, the dataset was filtered so that all so called stopped procedures were removed. 77 cases remained.

The last step in the case selection was to find the cases which were already finished. Because this information was not available in the provided dataset, the case numbers had to be transformed to different case numbers suitable for a general project database (SAP). In this database, the unfinished projects were filtered out. The remaining cases were transferred back to the original case numbers. After the case selection process was finished, 24 cases were found. All of the 24 remaining cases were finished D&C ‘waterbouw’ projects by Rijkswaterstaat, tendered in the past ten years.

3.2 Operationalization

In this section the four input conditions and the output condition innovation are operationalized.

3.2.1 Innovation

Innovation in this thesis is operationalized from a public perspective, as the thesis is conducted at Rijkswaterstaat. To get a precise as possible overview of the degree of innovation per case, contract (or project) managers were asked about their perspective. This means that innovation is operationalized as the opinion of the contract manager or project manager on the occurrence of innovation within the project.

The information gathered in the literature research in chapter 2.1 was used as a base for the operationalization of innovation. Based on definitions by OECD (2005), UNDP (2017), Rijkswaterstaat (2014), and EPA (no date) a definitions was formulated that fits the goal of this thesis:

> *‘’The implementation of a radically or incrementally improved product (good or service), or process in water related infrastructure.’’*

This definition distinguishes between four forms of innovation, based on nature (radical and incremental) and type (product and process) of the innovation. These four forms of innovation are what is measured in this thesis, from a public perspective. Resulting from these four forms of innovation, one (or a combination) of four outcomes are possible, if the absence of innovation is not considered an outcome: technologically new product, technologically improved product, technologically new process, and technologically improved process. The relations between the four outcomes and the nature and type of innovation are schematically presented in figure 3.1.

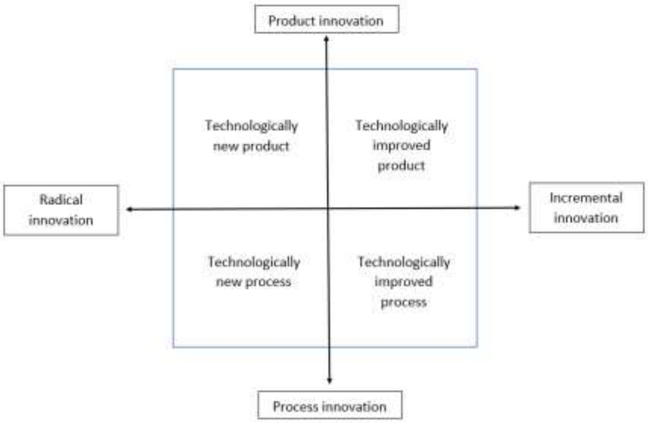


Figure 3.1: schematic presentation of the relations between the four innovation outcomes and the nature and type of innovation. Source: Author's own.

For the scope of this thesis, it was only necessary to find out if innovation occurred in a case or not, so only measuring the occurrence of innovation in general (yes/no) would have been sufficient. However, in order to get a sense of what innovation looks like in the cases, and to validate the public perspectives that were found during data collection, it was also measured which (combination) of the four innovation outcomes was found in each case.

3.2.2 Best Value Procurement (BVP)

Best Value Procurement was a straightforward condition to operationalize. The only thing that had to be measured was if the Best Value Procurement method was applied in a case or not, with the answer being either yes or no.

3.2.3 Competition between bidders

Competition between bidders is operationalized based on the absolute number of contractors participating in the bidding process combined with the price competitiveness in the same bidding process. This decision was made based on a the fact that numbers of bidders is considered the main indicator of competition, while aggressive bidding (or price competition) is believed to be the secondary indicator, according to Hong and Shum (2002).

The number of bidders was measured by taking the absolute number of bidders participating in the bidding process of a case. Price competitiveness was operationalized by calculating the average of all bids on a certain case. The difference between this average bid and the price estimate by Rijkswaterstaat in percentage was considered to indicate price competitiveness. Based on personal correspondence with a Rijkswaterstaat expert (2019), it was expected that in most cases this number would turn out to be negative, which indicates that the average bid was lower than the price estimate by Rijkswaterstaat, indicating higher price competitiveness.

3.2.4 Risk transfer to the private party

It has to be taken into account that projects of different (financial) scale are likely to have risks of different proportions. This means, in order to get comparable data, no absolute numbers can be used. In other words, the impact of the risks assumed by the private sector measured as an absolute financial number is not representative. Further, as this thesis is written at Rijkswaterstaat, a public perspective is taken, meaning that risk transfer is operationalized from a public perspective.

In order to measure risk transfer to the private party, the categorization of risks presented in chapter 2.4 is used (table 2.3) (Bing et al., 2005; Zhang et al., 2016; Li, 2003). Table 2.3 shows three categories of risks in PPPs. However, based on personal correspondence with Rijkswaterstaat experts (2019) and partially on findings in theory (e.g. Zhang et al., 2016) it was decided not to include macro level risks in the analysis, as this category consists of risks that are inherently initiated on a level out the contractors' reach and therefore are generally adopted by the public sector.

For the sub categories belonging to micro- and meso risks, a score between 1 and 5 can be given, with score 1 indicating that the risk in completely transferred to the private party, and score 5 indicating that the risk is adopted by the public party, which in this case is Rijkswaterstaat. Table 3.1 shows the measured sub categories and the potential scores. The actual scores acquired during data collection can be found in chapter 4.1.

Table 3.1: risk operationalization	
Meso level risks (endogenous/behavioral)	
Sub category	**Score range**
Project selection	1-5
Project finance	1-5
Residual risks	1-5
Design	1-5
Construction	1-5
Operation	1-5
Micro level risks (stakeholders)	
Sub category	**Score range**
Relationship	1-5
Third party	1-5

The list of categories contains 8 sub categories, all using a 1-5 score scale. Thus, the highest possible total score for a single case is 40 (8*5) and the lowest is 8 (8*1). For this condition, a higher score indicates more risks for the public sector and, vice versa, a lower score implies that more risks were transferred to the private party. For every case, the total score was divided by the amount of subcategories (8) to get an average score between 1 and 5.

3.2.5 Penalties against the private sector

In chapter 2.5 it is mentioned that the presence of penalties for underperformance, rectification periods, and the nature of penalties should be clearly defined in the contract (Iossa et al., 2007). The nature of penalties on which the focus of this thesis lies was based on the research of Rangel and Galende (2010), that is monetary penalties. That leaves the presence of (monetary) penalties and the inclusion of rectification periods to be measured in order to operationalize penalties.

A case, in this thesis, can thus have penalties included in the contract, with or without rectification periods, or has no penalties included in the contract.

3.3 Methods of data collection

In order to complement the theoretical framework in terms of formulating expectations on the relations between the input conditions and innovation, and to gather information for the operationalization and calibration of the conditions used in this thesis, explorative semi-structured interviews were conducted with experts from Rijkswaterstaat. Further, questionnaires were spread among the contract and project managers of the cases to gather information on innovation in the projects and the four input conditions. The output of the questionnaires was used to give the different conditions QCA scores, in order to successfully analyse the data. Lastly, a database provided by Rijkswaterstaat was analysed and useable data was extracted. Thus, in short, two interviews were held to explore the practical understanding of innovation and the input conditions within Rijkswaterstaat, and to gain knowledge about the structure of the organization, so the researcher knew where to look for suitable data. Next, data was taken from a dataset provided by Rijkswaterstaat. After the interviews were held and the dataset was analysed, a questionnaire was constructed, based on both literature and the two interviews, to acquire the data needed for the QCA analysis.

3.3.1 Semi-structured interviews

Two semi-structured explorative interviews were held with Rijkswaterstaat experts with the goal to get acquainted with the organization (Appendix C and D). This helped to look for relevant information in a more structured and efficient manner, and also gave insights in the mechanism at hand in Rijkswaterstaat. The choice has been made to conduct the interviews in a semi-structured manner. A semi-structured interview is a broad term but it typically refers to a situation where the interviewer has a list of questions in the form of an interview guide but is able to alter the sequence of the listed questions (Bryman, 2012). In a semi-structured interview the questions are frequently phrased in a more general way in their frame of reference compared to an authentic structured interview (ibid.).

This flexible type of interviewing allowed the interviewer to explore the topic outside his own knowledge (de Pelsmacker & van Kenhove, 2006). Put differently, certain topics may come up during the interview which the interviewer had no knowledge of beforehand or did not take into account, even though these topics could be vital for a better understanding of the conditions. So the choice for semi-structured interviews in this thesis was partly made based on the fact that it allowed the interviewer to ask additional questions that came up during the interview in order to gather more information, which seemed a logical choice as the researcher was not familiar with the Rijkswaterstaat structure and its understanding of the conditions.

The abovementioned characteristics of a semi-structured interview were considered ideal for the goal of these explorative interviews. Even though the researcher gained theoretical knowledge about the key topics of this thesis, more practical information on the topics was considered necessary. This decision was made because informal talks during office hours at Rijkswaterstaat showed the researcher that theory and practice (understanding of certain topics at Rijkswaterstaat) are not necessarily similar. The thesis is not only written with the help of Rijkswaterstaat data but also partly focused on Rijkswaterstaat wishes to gain information about the topic, thus it was necessary to get acquainted with the terminology and approaches used at Rijkswaterstaat. Further, the researcher was not familiar with the structure of the organization. In other words, the interviews helped the researcher to get acquainted with Rijkswaterstaat and were to find the information needed.

Two explorative interviews were held, both of which covered all conditions. The difference between the two interviews were perspective based: one interviewee was an innovation expert, and one interviewee was a contract and risk expert. The interviews were preferred to be held face-to-face, as this has multiple advantages over non-personal interviews such as longer sustainability of the interview and the opportunity to engage in observation of non-verbal language (Frey, 2004; Bryman, 2012). However, due to limited time availability the decision was made to conduct the interviews via telephone.

The interviews were held on the 27th of March 2019 and the 3rd of April 2019 and took approximately 40 minutes each. Even though a face-to-face interview was preferred, both interview were conducted over the phone, due to availability constraints of both the interviewer and the interviewees. Both interviews were transcribed and coded.

