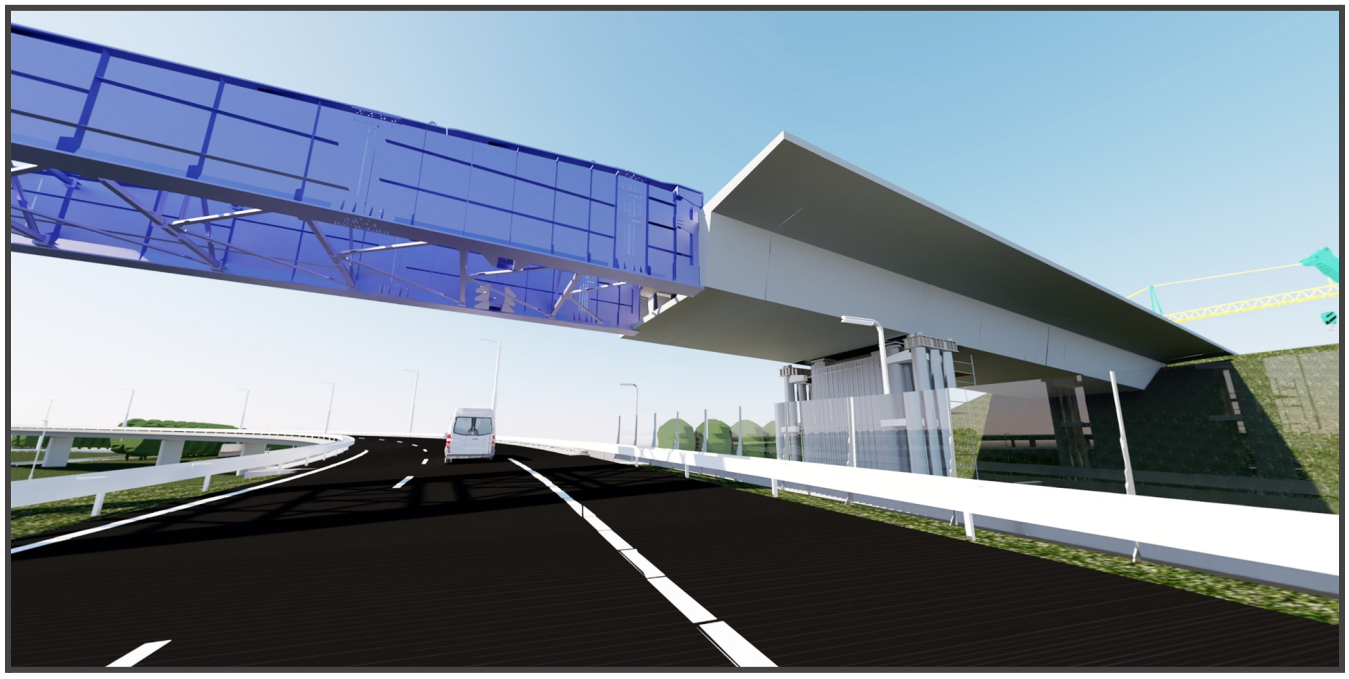
Public-Private Partnerships in road infrastructure projects: The incentives and barriers to innovation



university of groningen

Colophon

Title:

Public-Private Partnerships in road infrastructure projects: The incentives and barriers to innovation.

Word count:	6191
Author:	L.W. (Luc) Roetenberg
Student Number:	S3675777
Contact:	l.w.roetenberg@student.rug.nl
University:	Rijksuniversiteit Groningen
Course:	Technische Planologie [Spatial Planning & Design]
Version:	Final Version Bachelor Thesis
Date:	17 June, 2022
Supervisor:	Dr. S. (Stefan) Verweij

Table of Contents

Abstract

Public-Private Partnerships (PPPs) are frequently associated with better performances regarding time, costs, and quality. However, it is not always clear if innovation is stimulated or hampered by PPPs. Existing literature shows the need for further empirical research on this. This research adds to the literature by focussing on how innovation is perceived by the adopter: the construction industry. Two contract forms that are commonly used for infrastructure projects in The Netherlands are compared: DBFM and D&C. The aim is to investigate the incentives and barriers for innovation between these two contract forms. Data is collected from semi-structured interviews and secondary data sources. Three aspects that can have an effect on innovation are distinguished and analysed. These are Risk allocation, payment method, and flexibility. The main findings show that it appears that the 'freedom' to innovate is relatively equal between DBFM and D&C, but that DBFM provides more incentives compared to D&C. The main incentive in DBFM is the availability-dependent payment in combination with long contractual time periods. Although incentives are more prevalent in DBFM, the application of innovations are mostly incremental due to the high risk profile. Therefore, experimental innovations are more applicable in D&C's. In general, a recurring theme is that it is very important for the private partner to have a return on investment from innovations. For this, award criteria within public procurement is one of the main incentives whether contractors take on innovations or not.

1| Introduction

1.1 Background

Public-Private Partnerships (PPPs) are a popular choice by governments for the development of large-scale construction projects (Hodge, 2004; EPEC, 2015). Countries with relatively long histories in PPPs have found that these construction projects are managed in a more efficient manner than traditional public procurement (World Bank, 2017). Motivations for the use of PPPs are advantages such as better cost performance, better time performance, higher quality of the delivered product, and many more (EPEC, 2015). By allocating certain risks to the private sector, it can increase performance and efficiency in the development of large-scale projects (EPEC, 2015). However, there is still an ongoing debate on the overall performance of PPPs, and how certain challenges might be addressed (Koppenjan et al., 2020; Verweij and Van Meerkerk, 2020). Some features of PPPs may positively affect certain performance aspects like time and costs, although to reach these positive results, other aspects might be impacted negatively. An example of this is that innovation might be impacted negatively due to time pressure, because actors have less time to develop and assess the profitability and risks of new technologies (Gil et al, 2012).