3.3.2 Rijkswaterstaat dataset

Rijkswaterstaat provided two datasets for this thesis. The first dataset consisted of all tendered projects of the past 15 years and was primarily used for the case selection process, as described in chapter 3.1.2. This process took place at the Rijkswaterstaat office in Utrecht, the Netherlands. Most of the selection process was straightforward and could thus be handled by the researcher. However, one step in the selection process, where the goal was to select projects that were already delivered at the time of writing, required access to an additional dataset and knowledge about project codes. The reason for this is that the sought after information was not available in the provided dataset. Of all the remaining projects, the codes had to be transformed to a different kind of code, suitable for a different dataset that included information about the moment of delivery of the projects. For this step, assistance was needed from a colleague at the Rijkswaterstaat department.

The second dataset provided by Rijkswaterstaat included detailed information about the projects and their tendering processes. Using this dataset, the selected case were tested on the use of the BVP method, and the indicators for competition were measured: number of bidders and price competition. In this dataset, the selected cases could be found by searching for the projects codes, that were available in the first dataset. Again, this dataset analysis took place at the Rijkswaterstaat office in Utrecht, as the information is classified and should not leave the department.

3.3.3 Questionnaires

To get insight in the degree of innovation that was implemented in the different cases and to collect data on the input conditions, a questionnaire was spread among contract managers and project managers of the project cases. Information on the input conditions 'BVP' and 'competition between bidders' was already available in the earlier discussed datasets and thus did not necessarily have to be included in the questionnaire. However, to verify the available data and to empirically explain the relations between input conditions and innovation, all condition were included in the questionnaire. The questionnaire is attached in Appendix A.

The questionnaire was split up in five sections. The first section consisted of questions about the output condition innovation. Different questions were asked on the occurrence of innovation, the nature of the innovation, the type of innovation, and about examples of innovation in the case. In other to gather information about the occurrence of information in the different cases, a questionnaire was sent to contract managers or project managers of the cases, depending on their availability. In 2017, a baseline measurement has been carried out by the Innovation and Market Department of Rijkswaterstaat to gain knowledge about innovation in different projects. This data was acquired using a questionnaire with three questions that was sent to the technical managers of the projects. The same questionnaire was used as a base in this thesis, with the addition of questions about the nature of the innovation (radical or incremental) and the type of innovation (product or process), to map the occurrence of innovation. Besides mapping the occurrence of innovation, this questionnaire also asked for examples of innovation, if implemented. Lastly, a matrix was presented to the respondents in which they could position the overall characteristics of the innovation, if present. Using this questionnaire allowed the researcher to map innovation in the case projects, but it also fulfilled the request of Rijkswaterstaat to have more insight in the occurrence of innovation in projects in a similar manner as done before in the baseline measurement that took place in 2017.

The remaining sections covered the four input conditions, respectively BVP, competition between bidders, assumed risk by the private sector, and penalties for the private sector.

The data acquired for the input condition competition is found in a dataset provided by Rijkswaterstaat, in which the number of bidders is listed alongside the individual bids on the contract, per potential contractor. For this condition, no further in-dept information was needed. However, in the questionnaire contract managers were still asked to answer questions about the nature of competition in the case in order to verify the data found in the datasets. Further, the managers were asked to identify and clarify the relation between competition in the bidding process and the occurrence of innovation, to empirically increase understanding of this relation.

The section on risk transfer presented the respondents with a list of categories and subcategories, as shown in table 3.1. Respondents were asked to score every subcategory between 1 and 5. A lower score meant that more risks were transferred to the private party. The average of all sub category scores was used as the final score for risk transfer in every case. As explained in chapter 3.2.4, macro risks were originally included in that categorization based on Bing et al. (2005) and Zhang et al. (2016), but are excluded in this thesis. In order to verify this exclusion, respondents were still asked to score the sub categories belonging to macro risks. Noteworthy is that the results underpinned the decision to not include macro risks: macro level risks scored significantly higher than meso and micro risks.

The section in the questionnaire that covered the input conditions penalties, simply presented the respondents with a question on the inclusion of penalties in the contract, the inclusion of rectification periods in the contract, and the expected relation between penalties and innovation.

Initially, the decision was made to have face to face interviews with all managers to gather data on the conditions. However, due to the busy schedules of the managers, they were also given the option to fill in the questionnaire themselves. Even though face to face interviews were preferred, circumstances forced the researcher to be content with the managers filling in the questionnaires themselves. Contract and project managers were contacted through an e-mail introducing the researcher, the topic and inviting them to participate in the research. Because the managers were located throughout the Netherlands, there was no fixed location where the questionnaires were filled out. Respondents were asked to fill in the date and place of filling in the questionnaire. The questionnaires were sent in the end of April and a first deadline for response was set at May 10th. After two weeks a reminder was sent to those who did not respond yet, with a second deadline at June 10th. In total, 24 questionnaires were sent, according to the available cases based on the case selection process. Between the end of April and the second deadline (June 10th) 13 completely filled out questionnaires were received, which is a response of approximately 54%.

3.4 Calibration

After selection the relevant cases, operationalizing the conditions, and collecting the data, the next step is calibration. This sub chapter first introduces the calibration on innovation in this thesis, after which the calibration of the input condition are presented.

Initially, the decision was made to calibrate the conditions using fuzzy sets, with scores between 0 and 1. Here the score of 0 indicates no membership of the case in the condition and the score of 1 means that the case has a full membership in the condition. The tip-over between more full membership and more no membership is in this case set at the score of 0,5. However, during data analysis it became clear that fuzzy set analysis did not result in any useable data. The reason for this peculiar outcome has not been identified, even after consultation with the supervisor of this thesis. QCA, which is the data analysis method in this thesis, is an iterative process, which allowed to go back and revise the calibration of the conditions. Thus, in order to get useable data out of the analysis, the decision was made to convert the originally calibrated fuzzy set data into crisp set data, meaning that cases could only score a 1 or a 0 on the conditions. In this sub chapter, the original fuzzy set calibration is presented, as this served as a base for the crisp set calibration, where the fuzzy scores were round of. This meant that fuzzy scores between 0 and 0,5 were transformed into a 0, and scores between 0,5 and 1 were transformed to a 1. At the end of the fuzzy set calibration of each individual condition, the crisp set calibration is presented.

3.4.1 Innovation

In section 3.2.1 was explained that innovation in this thesis, when present, can take on four forms which all represent the occurrence of innovation. The form in which an innovation occurs depends on its nature (incremental or radical) and the type of innovation (product or process). All cases that showed innovation, from a public perspective, were regarded as having a membership in innovation and thus should be allocated a score above the tip-over point.

In this thesis, a case with no innovation was given the score of 0. Cases with incremental innovation, regardless of the type, scored 0,67. Cases with radical innovation scored a 1. This calibration has been based on theoretical grounds. Radical innovation was assigned a higher score than incremental innovation. This division was based on Ericson and Kastensson (2011), stating that radical, abrupt innovation is vital for long-term survival and the increase of future revenue numbers for a business, whereas incremental innovation is more related to short-term benefits. Another statement underlining that radical innovation was assigned a higher score, is that radical innovation requires a high degree of new knowledge, whereas incremental innovation can occur with significantly less new knowledge (Ericson and Kastensson, 2011). Furhter, radical innovation is considered very rare and a major driver of economic growth, creating new markets which can take down big firms while propelling small businesses to market leadership (Chandy and Tellis, 2000).

No distinction in calibration was made between product and process innovation, as different types of innovation can be heavily interrelated, as discussed in chapter 2.1. For product and process innovation, which is also considered a single type of innovation by OECD (1996), this means that the emerge of one of the two, is likely to result in the emerge of the other type. For instance, a new material is implemented on the market (product innovation) but it cannot be put into place with the existing technologies or devices. This would eventually result in process innovation in the form of new or improved technologies that are suitable for the new material. Figure 3.2 shows the different forms of innovation and their scores, in case of no innovation a case is rewarded the score 0.

Figure 3.2: schematic presentation of operationalization and calibration of output condition innovation. Source: author's own.

As mentioned in the introduction of sub chapter 3.4, the original calibration used fuzzy sets. However, after analysing the results, the decision was made to change this to crisp sets. For innovation, this means that all presents forms of innovation score a 1, and that cases without innovation score 0.

3.4.2 Best Value Procurement (BVP)

The calibration of this condition was straightforward. BVP is a Boolean condition, meaning that it is either present or not present. In the original calibration of this thesis, this condition already used crisp sets, with BVP being present (score 1) or not present (score 0). When revising the calibration for all conditions, nothing needed to be changed for this condition.

3.4.3 Competition between bidders

As mentioned earlier, the first step in measuring competition between bidders was to identify the amount of bidders in the bidding process for every selected case. The lowest number of bidders for a single bidding process in the selected cases is 1, while the highest is 8. The average lies right in between with 4,29. Good practice would be to set a threshold that divides the number of bidders in low and high. However, based on literature and personal correspondence with Rijkswaterstaat experts (2019), no clear threshold could be found.

Due to the inability to set a threshold based on theory, a cluster analysis was executed to set a threshold that would divide the cases into two groups: low number of bidders and high number of bidders. The cluster analysis was performed using SPSS software and included the number of bidders of all 13 cases included in the research. The cluster analysis resulted in cluster 1 (high) and cluster 2 (low) among which the cases are divided. The clusters are presented in table 3.1 alongside the clusters of price competition. The dendrogram illustrating the clusters can be found in appendix E.

The second step concerned the price competitiveness. In the process of operationalizing price competitiveness, the average of all bids to a certain case was calculated, using a dataset provided by Rijkswaterstaat. Next, the difference in percentage between the average bid and the price estimate by Rijkswaterstaat was calculated. If this percentage difference is negative, the average bid was lower than the client estimate, indicating more price competitiveness. The percentages varied between +15,95 percent and – 71,43 percent, with an average of -32,90 percent. Again, a SPSS cluster analysis was performed to distinguish two groups (again no useable guidelines were found to calibrate this indicator based on theory or Rijkswaterstaat expertise): low price competitiveness and high price between. The schematic representation of the cluster analysis for price competitiveness in the form of a dendrogram is presented in appendix F.

Table 3.2: clusters for number of bidders and price competition

	Cluster	Minimum	Maximum
Bidders	Cluster 1 - low	1	5
	Cluster 2 – high	7	8
Price %	Cluster 1 – low	15,95	-28,67
	Cluster 2 – high	-34,33	-71,43

The third and last step was to combine the two discussed features and calibrate the data. The matrix below presents the number of bidders on the y-axis and the price competitiveness on the x-axis. The figure shows that a high number of bidders in combination with an average bid much lower than the client estimate is considered the highest form of competition (score 1). On the contrary, a low number of bidders in combination with an average bid only slightly lower, similar, or even higher than the estimate is considered the lowest form of competition (score 0).

In between two combinations are left: high numbers of bidders in combination with low price competition and low number of bidders combined with high price competition. As mentioned before, Hong and Shum (2002) argue that the number of bidders is the primary indicator for competition with price competition being the secondary indicator. This hints to situation where the number of bidders should have more weight in assessing overall competition than price competition because, according to Hong and Shum (2002), the two indicators are related: higher price competition could be the results of more bidders.

In order to verify these statements applied to this research, the two indicators were statistically tested to conclude if any correlation can be identified. If the correlation is indeed present, it proves that the number of bidders should have more weight in assessing overall competition. However, the Pearson Correlation test (SPSS Software) shows no significant correlation between the two indicators. In case of testing the presence of correlation, the null hypothesis argues that no correlation is found. When the result of the test is not significant, as in this case, the null hypothesis is accepted. This means that, is this research, the number of bidders and price competition are given equal importance in assessing overall competition. This results in the calibration of competition as presented in the matrix below.

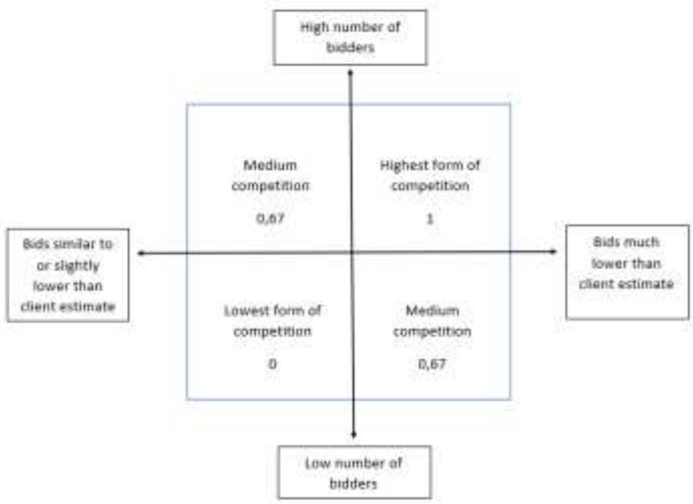


figure 3.3: schematic presentation of different degrees of competition and calibration. Source: Author's own.

Figure 3.3 illustrates the original fuzzy set calibration in this thesis. The shift to crisp sets meant that, based on figure 3.3, both medium and high forms of competition score a 1 and low forms of competition score a 0.

3.4.4 Risk transfer to the private sector

As discussed in section 3.2.4, contract managers scored multiple sub categories of risks between 1 and 5, of which the average was calculated. This means that the raw date for this condition is a number between 1 and 5.

No useable guidelines were found on how to calibrate this condition appropriately during the literature research in this thesis and consultation with Rijkswaterstaat experts, meaning that a cluster analysis had to be performed on the gathered data to distinguish cases with high risk transfer from cases with low risk transfer. The cluster analysis clearly defines four clusters of which the dendrogram is attached in appendix G. The table below (3.3) presents the minimum and maximum risk scores for each cluster. The minimum and maximum values are the average scores on meso and micro risks combined.

Table 3.3: clusters for risk transfer and QCA scores				
	Cluster	**Minimum**	**Maximum**	**Score**
Average risk score	Cluster 1	2,25	2,50	0
	Cluster 2	2,75	2,90	0,33
	Cluster 3	3,13	3,75	0,67
	Cluster 4	5	5	1

The table additionally shows the allocated QCA scores for every cluster. The theory and the explorative interviews suggested that a higher risk transfer to the private party does not have a positive effect on the occurrence of innovation, thus cases with high risk transfer (and thus low average risk scores) are given a low score and vice versa. To illustrate this statement: cluster 1 was given a score of 0, meaning that it is expected not to benefit innovation. cluster 1 also show the lowest raw data scores, which means that cases in this cluster had a relatively high risk transfer to the private party. This high risk transfer is not expected to have positive relation with the occurrence of innovation.

Using the revised crisp set calibration, cluster 1 and 2 were given a score of 0 and cluster 3 and 4 a score of 1.

3.4.5 Penalties against the private sector

For this input condition, a three-way fuzzy set was used, based on the three combinations discussed in the latter paragraph. In this thesis, a contract that includes penalties and does not include a rectification period in considered the highest form of a penalty system, and thus scores a 1. The second highest score entails contracts that include a rectification period alongside the penalties (score 0,67). Contracts that do not include penalties are given the score 0. The matrix below schematically shows the calibration of this input condition.

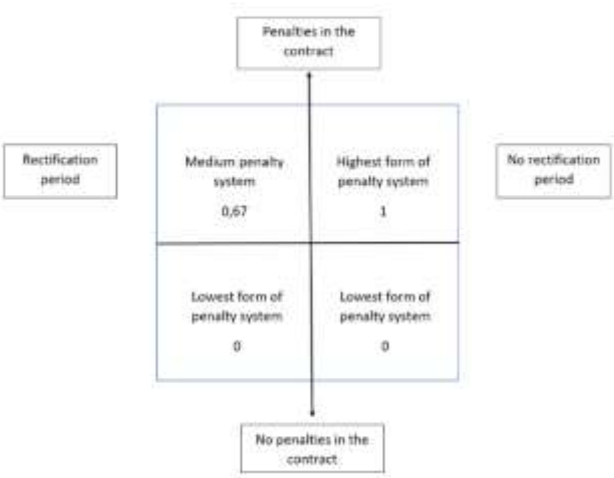


Figure 3.4: schematic presentation of different degrees of penalty system and calibration. Source: Author's own.

The penalty systems in figure 3.4 are calibrated according to fuzzy sets. In the revised crisp set calibration the medium and high form of penalty system were given score 1. The low forms of penalty systems received the score of 0.

3.5 Method of data analysis

In this thesis, the QCA method is used for data analysis. This sub chapter explains what this method entails and why it fits this thesis.

3.5.1 The QCA method

QCA is a research method that allows the researcher to identity conditions or combinations of conditions (also: configurations) that may lead to a certain output (Verweij, 2015). In this thesis, the output condition is defined as technical product and process innovation in water related infrastructure projects, and the input conditions are procurement method, competition between bidders, penalties against the private sector, and the risk assumed by the private sector.

3.5.2 Justifying the QCA method

When researching infrastructure projects, including water related infrastructure projects, the cases' complexity (shaped by heterogeneity, uniqueness, and context) and the two traditional research methods in social sciences (single-N method and large-N method) tend to collide (Ragin, 1998). This 'conundrum' is described by Gerrits and Verweij (2018). The single-N method or single case study is useful to evaluate infrastructure projects because it allows the researcher to formulate in-depth clarifications, with a focus on the heterogeneity, uniqueness, and context of a particular project. A downside of the single-N study is that its generalization capability is limited. In other words, the outcome of a single case study is not very relevant for explaining other or future projects (Smtyh and Morris, 2007). On the contrary, large-N studies are suitable for generalization and the comparison of projects, but are limited in terms of including complexity of a single case (ibid.). The QCA method combines the advantages of both the single-N studies and the large-N studies and therefore can be referred to as a middle-N method (Gerrits and Verweij, 2018).

By combining advantages of both traditional methods, the QCA method can be used to look at generic patterns between cases and at the same time take into account the complexity of these patterns (Gerrits and Verweij, 2018). QCA is "*a powerful approach for a moderate number of cases number of aspects or conditions"* (Gerrits and Verweij, 2018. p18) which identifies the conditions or configurations of conditions that determine a particular outcome. Linking the latter statement to this thesis: QCA can for instance be used as a method to identify in which context (or: in combination with which other conditions) the Best Value Procurement (BVP) method is most likely to result in the occurrence of innovation in water related infrastructure projects and, subsequently, how this relates to projects that were subject to other procurement methods.

In short, QCA fits this thesis as the goal is to identify conditions or configurations of conditions that can explain the presence of product or process innovation in water related D&C projects. The relevance of looking at configurations when looking at innovation in PPPs, which was discussed in chapter 1.3, was also underlined by Van den Hurk at Verweij (2017).

3.5.3 Explaining the QCA method

QCA is a research method in which cases (projects in this thesis) have a membership in particular conditions (Ragin, 1998). The degree to which a case can be member of a certain condition, depends on which categorization is used for that particular condition: the Boolean logic (Ragin, 1987) or fuzzy sets (Ragin 2008). If a condition used a Boolean logic to ascribe membership to a set, only two categories are possible: member (score 1) or non-member (score 0) (Ragin, 1998). Using fuzzy sets, more scores are possible on the scale between 0 (full exclusion) and 1 (full inclusion), for instance by adding the scores 0,33 (weak inclusion) and 0,67 (strong inclusion) (Ragin, 2007).

Whereas the Boolean logic seems to be 'too simple' for research in social sciences (as conditions are mostly not considered to be fully present or absent, but vary on an axis in between), fuzzy sets have their own difficulties. As can be expected, the reliability of using fuzzy sets depends on the way how these are constructed (Ragin, 2007). In other words, what does full inclusion mean? What does full exclusion mean? And even more difficult, what does any score in between 0 and 1 entail? To solve this issue, calibration in necessary. In many research fields, calibration is the act of adjusting measuring instruments and outcomes to match certain known standards, which makes the outcomes understandable (Byrne, 2002). The process of calibration for linking set memberships to the different cases must be transparent and based on theoretical and empirical information (Wagemann and Schneider, 2010).