In an effort to meet the growing demands of citizens and road users, societies are in need of innovative and reliable public infrastructure (Callens et al, 2021). One of the sustainable development goals of the United Nations is to promote ‘Industry, Innovation, and Infrastructure (UNDP, 2016). However, a report by Rijkswaterstaat (2019) notes that the productivity in the construction sector is typically lower relative to other sectors. According to the European Central Bank (2017), innovation can lead to higher productivity due to the same input generating greater output. For the construction of infrastructure this means that to increase productivity, it is crucial to stimulate innovation (Brown & Osborne, 2012) also because it increases the efficiency and quality of infrastructure development and management (EPEC, 2015).

There is a considerable discussion concerning what innovation means and it is not always clear if innovation is stimulated or hampered by PPPs. The report of the European PPP Expertise Centre (EPEC, 2015) mentions that PPPs are able to harness innovation because there are more incentives created to maximise efficiency in delivering public services. On the other side,

reports show that PPPs can also have a negative impact on innovation, mainly due to the increased risks for the private party (Hueskes et al. 2019; Koppenjan et al. 2020). Within the public sector, risk is generally described as a negative phenomenon, something that is best to be minimised if not avoided (Brown & Osborne, 2012). In contrast, innovation carries significant risks by its nature, making effective risk-taking crucial for the development of successful innovations (Brown & Osborne, 2012; gil et al. 2012). Additionally, PPP contracts formulate specifications and agreements in close detail, this rigid structure can hinder flexibility and innovation (Hueskes et al. 2019). Therefore, it is interesting to study how different forms of PPPs, which are often risk-averse, deal with innovations that are generally risky to undertake.

This research attempts to determine how different contract forms that are used in infrastructure development impact innovation capabilities and outcomes. Despite the interest in identifying the impact of PPPs on innovation, there is relatively little empirical evidence on this topic (Himmel & Siemiatycki, 2017; Russel et al., 2006). More research is needed to clarify what conditions stimulate and hinder innovation by PPPs (Callens et al. 2021). This study adds to this by analysing the main incentives and barriers to innovation that are present between two PPP contract forms.

1.2 Objectives and research questions

This research aims to investigate the incentives and barriers for innovation between different PPP contract types in road infrastructure projects in The Netherlands. For this study, two PPP contract types are distinguished and compared with regard to how their risk profile influences incentives and barriers to innovation. These two contract forms are: ‘Design & Construct’ (D&C) and ‘Design Build Finance Maintain’ (DBFM), these are chosen because they are commonly used in infrastructure projects in The Netherlands. First of all, it is important to compare how the two contract types are different, and how this might affect innovation outcomes in a project. Furthermore, underlying factors that form incentives or barriers to innovation are analysed. For this, the following research question is formulated:

- *What are the incentives and barriers to innovation between different PPP contracts in road infrastructure projects in The Netherlands?*

To help answer this question the following sub-questions are used:

- *What type of PPP contracts are used in road infrastructure projects in The Netherlands?*
- *What different types of innovations are there in infrastructure projects?*
- *What are the main aspects that influence innovative outcomes in projects?*

1.3 Reading Guide

This thesis consists of seven chapters. The first chapter already introduced the research, emphasising the research problem and relevance of this study. The central concept within this topic will be elaborated in chapter to, the Theoretical Framework. Chapter three explains the methodology that is used to answer the research questions. In chapter four, the main results will be presented, chapter 5 will follow by discussing the results of this research and relating these to the theoretical framework. Chapter 6 provides the main conclusions of this research.

2| Theoretical framework

2.1 Defining Public-Private Partnerships

There is no one clear definition of when something is considered as a public-private partnership or not (Hodge & Greve 2016). Nevertheless, most definitions share two crucial concepts: risk allocation and innovation are both mentioned as key aspects of PPPs (Hodge & Greve, 2016). In general, a public-private partnership (PPP) is an arrangement between the public and private sector in which companies and government bodies work together, often for a relatively long duration (Netherlands Enterprise Agency, 2017). In PPPs, the government has no expertise-related involvement but concentrates primarily on setting out the objectives to be achieved in terms of quality, pricing, time, and public interest (Netherlands Enterprise Agency, 2017). To make sure that these objectives are met, the public sector is responsible for monitoring the project (Netherlands Enterprise Agency, 2017).

There are many different types of PPP forms that are used in infrastructure development (Yescombe, 2007). This study focuses on two PPP contract forms that are commonly used in infrastructure projects in The Netherlands. In specific these are ‘Design & Construct’ (D&C) and ‘Design Build Finance Maintain’ (DBFM) contracts. In PPP forms, the design, construction, operation, financing, and/or maintenance are integrated into a single contract (Reynaers, 2014). There is no real consensus on when something can be called a PPP. However, the Netherlands Enterprise Agency (2017) and Little (2011) both consider DBFM and D&C as PPPs. These integrated contracts are different from traditional procurement, in which the private partner is only tasked with the construction of a project.

Design & Construct (D&C) is the integrated contract form that is most commonly used in infrastructure projects in The Netherlands (Pianoo, 2022). In projects with a D&C contract, the private partner is in charge of both the design and construction of a project. Public clients consider some aspects so important that some performance requirements are set in contract document specifications, and the contractor is responsible to determine what work he must perform to carry out the task. The standard D&C contract is based on the UAV-GC 2005, which states the universal administrative requirements of integrated contracts. This is more efficient for

both the public and private partner because they no longer have to check all the administrative-legal aspects in detail for each project (Pianoo, 2016).