In this thesis, four input conditions have been identified to explain innovation in water related infrastructure projects, which means that sixteen combinations are possible (2^4). Or, in QCA terms, sixteen different configurations of input conditions can be distinguished. According to Wagemann and Schneider (2010) the number of conditions should be kept limited for two reasons. Firstly, with the increase of input conditions, the number of possible configurations grows exponentially. Secondly, a higher number of input conditions increases the complexity of the results, making it more difficult to comprehend.

Chapter 4: Data analysis

In this chapter the results of the data analysis are presented. First, a general description of the cases is given and the raw data is presented in table 4.1.1. The rest of part 4.1 presents descriptive analyses per condition and concludes with a necessity analysis. Further, the calibrated data is presented, two truth table analyses are conducted and the results are interpreted. The eventual results will be interpreted briefly in this chapter and further discussed in chapter 5. The calibration was done according the guidelines set in chapter 3.

4.1 descriptive analysis

4.1.1 general description of the cases

All cases used in this thesis are D&C projects in the water related infrastructure development in the Netherlands. The set timeframe in which the projects were tendered is the past ten years and cases should already be delivered at the moment of writing. Further, in all projects Rijkswaterstaat was the public client and key stakeholder. The diversity of the cases in terms of the project goal is broad, ranging from groyne improvements to optimizing navigational routes. The table below shows the raw data collected through the questionnaire, complemented with data from a Rijkswaterstaat dataset.

Table 4.1: Raw data

Case	Innovation				Competition		Risks				Penalties		BVP
	Occurs	*Driver*	*Type*	*Nature*	*#*	*Price*	*Macro*	*Meso*	*Micro*	*Total*	*Occurs*	*Rect.*	*occurs*
A	No				4	-15,70%	5	2,83	2,5	3,62	Yes	No	No
C	No				5	-38,18%	3,2	2,83	4	3.08	No	Yes	No
D	Yes	Public	Process	Both	5	-35,19%	3	3,2	2	2.92	No	No	No
E	Yes	-	Process	Incr.	4	-28,67%	5	3,67	4	4,23	Yes	No	No
F	No				8	-56,54%	4,4	3	2,5	3,46	Yes	Yes	No
I	No				3	-25,00%	4,4	2	3	3,08	Yes	No	No
J	No				5	-56,85%	4,4	3	2,5	3,46	Yes	Yes	No
L	No				5	-20,50%	5	2	3	3,31	Yes	No	No
M	Yes	Private	Product	Incr.	5	-43,39%	3,4	2,33	3	2,85	No	No	No
N	No				5	15,95%	4,4	3	2,5	3,46	Yes	Yes	No
0	Yes	Private	Product	Incr.	5	-26,27%	3,6	2,5	2,5	2,92	Yes	No	No
R	Yes	private	Product	Incr.	1	-16,57%	5	5	5	5	Yes	Yes	No
U	No				7	-34,33%	3,5	3	3,5	3,2	yes	No	Yes

4.1.2 Innovation

5 out of 13 cases show TPP innovation. Besides only looking at the occurrence of innovation, various characteristics were investigated as well: the type of innovation (product or process), the nature of the innovation (radical or incremental), and respondents were asked to provide an example of the implemented innovations in case, if applicable.

Compared to the research by Verweij et al. (2019) regarding innovation in DBFM projects, the occurrence of innovation in the cases in this cases seems rather low. Verweij et al. (2019) found that 8 out of 11 DBFM cases showed innovation, whereas this thesis found innovation in 5 out of 13 cases. This could be because of the focus in terms of contract form. However, more dissimilarities can be identified between the two studies, such as the focus on different systems: Verweij et al. (2019) focused on infrastructure projects and this thesis focuses on water related infrastructure projects.

Cases were given the score 1 if an innovative product or process was used in the project, according to the contract manager. In most cases, the innovation was incremental of nature, which was not entirely unexpected as the literature showed that radical innovation requires a high degree of new knowledge compared to incremental innovation, which makes it a rare phenomenon (Ericson and Kastensson, 2011; Chandy and Tellis, 2000). In other words, less effort is needed in order to develop an incremental innovation which makes it more likely to occur on a regular basis than radical innovation. Opposed to the nature of innovation, there is no obvious difference between de occurrence frequency of the two types of innovation, product and process innovation.

Further, the vast majority of implemented innovations in the cases were market driven. A reason for this can be the use of the D&C contract in all cases, which was a factor in the area of homogeneity. As mentioned earlier (chapter 1.3), one of the characteristics of D&C contracts is that the private contractor is responsible for the design of the project and thus has more freedom to develop creative designs.

Diverse innovations were found when analysing the examples of innovation implemented in the cases. However, all innovations can be led back to increasing efficiency in one form or another. For example, one contract manager mentioned a technical improvement in separating fresh and salt water that increased energy efficiency. Another example concerned the computerization of the mooring system on a floating landing quay with the goal to increase time efficiency. Yet another example of innovation that increased efficiency is the use of drones to verify and validate the measuring of height of vegetation.

4.1.3 Best Value Procurement

Of the 13 cases in this research, only one used the BVP method. A possible explanation for this low number is that BVP is a relatively new method that has been used for the past ten years. This combined with the fact that this research only included delivered projects could explain the lack of BVP projects in the case selection. This finding results in a lack of variation with respect to the BVP input condition, which led to the exclusion of the condition in the analysis, presented in chapters 4.2 and 4.3. However, a robustness check has been performed including the BVP condition, to find out if it shows different results than the analysis without the condition.

Similarly to the theory, the experts mention that BVP is designed to obtain the best quality and that innovation is believed to be a primary tool in achieving this. However, a potential drawback of BVP could be that contractors are obliged to deliver proof of competence by presenting already delivered projects in which they used (partly) similar solutions. This means that, by definition, innovation in BVP projects is incremental. In other words, the experts argue that radical innovation is excluded as an outcome when BVP is applied.

In terms of expert expectations on the relation between BVP and innovation not all opinions are alike. Whereas attitudes towards BVP are predominantly positive in terms of innovative outcomes, minor doubts were detected when BVP is compared to more traditional collaboration forms, as BVP is quite a complicated model.

4.1.4 Competition between bidders

The data for competition between bidders consists of two components: the absolute number of contractors participating in the bidding process and price competitiveness. For the number of bidders, only two cases (F and U) scored high. The distribution for price competition is more equal: 7 scored high and 6 scored low. The calibration rules set out in chapter 3 state that a case scores 1 when both components are high, 0,67 when one component scores high, and 0 when both components score low.

Figure 4.1a presents the distribution of the cases for competition on a matrix, with every blue dot representing a case and the black horizontal and vertical line acting as the thresholds of the clusters. This figure clearly shows which cases were allocated which score: the top left square, with six cases (A, E, L, N, O, and R), scores low on both number of bidders and price competition and thus scores 0. The bottom left square (C, D, I, J, and M) has high price competition and a low number of bidders and scores 0,67. The left over cases (F and U), located in the right bottom square of the matrix, score high on both components and thus score 1. Figure 4.1b visualizes the raw data per case.

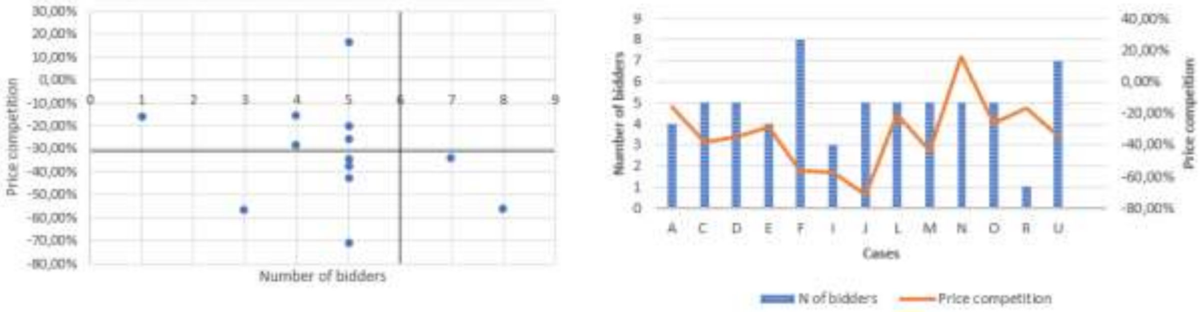


Figure 4.1a and 4.1b: distribution of cases based on raw data for competition.

The majority of the contract managers argued that competition had no specific one on one influence on the occurrence of innovation in the researched projects. The remaining managers had no opinion and no managers defined a one on one relation between competition and innovation in the specific project.

In the explorative interviews, however, the experts tend to argue for a positive influence of competition on innovation. More bidders in the process tend to drive contractors towards making more effort to stand out, also by innovating. Further, experts state that a high number of bidders can have a positive influence on innovation, but that the difference between for instance 5 or 10 has no significant influence. In conclusion, based on the questionnaire among contract managers and expert interviews, competition may result in more innovation, but it is not a guarantee.

4.1.5 Assumed risk by the private sector

As mentioned earlier, data on risk transfer was collected using a questionnaire that was based on Bing et al. (2005) and Zhang et al. (2016). Initially this covered three categories (micro, meso, and macro) but on grounds of personal correspondence with Rijkswaterstaat experts (2019) it was decided not to include the macro category as the these risks generally manifest on a high level and are thus, in most cases, adopted by the public sector. When looking at the raw data, this statement was underlined: the vast majority of the cases scored between 4 and 5 on macro level risks, meaning that the risks were almost completely taken on by the public party.