DBFM projects are different from D&C in that these are a type of PPP in which the private partner is not only responsible for the design and construction, but also for maintaining, and (partly) financing the project (Lenferink, Tillema, & Arts, 2013). The objective of a DBFM contract is usually the delivery of a service or the development and operation of infrastructure where the contractor is paid based on results achieved or service provided (Vecchi et al. 2021). Furthermore, DBFM contracts are usually only applied to projects that are large in terms of their scope and budget (Verweij, Loomans, & Leendertse, 2019). For instance, in The Netherlands, DBFM's are in principle only applied to infrastructure projects with a minimum contract value of €60 million (Ministerie van Financiën, 2016). Additionally, DBFM's are not a goal in itself, but are only used if they can create added value (Ministerie van Financiën, 2016).

2.2 Public-Private Partnerships and innovation

The type of project can be both a driver or restriction of innovation. According to Russel et al. (2006), innovation potential tends to be higher in civil engineering projects such as roads, rails, tunnels, and bridges than in building projects, primarily due to the size and complexity of these projects. Size and complexity are capable of driving innovation because such projects require unique design concepts, physical components, and construction methods to effectively address concerns about performance and environmental impact, therefore this creates a much broader solution set (Russel et al. 2006).

The concept of innovation is somewhat hard to define, but it can be seen as finding new and better ways of doing things, by introducing new ideas or new types of products and services (Broughel & Thierer, 2019). Rogers (2003, p.12) defines innovation as "An idea, practice, or object that is perceived as new by an individual or other unit of adoption", which is shared and used in other literature (Callens et al. 2021; De Vries et al. 2016). Perception is important because something might be considered very innovative in one case, but not as innovative in another case (Callens et al. 2021). Since the construction industry is more an innovation adopter rather than an innovation developer (Verweij, Loomans & Leendertse, 2019), this research focuses on how innovation is perceived by the adopter: the construction industry.

Generally, four different types of innovations are distinguished: product, process, organisational, and financial (OECD/Eurostat, 2005; Russel et al., 2006). However, this study only considers product and process innovations in infrastructure projects and focuses on how D&C and DBFM contract forms influence these innovations. Product innovations can be seen as a new or significantly improved good or service with respect to its characteristics (OECD/Eurostat, 2005). These innovations are achieved through the incorporation of innovative technologies into an infrastructure project (Himmel & Siemiatycki, 2017; OECD/Eurostat, 2005), examples are advanced construction equipment, the use of new materials, the use of advanced technology in operation and maintenance phases, and new designs or concepts (Russel et al., 2006; Tawiah & Rusell, 2008). Process innovation relates to the implementation of new or improved production or delivery methods such as changes in site preparation, logistics, or assembling activities necessary during the construction or maintenance of a project (OECD/Eurostat, 2005; Himmel & Siemiatycki, 2017).

2.3 PPP aspects that influence innovation

2.3.1 Risk allocation

A key aspect of a Public-Private Partnership is the allocation of risk between the public and the private sector (Koppenjan et al, 2020). It is claimed that the private sector is more capable to manage certain risks than the public sector (Koppenjan et al. 2020), primarily due to their superior knowledge regarding the technical complexity of constructing and operating such projects (EPEC, 2015). In DBFM projects, the risk profile is generally much higher for private partners compared to D&C projects. The reason for this is that the private partner is also responsible for the financing and maintenance of the project, having to manage more risks for time periods up to 30 years. According to Koppenjan et al. (2020), the increased risks for the private partner in DBFM projects negatively influences innovation. Contractors may be reluctant to adopt unproven technologies, because these may be perceived as increasing the risks (gil et al. 2012). Due to the already higher risk profile in DBFM compared to D&C, this may mean that contractors are less likely to take on innovative ideas in DBFM, choosing the conventional, proven methods instead.

2.3.2 Payment method/bundling

As mentioned previously, D&C and DBFM contracts are different in the project delivery and the responsibilities of the private consortia. This also leads to a difference in payment methods. In D&C, the private consortium is paid mostly for the performance that is delivered in the construction phase of the project and does not depend on payments after the construction has finished (Koppenjan et al. 2022). For DBFM projects this is different due to the maintenance aspect that is part of this contract. Since the private consortium is also responsible for the maintenance, payment in a DBFM contract is dependent on the availability of the realised road infrastructure (Koppenjan et al. 2022). Gil et al. (2012) also emphasises that differences in the assessments of profitability and risk are influencing the innovations. In DBFM projects the payment is dependent on availability, which means that the private partner receives lower payments from the principal when a road is unavailable due to maintenance or repairs, which leads to lower profits. Therefore, the private partner has an incentive to invest in infrastructure that requires fewer repairs and less maintenance (Koppenjan et al, 2022), which is not so much the case in D&C projects. Consequently, DBFMs may be more likely to adopt new technologies and materials that are of higher quality to increase the life cycle of their product.

2.3.3 Flexibility

Existing literature mentions flexibility as an important aspect that influences innovation. According to a report of Rijkswaterstaat (2019), strict regulations and contractual agreements can form barriers that hinder innovation potential. Additionally, the rigid structure of formulating specifications and agreements in close detail within contracts hinders flexibility and innovation (Hueskes et al. 2019). Furthermore, decision making about technological improvements can be inherently constrained by the strict schedule of projects (Gil et al. 2012). Inflexibility within projects can thus be seen as a barrier to innovation, limiting the chance to come up with innovative ideas that are not part of the agreement. Flexible contracts have incorporated the possibility of changing project implementation, for example due to technical necessities (Verweij et al. 2015). This is done by using contract changes, according to Verweij et al. (2015), data suggests that DBFM contracts have lower contract change costs. This indicates that contract changes are cheaper to realise than in other contract forms, possibly making it more flexible.

2.4 Conceptual Model

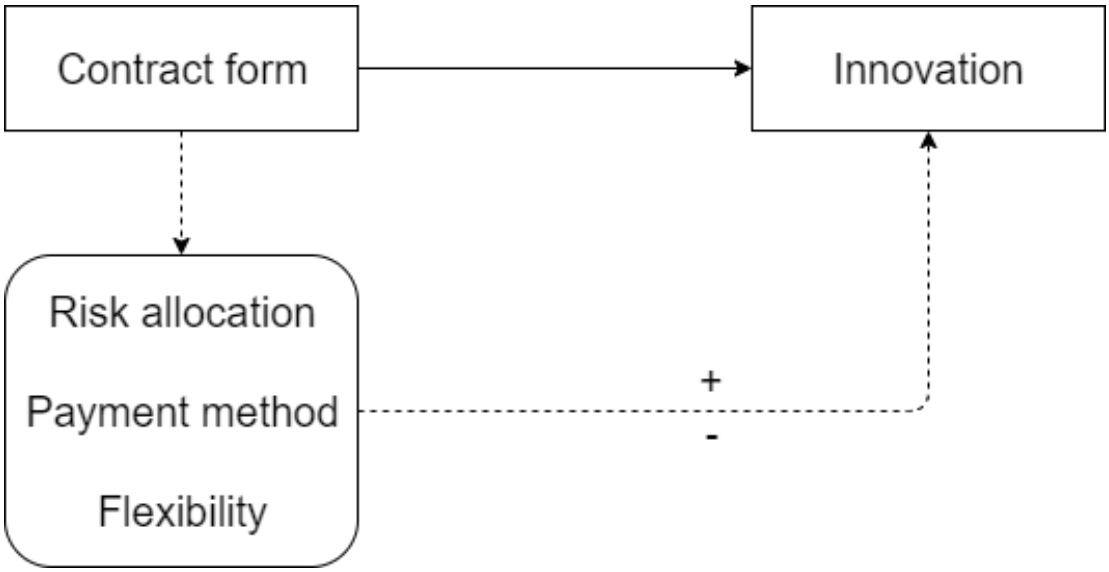


Figure 1: Conceptual model (Author, 2022).

The conceptual model (figure 1) shows a visual representation of the concepts in the theoretical Framework. It shows how the contract form has an effect on innovation in infrastructure projects. This study focuses on three variables that can differ between the contract forms: Risk allocation, payment method, and flexibility. It is investigated how these variables affect innovation, either positively (+) or negatively (-). This is done by comparing the DBFM and D&C contract form. Subsequently, it is determined how these variables form incentives and barriers to innovation in road infrastructure projects.

3| Methodology

3.1 Data Collection

For the data collection this study makes use of data triangulation by collecting data from different sources. This data consists of both primary and secondary data. The primary data consists of three semi-structured interviews, the secondary data consists of multiple media documents. In the theoretical framework, subquestion 1 is already answered in the theoretical framework by means of a literature review. Subquestion 2 and 3 are answered on the basis of the literature review, primary, and secondary data analysis.

SQ 1: What type of PPP contracts are used in road infrastructure projects in The Netherlands?
SQ 2: What different types of innovations are there in infrastructure projects?
SQ 3: What are the main aspects that influence innovative outcomes in projects?

3.1.1 Primary data collection

The primary data is collected by conducting semi-structured interviews with individuals that have been working on infrastructure projects for the private sector. This is because this research focuses on the perceptions of the private sector towards innovation. Therefore, semi-structured interviews are very useful to understand how actors in the private sector experience innovation. The participants are selected based on their function and the experience they have with both D&C and DBFM projects. Table 1 provides an overview of the respondents. The job functions of the respondents are project managers, or people involved in managing the design or innovation in certain projects. It is convenient if the respondent has been involved in both project types because then they can answer questions based on their own personal experience with both of them. Semi-structured interviews provide the opportunity to ask open-ended questions, so the participants can answer the questions based on their own personal perspectives. An interview guide is constructed (Appendix 1) so there is sufficient structure in the data that is collected, which makes for a better comparison. Interviews are conducted in Dutch via Microsoft teams, and have been recorded with Vimeo and a recorder on a smartphone to provide a backup device, limiting errors in the recordings. After this recording is used to transcribe the interview, the recording is permanently deleted.

Table 1: An overview of the interviewees and their function (Author, 2022)

Name in Thesis:	Organisation	Function(s) (in Dutch)	Date	Online Medium	Duration (Minutes)
Respondent 1 (R-1)	Heijmans	Innovatie Manager, Programmamanager Duurzaamheid	6-5-2022	Microsoft Teams	41
Respondent 2 (R-2)	Heijmans	Risico officier, Ontwerp Manager Senior	11-5-2022	Microsoft Teams	40
Respondent 3 (R-3)	Dura Vermeer	Projectmanager Infra, Integraal Project Management (IPM)	2-6-2022	Phone call	33

3.1.2 Ethical considerations

At the start of each interview, consent is requested for the recording of the interview. It is explained that this recording is only used to transcribe the interview, after which the recording is permanently deleted. Additionally, the interviewee is told his/her rights, that they remain anonymous and no sensitive information will be released. Permission is asked to only use their current function and organisation. Furthermore it is explained how I will treat the data. Since quotes are translated to English, it is asked if they want to first look into the quotes that are going to be used in the document, so the respondent can comment if this is put in the proper context.