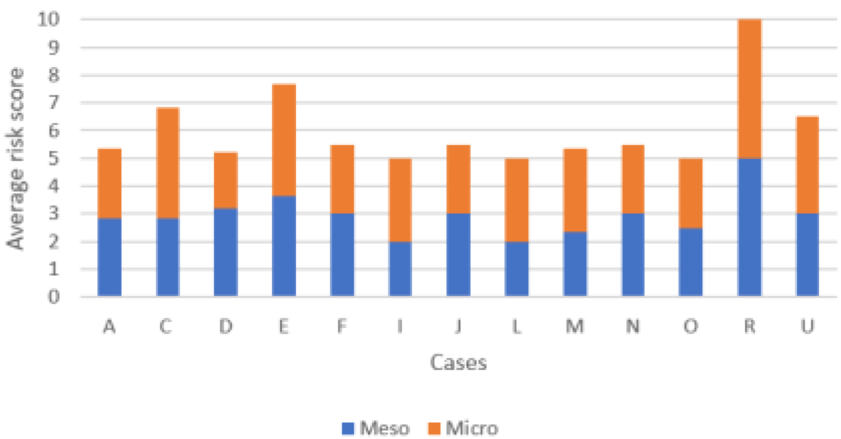


Figure 4.2: average scores on micro and meso risks per case.

As can be seen in figure 4.2, the majority of the cases score around an average score of 5, with a couple cases scoring higher (C, E, R, and U). Therefore, it comes as no surprise that the 4 outliers were, based on cluster analysis, appointed scores of 0,67 (C, E, and U) and 1 (R). The remaining cases scored either 0,33 or 0. The dendrogram is attached in appendix G.

Notable is that case R scores a 5 on all risk categories, meaning that all risks were transferred to the public sector. Going back to the case revealed that this project was similar to a project carried out earlier. Rijkswaterstaat bought all necessary parts of the initial innovator and tendered the project with a semi fixed design. Thus, the initial innovator was barely involved in this project. The contractor in this case had the sole job of implementing the parts in an almost completely fixed design and thus had few risks to account for. Despite the low involvement of the contractor in the design phase, this project was still listed as a D&C contract by Rijkswaterstaat and as this thesis is written from a public perspective, the case was included as D&C.

Noteworthy is that even though figure 4.2 clearly illustrates the scores of risk transfer per case, it does not show the average that was used to calibrate the cases. The scores that were used for calibration were calculated by dividing the total score per by the amount of sub categories: 6 for meso level risks and 2 for micro level risks. These scores are listed in the table below.

Table 4.2: combined average risk scores per case.

Case	A	C	D	E	F	I	J	L	M	N	O	R	U
Score	2,75	3,13	2,90	3,75	2,88	2,25	2,88	2,25	2,50	2,88	2,5	5	3,13

Rijkswaterstaat experts which were interviewed seem to be likeminded in terms of the relation between risk transfer and innovation. The general thought is that private parties will get ‘shy’ when they assume more risks, which decreases their preparedness to innovate. So, based on the opinions of the Rijkswaterstaat experts, transferring more risks to the private party has a negative influence on innovation. However, as mentioned in the theoretical framework in section 2.4, there is still no empirical evidence on what type of risks have more influence on the occurrence of innovation, meaning that the opinions of the Rijkswaterstaat experts are based on their own experiences.

4.1.6 Penalties against the private sector

The raw data for this condition consists of two indicators: the occurrence of penalties in the contract and rectification periods. In general, most cases score positive on the presence of penalties in the contract: 10 out of 13. The data on rectification periods in more equally divided: 8 out of 13 included these periods in the contract. Three scores were possible for this condition: penalty without rectification period (1), penalty with rectification period (0,67), and no penalty (0). As the presence of penalties is expected to benefit innovation, this was given the highest score. Table 4.1 in chapter 4.1.1 lists the raw data on this condition.

4.1.7: Calibrated data

This sub chapter presents the calibrated data for all conditions. First, the calibrated data matrix for fuzzy sets is shown in table 4.3 as these were used in the initial research. Next, the data matrix for crisp sets is presented in table 4.4, which was used for the final research.

The original idea in this thesis was to use fuzzy sets for the QCA as discussed in sub chapter 3.4. However, when multiple analyses were performed with the fuzzy set data matrix, unexpected and not useable results came out: low consistency and contradictions that were not expected based on case knowledge. As QCA is an iterative process, multiple attempts were done to go back to the cases to find out if there were any flaws to be found. After going back to the operationalization and calibration process without finding any obvious errors from the researcher's point of view it was decided to leave it unchanged, as the researcher was content with it. Based on the latter, the decision was made to switch to crisp sets. This meant that all calibrated data had to be rounded off: all scores between 0 and 0,5 were round off to 0, and all scores between 0,5 and 1 were rounded off to 1.

Crisp set QCA (csQCA) is also considered a valid option for this thesis as its goal is to "*integrate the best features of the case-oriented approach with the best features of the variable oriented-approach*" (Ragin, 1987, p. 84), which also builds upon the call for other than traditional research methods in the field op PPPs by Van den Hurk and Verweij (2017). csQCA is build up from four features, which can all be considered relevant for this thesis (Marx et al., 2013). (1) It is a case approach that considers every case as a configuration of conditions that need thorough understanding. In this thesis all cases are seen as configurations of conditions that are interrelated. (2) It is comparative, meaning that similarities and differences between cases are explored, which is the goal in this thesis by comparing cases with respect to the conditions. (3) The csQCA strategy includes equifinality, meaning that configurations of conditions produce an outcome and that different configurations can produce the same outcome. Further, it entails that a conditions can have a different effect on the outcome, depending on the context. In this thesis it was not ruled out that different configurations can lead to a similar outcome and that this option should be taken seriously. (4) The strategy is systemic in comparing the cases, suing Boolean logic to identify causal relations that are parsimonious, meaning that solutions with the lowest possible number of conditions within a set of conditions are identified. This thesis seeks to find combinations of conditions that produce the outcome innovation and these combinations could also consist of less conditions than the four conditions considered in this thesis.

Table 4.3: Calibrated data matrix, fuzzy sets

case	Innovation	Penalties	Competition	Risks	BVP
A	0	1	0	0	0
C	0	0	0,67	0,67	0
D	1	0	0,67	0	0
E	0,67	1	0	0,67	0
F	0	0,67	1	0	0
I	0	1	0,67	0,33	0
J	0	0,67	0,67	0	0
L	0	1	0	0,33	0
M	0,67	0	0,67	0,33	0
N	0	0,67	0	0	0
O	0,67	1	0	0	0
R	0,67	0,67	0	1	0
U	0	1	1	0,67	1

Table 4.4: Calibrated data matrix, crisp sets

case	Innovation	Penalties	Competition	Risks	BVP
A	0	1	0	0	0
C	0	0	1	1	0
D	1	0	1	0	0
E	1	1	0	1	0
F	0	1	1	0	0
I	0	1	1	0	0
J	0	1	1	0	0
L	0	1	0	0	0
M	1	0	1	0	0
N	0	1	0	0	0
O	1	1	0	0	0
R	1	1	0	1	0
U	0	1	1	1	1

Before the truth table analyses are performed, an analysis of necessity is done using the fsQCA software (Ragin and Sean, 2016). In this analysis, each input condition is tested separately in relation to the outcome condition innovation. A condition is considered necessary if the consistency is higher than 0,9. In this case, the highest found consistency is 0,6 for penalties. The results are shown in table 4.5. Another necessity analysis was conducted for the outcome negated innovation as explaining which conditions could possibly explain low innovation will also be part of the analysis in this thesis. The only difference with the latter necessity analysis is that the outcome condition was changed to ~innovation. this analysis is shown in table 4.5. Again, the condition with the highest consistency is penalties with 0.875000. Thus, in both analyses no necessary conditions were identified.

Table 4.5: Necessary condition analysis for innovation.

	Consistency	Coverage
BVP	0,000000	0,000000
Competition	0,400000	0,285714
Risks	0,400000	0,500000
Penalties	0,600000	0,300000

Table 4.5: Necessary condition analysis for ~innovation.

	Consistency	Coverage
BVP	0,125000	1,000000
Competition	0,625000	0,714286
Risks	0.250000	0,500000
Penalties	0,875000	0,700000

4.2: Truth table analysis for outcome innovation

This sub chapter presents the truth table analysis for outcome innovation, using csQCA data. The first truth table analysis that was done competition, risks, and penalties as input condition. At the end of this part, the same analysis is done with the addition of BVP as input condition as a robustness check. Out of the eight (2^3) possible configuration in this truth table analysis, six are represented with at least one case. In the truth table below (table 4.6) the truth table rows with at least one case are displayed. The truth table is sorted on raw consistency.

Table 4.6: Truth table analysis, outcome innovation

Competition	Risks	Penalties	Innovation	Number	Cases	RAW consist
1	0	0	1	2	D, M	1
0	1	1	1	2	E,R	1
0	0	1	0	4	A, L, N, O	0,25
1	0	1	0	3	F, I, J	0
1	1	0	0	1	C	0
1	1	1	0	1	U	0

The tested model in this analysis is innovation = f(Competition, Risks, Penalties). The frequency cut-off point is set on 1 case meaning that every truth table row with at least one case is considered. The consistency cut-off point is 0,75, which is widely applied in QCA research (Ragin, 2010). Looking at the data, the practical consistency cut-off point is 1 as this is the score of the first case that exceeds 0,75. When applying these cut-off points, the first two truth table rows are relevant and consistent, while the remaining rows in table 4.6 are relevant, but not consistent. The column 'number' shows the number of cases in each configuration and the 'cases' column lists the specific cases in the row.

Using fsQCA software, a standard analysis was performed on the truth table using the Quine-McCluskey algorithm (Ragin, 2010). In order to analyse the results, the complex solution was taken into account as it is the most conservative method which does not include configurations that are not relevant (logical remainders) (Verweij et al., 2013). This decision was made because some relations between the input conditions and innovation are not certain, as is the case in this thesis. For instance, in sub chapter 2.4, the relation between risk transfer and innovation is not undisputed.

The results show that two different paths lead to innovation, as can be seen in table 4.7. As the two configurations are completely different, no further minimization was possible. The combined solution has a coverage of 0.8 and a consistency of 1. The coverage is 0.8 because 4 out of 5 cases with a positive outcome are represented in this combined solution. Consistency is 1 as all cases in the combined solution have a positive outcome. The coverage represents the explanatory value of the solution: it shows how much of the outcome is explained by each solution term (Ragin, 2010).