3.1.3 Secondary data collection

Secondary data has been drawn from multiple sources, including media articles, public interviews, reports, and a webinar. The articles are gained from Cobouw, which is an independent news site that publishes articles about the construction industry. These articles were selected on the basis of their content, which had to include a combination of variables from the theoretical framework, or about innovation in the infrastructure sector in general. Additionally, two reports and a webinar have been analysed which were also selected on this criteria. The selected data is shown in table 2, and is coded using the same scheme as the primary data collection (appendix 2). The full references for the secondary data is provided in section 7.1.

Table 2: An overview of secondary data sources

Author / organisation	**Title**	**Type of document**	**Date of publication**
Cobouw (S-1)	Dura Vermeer biedt infra aan als dienst met partnerprogramma De Circulaire Weg	Media article	30-07-2020
Cobouw (S-2)	Voor- en nadelen van DBFM(O)	Media article	27-0-2018
Cobouw (S-3)	D&C is geen stimulans voor technische innovatie	Media article	20-09-2013
Cobouw (S-4)	Is er toekomst voor pps? “Alleen met meer ‘wij’ dan ‘wij-zij’”	Media article	06-11-2017
Cobouw (S-5)	Met emvi zijn we te ver doorgeschoten	Media article	30-01-2015
Economisch Instituut voor de Bouw (EIB) (S-6)	Innovatie in de bouw	Report	2017
A16 Rotterdam (S-7)	Webinar: A16 Rotterdam in vogelvlucht	Video / webinar	31-05-2022

4| Results

4.1 Payment method & Integration

From the primary data it became clear that the payment method is a significant factor in stimulating innovation. DBFM projects provided an incentive for innovation that was not part of D&C, which is the aspect of availability-dependent payment (R-1, R-2). The availability-dependent payment method that is part of DBFM is a strong incentive for private consortia to come up with innovative ideas (R-1, R-2). This is because the private consortia strives to improve the availability of the infrastructure in order to maximise their profits, giving an impulse to quality improvements in general (S-1, S-2), but also to innovation (R-2). This is illustrated by an example from R-1:

"... during maintenance, if you are standing on the verge or hard shoulder with a vehicle, there will be a speed limit in the right-most lane; then the speed goes to 90. Well, then we already get a fine, because there is no full availability. We don't want that, so what have we done? [...] We have made a kind of bayonet connection behind the guide rail, so the vehicle can park behind the guide rail if maintenance has to be done. This does not result in a 90km per hour restriction on the lane, therefore you guarantee full availability. That is an innovation that is really brought by this contract form." (R-2, 2022).

This quote highlights that some innovative solutions are only done because of the incentive in the DBFM contract form. Furthermore, an important aspect of DBFM is that the maintenance is part of a long-term contractual agreement of between 15 and 25 years. This life-cycle approach does not only result in an incentive to deliver quality products, but also to provide the demands throughout this time period (S-2). According to R-1, it is not only about how 'free' the private partner is to innovate, but that this longer contractual time period is also important. *"When you have to construct something on which you have to give a 5-year warranty, that is quite a different story than when you have to make something for which you are responsible for 20 years."* (R-1, 2022). Stressing that some innovations are not applied in D&C projects because the cost-benefit analysis will turn out negative (R-1). From all three primary data sources it became evident that longer contractual time periods with regards to the maintenance lead to

innovations like the use of newer asphalt mixtures, so there was less need for maintenance (R-1, R-2).

R-3 emphasises that a longer contract duration is important for innovation because then it actually pays off to innovate. *"... the fact is that you simply need a longer contract period to do these kinds of innovations, because it just takes time and opportunity to test these innovations [...] so then it pays off to invest to innovate, but for me that is primarily explained by the duration of such contracts."* (R3, 2022). Although R-3 was talking about her experience with the two-phase contract, this can be compared to the longer contractual time period of DBFMs.

4.2 Risk allocation & Flexibility

Despite the previously mentioned benefits of the life-cycle approach, some sources also mention that this can have negative effects (S-2, S-4). According to S-4, multi-year contracts have hardly any added value over D&C contracts. Moreover, S-4 (2017) stresses that factors like time and environment are so unpredictable that DBFM contracts are already outdated the moment a contract is signed. S-4 and R-2 both stress that it is very difficult for private partners to make detailed estimates for costs in the far future. As R-2 describes this:

"... So at the very beginning, you should already have a relatively detailed description of when you want to spend money in those 25 years. That is extremely complex, and if you make a mistake it goes fast." (R-2, 2022).

The biggest difference between the risk profiles of DBFM and D&C is the finance component, in DBFM that is very important (R-2, 2022). The increased risk for the private partner in DBFM also has an impact on innovations. Experimental innovations are not really applied in DBFM projects, primarily because of the longer time period and higher risk profile (R1, R-2). The time period that a private partner is bound to a project is much longer in DBFM, which makes experimental innovations much more risky. An element of the risk profile is to give an estimate of the life cycle and technical lifespan of a product; the longer the time period, the more difficult this is to do (R-1). As described by R-1: *"... in a D&C you have that risk for 5 or 10 years, while in DBFM that risk is for 20 or 30 years."*. Furthermore, R-2 also states that experimental innovations are avoided because of the increased risk in DBFM: *"... of course, for real innovations you have to*

accept and take into account that it can fail [...] the space for this is not really present within a DBFM." (R-2, 2022). Hence, experimental innovations are more suitable for D&C projects because of their lower risk profile and the shorter time period of the contract. In that case, the contract form D&C is more flexible: *"Innovation can also fail… and in a DBFM you really can't have that."* (R-2, 2022). However, S-3 notes that D&C also does not provide a good basis for innovation. This is primarily because risks for innovation are primarily for the private sector. Due to the risk allocation in DBFM and D&C the contractor gets more responsibilities which increases the risk profile. According to S-3 this leads to *"the willingness to increase risks further by including new, unproven technologies will only get less."* (S-3, 2013).