Table 4.7: Results for outcome innovation

	RAW coverage	Unique coverage	Consistency
comp*~risk*~penal	0.4	0.4	1
~comp*risk*penal	0.4	0.4	1
Solution coverage	0.8		
Solution consistency	1		

As mentioned before (table 4.5), no conditions were found to be necessary for the occurrence of innovation. Further, the truth table analysis shows no sufficient conditions either. Necessary or sufficient conditions can be found when a causal relation is present between a single condition and the outcome condition: a conditions would be sufficient is it produces the outcome innovation by itself and a condition would be necessary if the outcome cannot be produced without it (Ragin, 2008; Schneider and Wagemann, 2010; Verweij et al., 2013). However, conjunctural causality is found, meaning that configurations of conditions lead to an outcome. Also, an equifinal causality if found, which means that two different rows lead to the same outcome (Schneider and Wagemann, 2010). In this case the results show two sufficient configurations of conditions that lead to innovation.

Further, all conditions that are included in the two configurations that lead to the outcome are INUS conditions. INUS stands for Insufficient but Non-redundant parts of a configuration which is itself Unnecessary but Sufficient. This means that all these conditions are part of a configuration that leads to the outcome, but none of the conditions is part of all configurations that lead to the outcome. Put differently, these INUS conditions lead to the conjunctural causality, also referred to as INUS-causality.

Interpretation

Cases D and M both have a high membership in competition (table 4.3 and 4.4). Further, both cases show a low membership in risks and penalties. In other words, these cases were subject to high competition, while much risk was transferred to the private party (as a low score on risk indicates that more risk in transferred to the private party), and no penalties were included in the contracts. Thus, when competition is high, risks for the private party are high, and no penalties are included in the contract, innovation is found. In QCA terms this solution is written as follows: comp*~risk*~penal → innovation.

Noticeable is that cases E and R perfectly mirror the previous solution. These cases score low on competition and high on both risks and penalties. In this situation innovation is found when competition is low, risks for the private sector are low, and penalties are included in the contract. In QCA terms: ~comp*risk*penal → innovation.

First conclusions show that no single necessary or sufficient conditions were found that explain innovation. Further, two solutions are found that are each other's opposites. Based on theory and the interviews with experts and contract managers, no logical explanation for this outcome was found at first sight. Also, the solution formulas are complex and no minimization took place as all three conditions are part of the formula. Due to their complexity and the absence of minimization possibilities, the solution formula are not very useful. The results will be discussed further in chapter 5.2.

Including BVP

When adding BVP as an input condition to the truth table analysis, the first consequence is that the amount of possible configurations increases from 8 (2^3) to 16 (2^4). Besides the change in possible configurations, no other changes were identified. The amount of configurations with at least one case stayed the same, with the same composition of cases per truth table row. Also the standard analysis showed no changes, neither in consistency nor in coverage. The most obvious cause of this condition not contributing to the results is the lack of diversity of cases within the condition: only case U used the BVP method, and no innovation was found in this case. In conclusion, adding BVP as an input condition did not change the results of the analysis, which means that not including BVP in the original analysis was a correct decision.

4.3: Truth table analysis for outcome ~innovation

The second truth table analysis has ~innovation as outcome condition and competition, risks, and penalties as input condition. The reason to conduct an analysis where the outcome is that no innovation was found, was to research if configurations of conditions could be found that have a negative relation with innovation in a project, which can be of practical relevance when innovation is a desired outcome. Subsequently, the results of this analysis can be compared to the first analysis, with innovation as outcome condition. Alike the first analysis, this analysis is performed both with and without inclusion of BVP as an input condition, so that a robustness check was carried out.

Table 4.8: Truth table analysis, outcome negate innovation

Competition	Risks	Penalties	~Innovation	Number	Cases	RAW consist
1	0	1	1	4	F, I, J	1
1	1	0	1	1	C	1
1	1	1	1	1	U	1
0	0	1	1	4	A, L, N, O	0,75
1	0	0	0	2	D, M	0
0	1	1	0	2	E, R	0

It may not come as a surprise that the composition of the truth table rows are similar to the previous analysis, as the same cases were used. Also, the same consistency cut-off point of 0.75 was used, and the frequency cut-off is set on 1. This resulted in 4 relevant and consistent configurations, and 2 relevant and inconsistent configurations. For this analysis the same software, algorithm, and solution were used.

The results (table 4.9) show that two minimized solution formulas lead to the absence of innovation, derived from four configurations that lead to ~innovation. The combined solution has a coverage of 1, which makes sense as all cases that lead to ~innovation are represented in the solutions. The solution consistency is 0.888889. This consistency can also be explained easily: out of the 9 cases included in the combined solution, one (case O) has innovation as outcome, so 8 out of 9 show ~innovation (which is equal to 0.888889).

Table 4.9: results for outcome ~innovation			
	RAW coverage	Unique coverage	Consistency
~risk*penal	0.75	0.75	0.857143
comp*risk	0.25	0.25	1
Solution coverage	1		
Solution consistency	0.888889		

Based on table 4.5, no necessary conditions were found that explain ~innovation and based on the truth table analysis no sufficient conditions were identified. Four sufficient configurations were found, out of which two sufficient solution formula were minimized. Alike the first analysis, all conditions in this solution are INUS conditions. Thus, a conjunctural causality is found and based on the fact that multiple rows lead to the outcome, the causality is equifinal.

Interpretation

In the solution (~risk*penal) seven cases are represented (F, I, J, A, L, N, and O). All these cases scored high on penalties and low on risk. This means that these cases had penalties included in the contract and much risk was transferred to the private parties. In short, innovation is not found when a project includes penalties in the contract and risk transfer to the contractor is high. In QCA terms: ~risk*penal → ~innovation.

In the other solution (comp*risk), which consists of cases C and U, both cases score high on competition and risk transfer. In other words, both cases were subject to a high degree of competition, while being transferred little risk. In practical terms this means that innovation is not found when a project has high competition between bidders and the minority of the risks is adopted by the private sector. The QCA notation is as follows: comp*risk → ~innovation.

The solutions illustrate that both high and low risk transfer to the private party can lead to the absence of innovation in water related D&C projects, depending on the context. This was also the case in the analysis on the outcome innovation and is in line with the indecisive theory on this topic which was presented in chapter 2.

Including BVP

As with the first analysis, BVP in included in a separate robustness check, which automatically increases the potential number of configurations to 16. Again, the relevant truth table rows and case compositions did not change. However, opposed to the first analysis' robustness check, the results of the complex solution differ after including BVP. The results are shown in table 4.10.

Table 4.10: results for outcome ~innovation, BVP included			
	RAW coverage	Unique coverage	Consistency
~bvp*~risk*penal	0.75	0.75	0.857143
~bvp*comp*risk*~penal	0.125	0.125	1
bvp*comp*risk*penal	0.125	0.125	1
Solution coverage	1		
Solution consistency	0.888889		

Compared to the same analysis without BVP as an input condition, the same cases lead to ~innovation. The first solution formula consists of the same cases as the first formula in the analysis without BVP, which does not come as a surprise as all these cases score negative on BVP. This means that ~BVP is simply added to the formula. The second solution formula of the original analysis (comp*risk) is in this analysis split up into two formulas. In the analysis without BVP the two cases were exactly the same apart from that fact that they scored differently on penalties. After minimization the formula comp*risk arose. After adding BVP, however, these two cases score differently on two different condition, BVP and penalties. The consequence of this is that no further minimization is possible, and thus the two are separated in two different formula. Thus, adding BVP led to four complex solution that could not be minimized and are thus not very useful, underpinning the decision not to include BVP in the original analysis as it does not contribute significantly to the results.

In conclusion, both analysis show minimal change when adding BVP as an input condition. The only difference is that in the second analysis one solution formula is split up into two formulas because two cases in the original formula score differently on BVP. A robustness check was carried out and substantiated the earlier made decision not to include BVP in the analysis.

Chapter 5: Discussion

In the following chapters the relations found in chapter 4 are discussed. In this chapter, the hypotheses formulated in chapter 2 are compared to the results in section 5.1. Section 5.2 discusses the solution formula for outcome innovation and outcome ~innovation, not including BVP as input condition. The outcomes are discussed and explanations are suggested based on theory, going back to the cases, and practical experience gained during the internship at Rijkswaterstaat