Despite the potential benefits of the life-cycle approach, it can also have a negative effect on innovation (S-2). An example is that due to the development of new technologies and insights, new ambitions and demands are difficult to realise because of contractual agreements which are costly to change (S-2). According to R-2, requesting contract changes is different between DBFM and D&C: *"... but in itself, if you want to submit a vtw ('request for change') [...] in a D&C that is just easier to realise."* (R-2, 2022). Showing that it is easier to request for contract changes in D&C compared to DBFM projects. Submitting a 'verzoek tot wijziging' or 'request for change' in a DBFM contract is especially hard because it has to be proposed to the bank consortia that is used for the financing of the project, this takes a lot of time (R-2).

By analysing the data it appears that in itself, DBFM contracts are not as flexible as D&C contracts. This might have negative consequences to apply innovative ideas during the design, implementation, and realisation of projects. However, R-2 also mentions that it can provide stability within a project: *"... in the design process it also gives peace of mind, because you know where you stand. That of course also improves the quality."* (R-2, 2022).

4.3 Award criteria: EMVI and Lowest price

During the data collection it became clear that the award criteria in the tendering phase of projects was also a very important factor that influenced innovation. Award criteria in a tender is a factor that is seen as an important incentive for innovation (R-1, R-2, R-3). In general, innovations only get implemented in a tender if it contributes to the win chance of that tender (R-1), or if there is some kind of return on investment (R-1, R-3). The two primary ways in which tenders can be won are the lowest-price criterion, and the 'Economisch Meest Voordelige Inschrijving' (EMVI), which translates to the 'Most Economically Advantageous Tender' (MEAT). In general, tenders in DBFM and D&C are both being awarded on the EMVI criteria, which means that both the quality and price are important aspects for winning tenders. However, R-2 states that even though the demands from Rijkswaterstaat are the same, D&C projects are more often selected on the basis of lowest-price. Although this distinction was not mentioned by other sources. The data shows that tenders that use the EMVI-criteria have led to more innovative solutions (R-1, R-2, R-3, S8). This is because innovative ideas or solutions get weighed in an EMVI score in which you can get a fictional discount on the total tender price (R-1, S8). An example from practice is the one that came forward during the webinar (S-7), which shows how innovations are incentivised through the award criteria in a tender guideline:

"We do not only look at the price during the tendering process, but we also look at quality criteria, one of which is traffic hinder. So we give an 'amount' of traffic hinder, and then the contractors are challenged to come up with a very smart solution to ensure that traffic hinder remains below a certain level." (S-7, 2022).

In EMVI criteria, innovation is closely related to the associated weighing factor of innovative solutions (S-6). Thus, to stimulate innovation, it is crucial to give high priority to quality, sustainability and innovation in the tender guidelines (R-3, S-6). This is illustrated by the following quote:

"... that is always the consideration when offering such an innovation; does it yield a lot of discount? Yes, then the contracting parties will take on these innovations. So if you want to stimulate that, you should also link a significant part of the fictive discount to it." (R-3, 2022).

However, it appears that in many of tenders, quality is not weighed heavily (S-5, S-6), in these tenders there was no distinction in quality, which in the end only resulted in higher transaction costs for the contractor (S-5, S-6). This results in that tenders are frequently still selected based on the lowest price, where sustainability and quality aspects did not receive a lot of attention (R-1, S-5). R-1 also illustrates this in the following quote:

“A lot of innovation in the last 20 years in the infrastructure sector was actually all about cost reduction [...] well, then everyone is in a race to the bottom to deliver certain performances as cheaply as possible. That isn’t necessarily a bad thing, but it isn’t the situation in which there is an important role for sustainability.” (R-1, 2022).

5| Discussion

5.1 Interpretation of the results

Although availability-dependent payment can lead to innovative solutions, the results suggest that the main explanation for innovation is the longer contractual agreement compared to D&C contracts. Due to this longer contractual period in DBFM, the assessment of the profitability of an innovation is more likely to be positive (Gil et al. 2012), which is also reflected in the results. However, the results also show that this longer contractual time period can lead to barriers. It shows that the longer time period makes a contractor inflexible, leaving little space to deviate from original plans to optimise during the realisation of a project. In DBFM that is perceived as too risky, primarily because of the involvement of bank consortia. However, from the results there is no clear relationship in the flexibility between DBFM, D&C, and innovations.

Furthermore, the results regarding the risk allocation in DBFM and D&C contracts show that the higher risk profile is affecting innovations negatively, which is also shared in Koppenjan et al. (2020). The results show that due to higher risk profiles, experimental or radical innovations are indeed less likely to occur in DBFM projects, because these innovations are perceived as increasing the risks even further (Gil et al. 2012). It appears that DBFM projects lead to more incremental innovations, like optimisation of processes, maintenance or newer asphalt mixtures that would not be beneficial in D&C, because the costs would not weigh up to the benefits.