5.1 Hypotheses

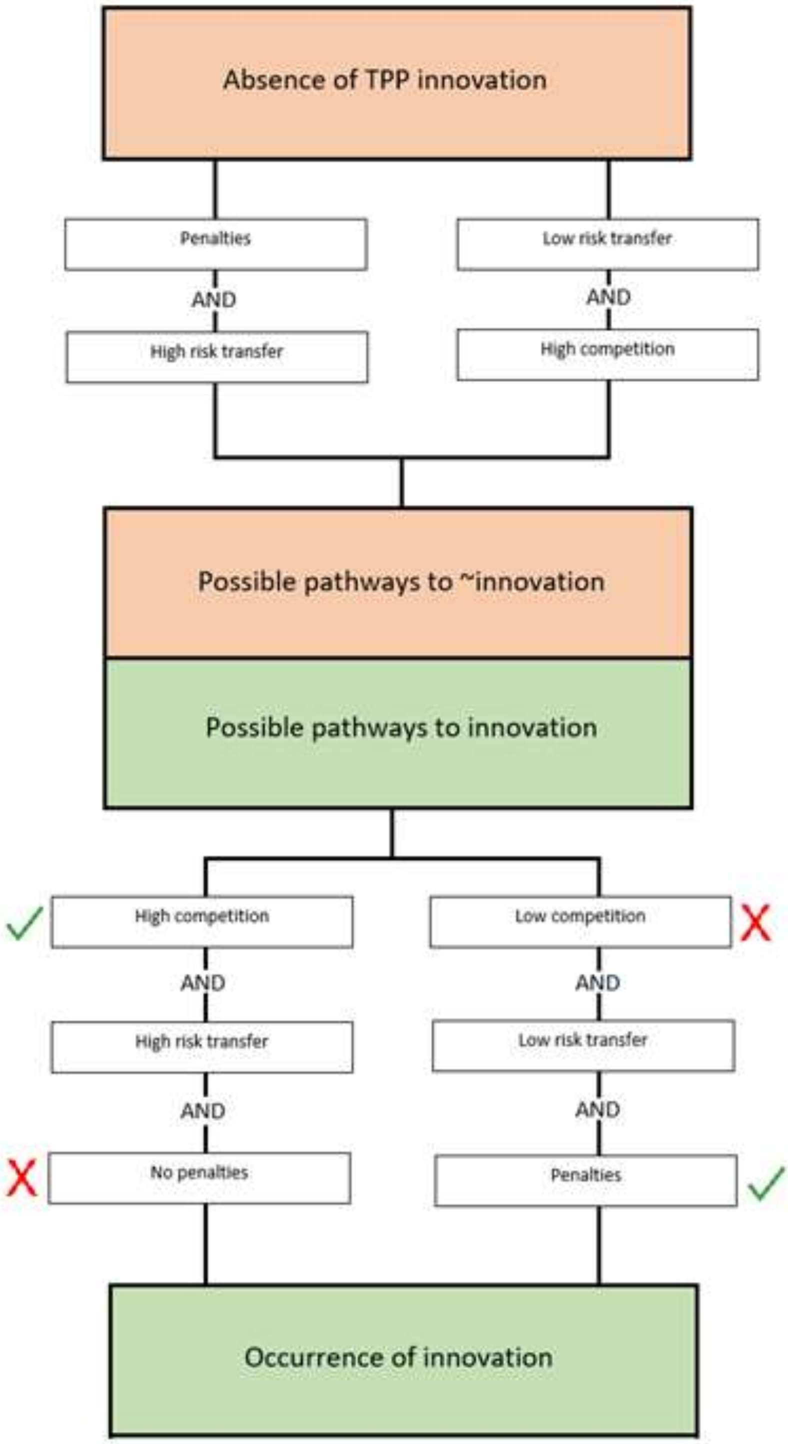
Important to clarify when comparing the hypotheses to the results is that the hypotheses were based on expected relations between singular conditions and innovation. This resulted from the fact that literature research in chapter 2 did not deliver expectations between the specific set of input conditions used in this thesis and innovation, because QCA has so far not been applied in a research considering the exact conditions as used in this thesis. However, the goal of this thesis was to identify configurations of conditions, which is why QCA was applied. This entails that, even though no sufficient or necessary conditions were identified, it cannot be concluded with complete certainty if the hypotheses should be accepted or rejected. What can be concluded, however, is that the results of this thesis do not support the hypotheses.

In figure 5.1, the hypotheses have been included in the form of green check marks and red crosses next to the solution formula. The green check marks indicate that that specific condition was expected to lead to the corresponding outcome, and vice versa for the red crosses. The hypotheses are only included in the pathway to innovation, as hypotheses in chapter 2 were only formulated for this outcome. Merely mirroring the hypotheses for outcome ~innovation was considered too short-minded. Again, the QCA method applied in this research focuses on configurations of conditions, as can be seen in figure 5.1. This means that the conditions are tested in the context of other conditions, so no conclusive statements can be made here about the hypotheses based on singular relations, even though they are included in the figure. What can be argued with respect to single conditions is that they relate differently to innovation when subject to a different context, which automatically means that the hypotheses made in chapter 2 are not very useful when looking at configurations, unless necessary or sufficient conditions are found. This also shows the importance of looking at configurations when explaining innovation in a case.

5.2 Solution formula

This section discussed the solution formula leading to the outcomes innovation and ~innovation. To give an overview of the results, figure 5.1 is presented in which all pathways towards both innovation and ~innovation are visualized.

Figure 5.1: visualization of solution pathways.



5.2.1 Pathway to innovation

As presented in figure 5.1, two pathways that are the exact opposite of each other lead to innovation. both pathways consist of all conditions used in this thesis, which makes them complex, and could not be minimized. The complexity of the pathways makes them difficult to explain and not very useful por practice.

Based on the literature research presented in chapter 2, both pathways could be explained with a limited degree of certainty, since these conditions are never used before in the same context, using QCA. Besides, the relations explained in chapter 2 are between singular input conditions and innovation, and the results show configurations of conditions.

In terms of competition between bidders, the relation with innovation could be both positive and negative. For instance, Rangel and Galende (2010) argue that innovation could be the outcome of contactors trying to acquire competitive advantage through efficiency, based on their empirical study. Also Akintoye et al. (2003) conclude their empirical study by saying that a highly competitive environment forces contractors to be innovative and thus advocate a positive relation. Another statement by Rangel and Galende (2010) implies that competition forces market parties to innovate in order to deliver better quality than competitors. On the contrary, other empirical findings suggest that too much competition leads to risk adverse behaviour, and as innovation is accounted for as risks, this results in using familiar methods and products (Köberle and Gaiser, 2008, 2009). High competition may also oppress innovation as competitors become too focused on price competition, that innovative ideas that improve quality and bring along financial risks are ignored. A final statement regarding the relation between competition and innovation is that of Hueskens (2019) and Edler and Uyarra (2013) who found that the exact mechanisms that help competition influence innovation have not been identified yet. Also, the interaction between competition and the other input conditions has not yet been explained in existing literature.

With respect to risk transfer to the private party, both Bing et al. (2005) and Hueskens (2019) conclude that empirical evidence lacks on its relation with the occurrence of innovation in PPPs. Moreover, no conclusive literature is available that determine what types of risks have to be transferred to the private party to encourage innovation (ibid.). Despite the lack of hard evidence regarding this relation, various researchers suggest that risk transfer may be positively related to innovation (e.g. Hueskens, 2019; Rangel and Galende, 2010; Iossa et al., 2007; Bing et al., 2005; Parker and Hardley, 2003). The general discourse here is that the public sector attempts to increase value for money by transferring risks, and that this value is created by the private party by applying increased efficiency and other improvements that may be established through innovation. However, other literature claims that risks increase exposure, resulting in negligence to innovate (Zhang et al., 2016; Nasirzadeh et al., 2014). Moreover, personal correspondence with a Rijkswaterstaat expert (2019) and added notes to the questionnaires by contract managers seem to agree with the proposed negative relation between risk transfer and innovation. The main argumentation behind this is that contactors have limited space for financial risks combined with the fact that innovation is considered a risk. In other words, innovation is financed with the same money that is reserved for risks. This means that if more money is reserved for risks, less remains for innovation.

The main argument with respect to the relation between penalties and innovation is that, besides avoiding underperformance, including penalties in the contract results in overperformance as contractors create a buffer between the desired quality and the delivered quality so that penalties are avoided (Rangel and Galende, 2010; Iossa et al., 2007; Vassallo, 2007). When contractors seek to create a quality buffer, research and development activities could emerge, possibly resulting in innovation. Further, Vassallo (2007) argues that contracts with penalties included are likely to deliver a high quality and improved efficiency when in an encouraging context. Combing this finding with the starting point of Dutch tender processes, EMVI, it seems likely that penalties is positively associated with innovation. Opposed to the finding in the literature research, correspondence with Rijkswaterstaat experts (Appendix C and D) and received explanations in the questionnaires state that penalties barely work with respect to encouraging innovation. On the contrary, they state that penalties may have a negative influence on innovation. The reasoning behind this is similar to that of the negative relation between risks and innovation, namely that innovation is financed from the same funds as risks. The experts revealed that penalties are also booked in as risks by the contractors. Thus, similar to risks, including (higher) penalties in the contract decreases to financial space for innovation in a project.

As became clear in the previous paragraphs, both solutions may be explained based on the literature research on singular relations between the input conditions and innovation. However, no conclusive explanations can be found for the identified configurations. Also going back to the cases, which is an inherent part of QCA, did not provide useful information to understand the mechanisms that resulted in these pathways. For instance, between the two pathways no significant differences were found in the nature, type, or initiator of the implemented innovation.

As the results show configurations that lead to innovation, the conditions somehow interact with each other beyond the identified singular relations in chapter 2. Together with Rijkswaterstaat experts the two pathways were analysed in an attempt to understand why these particular combinations from pathways to innovation. The outcome was one possible explanation regarding the interaction between penalties and risk transfer. The idea was that both conditions are booked in as risks, and that an excess of risks limits the funds for innovation, as innovation is also considered a risk by the private sector. So, based on literature research, both conditions could have a stimulating effect on innovation through for instance efficiency and overperformance (chapters 2.4 and 2.5). However, too much risks makes contactors 'shy' and diminishes funds for innovation, which could explain why in every pathway only one of the two conditions is present: either high risk transfer or penalties. On a critical note, this explanation still excludes one of the conditions in the formula, that is competition between bidders.

The fact remains that the two solution formula leading to innovation are each other's opposites. This underpins the importance of looking at configurations, as the literature on singular relations cannot give conclusive explanations on these pathways. It also supports the statement that the relations between input conditions and innovation are heavily context dependent: unknown interactions between the input conditions still have analyzed. And most likely, mechanism between the input conditions and contextual factors that were not included in this thesis have their influence as well.

5.2.2 Pathway to ~innovation

The two pathways leading to ~innovation, as presented in figure 5.1, are less complex and thus more useful compared to the pathways leading to innovation. Minimization took place resulting in solution formula consisting of two conditions. The first part of section 5.2.1 discussed the inconclusiveness of the literature on the relations between single conditions and innovation, of which the result is that every input condition can have both a negative and a positive influence on innovation, depending on the context. Moreover, the suggested relations do not withstand when looking at configurations, which is this case here. As the solution formula for ~innovation are minimized and more comprehensible, they are easier to logically explain. Based on literature research, correspondence with Rijkswaterstaat experts, and notes added by managers to the received questionnaires, the pathways to ~innovation are explained in the following paragraphs.