The most important finding of this research is the importance of award criteria in tenders. EMVI-criteria is very important for contractors in choosing to innovate or not. Public partners such as Rijkswaterstaat should give high priority to innovative solutions in tender guidelines if they want to stimulate innovation. There should always be a return on investment for the private sector, whether this is in financial terms or by having a competitive advantage over other tenderers.

This research adds to the literature by providing the private sector insights regarding incentives and barriers to innovation in road infrastructure projects in The Netherlands. Further understanding of obstacles and opportunities for innovation is important to make this sector

more innovative. The results and conclusions of this study may be interesting for policymakers and stakeholders that deal with innovation within this sector.

5.2 Limitations and Reflection

Despite the consideration of the research strategy, there are some limitations to this research. First, the research relied on collecting and analysing primary and secondary data. The primary dataset showed much overlapping and almost no contradictions. However, due to the primary data only consisting of three semi-structured interviews, it makes the amount of data very limited. Because of the limited primary data, secondary data has also been used to compare and contrast to the primary data to increase the validity and reliability of the results. Many of the secondary data sources overlapped with the data that was collected during the interviews.

After the first interview it became clear that next to the variables in the theoretical framework, important factors that influenced innovation were also present in the tendering phases. Due to this, some questions in the interview guide were added or slightly changed throughout the data collection process, which could also change the responses and limit consistency of the research. Therefore, the findings of this research should be taken as a starting point for further research, and is partly more explorative in retrospect. By analysing the results it becomes clear that award criteria in public procurement is a very important factor that influences innovation. However, this was not revealed during the literature review for the theoretical framework. Although there are multiple reports about how this influences innovation, current scientific research on this is lacking. Therefore this presents the need for further empirical research that goes deeper into the importance of award criteria and EMVI in public procurement to gain a greater understanding of how innovation is stimulated or hampered in this.

6| Conclusion

Overall, it seems like DBFM provides more incentives for innovation compared to D&C. The ‘freedom’ to innovate is relatively equal, but the incentives are lacking in D&C because the return on investment appears to be lower. This is primarily due to the absence of availability-dependent payment, in combination with shorter contractual time periods. Although it appears that DBFM provides more incentives, the innovation that takes place is often incremental in nature. Due to higher risk profiles in DBFM projects, experimental innovations are avoided because these are perceived as too risky to apply, because the risk associated with innovation is in most cases allocated to the private party. Due to the shorter contractual time period, experimental innovations were seen as more suitable for D&C projects.

Most importantly, it can be concluded that for innovation to take place, it is crucial that there is a return on investment for the contractor. This is not different between DBFM and D&C. A ‘return’ on investment can be in the form of financial profit or by increasing the chance to win a tender due to a competitive advantage. Innovation is stimulated by awarding tenders to the contractor that provides the highest scores in EMVI with regards to innovative solutions, sustainability, or quality. However, data suggests that many tenders are still being selected based on lowest-price, because criteria associated with innovation is not weighed heavily in EMVI scores. Highlighting that public procurement only stimulates innovation if the award criteria offers the space for innovative solutions, and that these solutions are also rewarded properly. The higher contractors can score with innovative solutions within EMVI criteria, the more likely they are to actually take on innovation in their tender proposal. It should be noted that only offering ‘freedom’ for creativity and innovation is not enough, and that providing the necessary incentives is crucial.

7| References

Broughel, J., Thierer, A. (2019). Technological Innovation and Economic Growth: A Brief Report on the Evidence. *Mercatus Research, Mercator Center at George Mason University.* Arlington, VA, February 2019.

Callens, C., Verhoest, K., Boon, J. (2021). Combined effects of procurement and collaboration on innovation in public-private partnerships: a qualitative comparative analysis of 24 infrastructure projects. *Public Management Review.*

De Bruijn, P.J.M., Maas, N. (2005). TNO rapport EPS 2005-13: Innovatie in de bouw. *TNO Bouw en Ondergrond.* Delft. Retrieved on 27 may, 2022 from https://www.tno.nl/media/2512/onderzoeksrapport-innovatie-in-de-bouw.pdf

De Vries, H., Bekkers, V., Tummers, L. (2016). Innovation in the Public Sector: A Systematic Review and Future Research Agenda. *Public Administation.* 94(1), pp. 146-166.

Duffield, C.F., Maghsoudi, S. (2013). Innovation for Infrastructure Projects. *Department of Infrastructure Engineering: The university of Melbourne.*

European Central Bank (2017). How does innovation lead to growth? Retrieved on 25 may, 2022 from:
https://www.ecb.europa.eu/ecb/educational/explainers/tell-me-more/html/growth.en.html

Gil, N., Miozzo, M., Massini, S. (2012). The innovation potential of new infrastructure development: An empirical study of Heathrow airport's T5 project. *Research Policy.* 41(2), pp. 452-466

Himmel, M., Siemiatycki, M. (2017). Infrastructure public-private partnerships as drivers of innovation? Lessons from Ontario, Canada. *Environment and Planning C: Politics and Space.* 35(5), pp. 746-764.

Hodge, G.A. (2004). The risky business of public-private partnerships. *Australian Journal of Public Administration*, 63(4), pp.37-49.

Hodgge, G.A., Greve, C. (2017). On Public-Private Partnership Performance: A Contemporary Review. *Public Works Management & Policy.* 22(1), pp. 55-78.

Hueskes, M., Koppenjan, J., & Verweij, S. (2019). Public-private partnerships for infrastructure: Lessons learned from Dutch and Flemish PhD-theses. *European Journal of Transport and Infrastructure Research.* 19(3).