The formula path ~risk*penal → ~innovation, meaning that high risk transfer to the private party combined with penalties lead to ~innovation, can be explained based on findings in section 5.2.1. Risks, penalties, and innovation are all booked in as risks by contactors (correspondence with Rijkswaterstaat expert, 2019). Contractors have a maximum risk exposure, meaning that a financial limit is set for adopting risks. In the case of this formula path, risk transfer to the private party is high and penalties are included in the contract, which means that the contractor already has a high risk exposure. As innovation is also considered a risk, the high risk exposure resulted in too little space for innovation to be accommodated. In other words, the financial capacity to innovate was not available due to high risk exposure in the form of high risk transfer and penalties included in the contract.

The second formula path, comp*risk → ~innovation, is less straightforward to explain. Going back to the cases explained why risk transfer was quite low. Both cases in this formula had limited space to implement own ideas. In case C a major part of the design was already established in the license applications by the public party, which then was adopted by the contractor. This meant that the bidders on this contract had very limited room to implement own innovative ideas in the design. Case U was the only case in which BVP was used, meaning that bidders had to proof that they applied the proposed solution before in a successful manner: optimization of previously used methods and solution were sought after, not new solutions. This also meant that the proposed idea was not risky and high risk transfer was not necessary. The contract manager further stated that even though Rijkswaterstaat was the owner of the majority of the risks, the contractor had the tools to control them.

The latter paragraph showed how both cases in this solution path had limited room for implementing new ideas, due to a pre-set design or because the proposed design had to be implemented successfully before. This, of course, constraints innovation. Further, and this explains the high competition, when contractors cannot distinguish themselves with new ideas they have to compete by lowering their bids. This reflects in the raw data, where both cases in this formula score high on price competition.

Thus, the lack of innovation in the second formula path ascribed to how the contracts were tendered, also leaving little risks for the contactors. As a consequence, bidders tried to outcompete each other based on price competition. In other words, the lack of innovation is the result of the tender process of these particular cases and as a consequence, risk transfer was low and competition was high. This means that ~innovation is not the result of the included input conditions, but that both the input conditions and ~innovation are the result of how the tender process was set up.

Chapter 6: Conclusions and recommendations

The aim of this thesis was to assess the relations between individual conditions and configurations of conditions and technical product and process innovation Dutch in water related infrastructure projects delivered through Design and Construct contracts.

6.1 General conclusions

In terms of the relation between individual conditions and innovation, none of the hypotheses were supported by the results: no necessary or sufficient conditions were found. This finding underlines the importance of assessing conditions as part of a broader configuration of conditions that results in innovation. Beforehand, it was expected that the chance of finding individual conditions that explain innovation was relatively small compared to finding configurations that explain innovation, as it is in the nature of QCA to identify configurations. A first conclusion thus is that configurations of conditions, opposed to single conditions, provide a route to innovation.

Besides the fact that no necessary or sufficient conditions were found and the hypotheses were not supported, the expected effects of individual conditions on innovation did also not withstand within configurations that lead to innovation. This results in the next conclusion: within a configuration, the processes that lead to innovation are not predictable by combining theory on individual conditions, as the results deviate from the theory. As discussed in chapter 5, this has to do with the context in which the conditions are situated, in which the conditions interact with each other in different ways.

6.2 Research questions

(1) The first sub question in this thesis regarded a theoretical assessment of the concept of innovation in the context of this research. Innovation, in general, proved to be a phenomenon that brings along advantages to those who innovate as it is essential for competitiveness and economic progress. As a concept, innovation is hard to grasp as it is widely applied and can be considered ambiguous. In this thesis, the decision was made to focus on product and process innovation and, therefore, the concept as a whole is defined as product and process innovation. Doing so, the concept was more straightforward and subsequently data gathering could be done in a concrete manner. Within this definition, innovation could be both incremental and radical of nature. The definition formulated for this thesis that resulted from literature research is as follows:

> *''The implementation of a radically or incrementally improved product (good or service), or process in water related infrastructure.''*

(2) This theoretical assessment of innovation is followed up by the second sub question on the expected relation between the single input conditions and the occurrence of innovation.

The main finding with respect to the relation between competition and innovation is that competition is likely to positively influence innovation through efficiency and the impulse to outcompete other bidders with innovative solutions. The exact mechanism that helps competition influence innovation, however, has not been discovered yet.

Risk transfer was considered to be context dependent. No conclusive theory was found that suggested a positive of negative relation between risk transfer and innovation, because empirical evidence lacks on the relation between risk transfer and innovation. Also, there appears to be no knowledge on the types of risks that should be transferred to the private party so that innovation is encouraged.

Penalties may lead to innovation as contactors overperform to create a buffer between the quality standards in the contract and the delivered outcome, possibly in the form of innovation, especially in an encouraging environment such as the EMVI strategy. However, penalties are book in as risks by contractors, which limits space for innovation, which is also booked in as a risk.

(3) The aim of the third and last sub question was to identify configurations of conditions that lead to innovation. During data analysis, it was decided to also consider ~innovation as an outcome condition. Two solution formulas were identified to lead to innovation:

comp~risk*~penal → innovation*

*~comp*risk*penal → innovation*

Two solution formulas were identified to lead to ~innovation as well:

*~risk*penal → ~innovation*

*comp*risk → ~innovation*

The main research question is as follows:

> *Which conditions or configurations of conditions could explain innovation in D&C water related infrastructure projects in the Netherlands?*
>
> With the researched conditions being *(1) type of risk assumed by the private sector (2) provision for penalties against the private sector if the project does not meet the quality requirements specified in the contract, (3) competition between bidders, (4) Best Value Procurement*

Based on the answer to sub question 2, expected results between single conditions and innovation were formulated. However, empirical results in this thesis show no single conditions that are sufficient or necessary to produce innovation. The configurations that lead to innovation and ~innovation were presented in the answer to sub question 3. The configurations resulting in innovation are considered not very useful as they not minimized, complex, and hard the comprehend which makes them less relevant for practice. On the other hand, the configurations that lead to ~innovation could be minimized to solution formulas consisting of two conditions. On of the formulas (comp*risk → ~innovation) turned out to lack innovation due to low design freedom in the way the contracts were tendered, which also explained the low risk transfer and high competition (especially price competition). The other formula (~risk*penal → ~innovation) could be explained fairly easy and is thus considered the most valuable finding of this thesis: high risk transfer to the private party combined with penalties included in the contract has a negative influence on the occurrence of innovation.

Noteworthy is that the results described are only applicable on cases similar to those included in this research. The results could very well be useful as a starting point further research recommendation or as practical relevance for Rijkswaterstaat, but one has to be careful when generalizing the outcomes.

6.3 Implications for Rijkswaterstaat

The first relevant finding for Rijkswaterstaat, as an organisation striving for innovation, is that only 5 out of 13 cases show any form of implemented innovation. Compared to, for example, the research by Verweij et al. (2019), where 8 out of 11 cases showed innovation, it is relatively low. So it seems that there is room for improvement in terms of encouraging innovation in water related infrastructure projects ('natte projecten') delivered through D&C contracts. Further, when innovation is occurring, it is mostly initiated by the market parties. A recommendation for Rijkswaterstaat to increase innovation could be to take a more leading role in initiating innovation.

The second relevant finding is that the combination of high risk transfer to the private party and the inclusion of penalties in the contract results in the absence of innovation. In other words, this combination should be avoided when innovation is sought after. Both of these conditions could very well be regulated by Rijkswaterstaat when setting up a contact. The recommendation would then be not to include this combination in the contract. Noteworthy is that it is not yet proven which types of risks have influence on innovation and thus this configuration. Future research should point this out, which then can be added to this recommendation.

A third and last recommendation for Rijkswaterstaat would be to actively keep researching this topic, which also means that data on these conditions (and maybe additional conditions) should be documented where possible. This way, future research is facilitated better and useful results are more likely to be provided. For instance, research on the mechanisms in the configurations that lead to innovation could be mapped.

6.4 Implications for academia

As expected beforehand, the main area of improvement for academia is acknowledging the importance of configurations of conditions when researching PPPs. As was seen in this thesis, predicted relations between input conditions and innovation did not withstand in the configurations leading to innovation and ~innovation. This implies that certain mechanisms and interactions between the conditions are active. More in depth research, for example focusing on the cases in the two configurations leading to innovation, should help in mapping those mechanisms and interactions.

The results of this thesis do not explicitly present minimized pathways leading to innovation in Dutch water related infrastructure projects delivered through D&C contracts. Opposed to the recommendation in the latter paragraph to go more in dept in order to analyse the mechanisms between conditions, a second recommendation would be to include more cases when available to attempt to explain innovation better in these projects.

Further, as adding BVP as an input condition did not have the desired outcome due to a lack of fitting cases, an interesting topic of future research would be to assess to relation between BVP and innovation. As BVP in water related infrastructure is not widely used yet, one could argue that this research could be conducted in a different sector such as road infrastructure.

Finally, risk transfer as a single conditions remains an interesting topic about which a lot remains unclear. For instance, literature research did not result in an expected relation between risk transfer and innovation. Also, it is still not clear which types of risks are associated specifically with innovation.

Chapter 7: Limitations

The first limitation of this thesis arose in chapter 2, literature research. Whereas the study, using QCA, has a strong focus on configurations of conditions, the literature research only provided expected results between single conditions and innovation. Even the expected results of single conditions were not conclusive as no single line of argumentation was identified in the literature. For instance, the exact influence of risk transfer on innovation has not been empirically studied sufficiently to give clear expectations.

Further, out of the 24 cases that were considered fit for this research after the case selection process, only 13 were included eventually. This had to do with a lack of response among the approach contract managers in the limited time frame available for this thesis. Another limitation linked to this is that lack of variety in the BVP condition, because of which this condition could not be included in the analysis.

Lastly, the original strategy fsQCA had to be replaced by csQCA. fsQCA presented outcomes that were not useful for this research. Normal good practice in QCA would require to go back to the cases and analyse the process of operationalization and calibration. Attempts were done, but no changes could be made in the limited time frame due to which csQCA was applied. Noteworthy is that csQCA was still a valid strategy for this thesis.

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