Khanom, N.A. (2010). Conceptual Issues in Defining Public Private Partnerships (PPPs). *Internation Review of Business Research Papers.* 6(2), pp. 150-163.

Koppenjan, J.F.M., Klijn, E.H., Duijn, M., Klaassen, H.L., Van Meerkerk, I.F., Metselaar, S.A., Warsen, R., Verweij, S. (2020). Leren van 15 Jaar DBFM-Projecten Bij RWS. *Rijkswaterstaat en Bouwend Nederland*, 2020.

Lenferink, S., Tillema, T., & Arts, J. (2013). Towards sustainable infrastructure development through integrated contracts: Experiences with inclusiveness in Dutch infrastructure projects. *International Journal of Project Management.* 31(4), pp. 615-627.

Little, R.G. (2011). The Emerging Role of Public-Private Partnerships in Megaproject Delivery. *Public Works Management & Policy*. 16(3).

Ministerie van Financiën (2016). Voortgangsrapportage DBFM(O) 2016/2017. [Progress report DBFM(O) 2016/2017]. Den Haag, The Netherlands: Ministerie van Financiën.

Netherlands Enterprise Agency, RVO (2017). Public-Private Partnership (PPP). Retrieved on 29 may, 2022 from: https://business.gov.nl/regulation/public-private-partnership/#:~:text=In%20a%20public%2Dprivate%20partnership,%2C%20for%20example%2C%20or%20infrastructure

Osborne, S., & Brown, L. (2012). Risk and innovation: towards a framework for risk governance in public services. *Public Management Review*. 15(2), pp. 186-208.

Pianoo, (2016). Design and Construct contracten (D&C). Retrieved on 20 may, 2022 from: https://www.pianoo.nl/nl/sectoren/gww/contractvormen/design-and-construct-contracten-dc

Reynaers, A. (2014). Public Values in Public-Private Partnerships. *Public Administration Review.* 74(1), pp. 41-50.

Rijkswaterstaat, Rijksvastgoedbedrijf Uneto VNI en Astrin het initiatief. (2016). Marktvisie [Market vision]. Retrieved on 20 may, 2022 from https://www.marktvisie.nu/wp-content/uploads/2018/04/Factsheet-Marktvisie-in-het-kort.pdf
Rogers, E.M. (2003). *Diffusion of innovations.* 5th Edition. New York: Free Press.

Russel, A.D., Tawiah, P.A., De Zoysa, S. (2006). Project innovation - A function of procurement mode? *Canadian Journal of Civil Engineering.* 33, pp. 1519-1537.

Tawiah, P.A., Russel, A.D. (2008). Assessing Infrastructure Project Innovation Potential as a Function of Procurement Mode. *Journal of Management in Engineering.* 24(3), pp. 173-186.

The European PPP Expertise Centre (EPEC), (2015). PPP Motivations and Challenges for the Public Sector*. European Investment Bank*.

United Nations Development Programme (UNDP), (2016). What are the Sustainable Development Goals? Retrieved on 20 may, 2022 from: https://www.undp.org/sustainable-development-goals?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQjwzLCVBhD3ARIsAPKYTcRP63h0b6Gy3lyYbVPiA_NTRotdSK9WTB33nHlZe86BmHDwLyxYB5saArZZEALw_wcB

Vecchi, V., Casalini, F., Cusumano, N., Leone, V.M. (2021). Project Risk and Optimal Allocation “in” Vecchi, F., Casalini, F., Public Private Partnerships (pp.85-101). Springer International Publishing.

Verweij, S., Loomans, O., Leendertse, W. (2020). The Role of the Public Partner in Innovation in Transport Infrastructure PPPs: A Qualitative Comparative Analysis of Nine Dutch DBFM Projects. *Public Works Management & Policy.* 25(1), pp. 5-32.

Verweij, S., Meerkerk, I. van, (2020). Do public-private partnerships perform better? A comparative analysis of costs for additional work and reasons for contract changes in Dutch transport infrastructure projects. *Transport policy.* 99, pp. 430-438.

Verweij, S., Van Meerkerk, I.F., Korthagen, I.A. (2015). Reasons for Contract Changes in Implementing Dutch Transportation Infrastructure Projects: An Empirical Exploration. *Transport Policy.* 37, pp. 195-202.

Yescombe, E.R. (2007). Public-Private Partnerships: Principles of Policy & Finance. *Butterworth-Heinemann.* 1st edition.

7.1 Secondary data sources

(S-1) in the report: Cobouw, (2020). Dura Vermeer biedt infra aan als dienst met partnerprogramma De Circulaire Weg. Cobouw. 30 July, 2020.

(S-2) in the report: Cobouw, (2018) Voor- en nadelen van DBFM(O). Cobouw. 27 February, 2018.

(S-3) in the report: Cobouw, (2013). D&C is geen stimulans voor technische innovatie. Cobouw. 20 September, 2013.

(S-4) in the report: Cobouw, (2017). Is er een toekomst voor ppps? “Alleen met meer ‘wij’ dan ‘wij-zij’”. Cobouw. 6 November, 2017.

(S-5) in the report: Cobouw, (2015). Met emvi zijn we te ver doorgeschoten. Cobouw. 30 January, 2015.

(S-6) in the report: Economisch Instituut voor de bouw (EIB) (2017). Innovatie in de bouw: opgaven en kansen.

(S-7) in the report: A16 Rotterdam, (2022). Webinar: A16 Rotterdam in vogelvlucht. Retrieved on 31 may, 2022 from: https://www.youtube.com/watch?v=RPp-XUyAdok

Appendix 1: Interview Guide

[INTRODUCTIE]

- Jezelf introduceren, uitleggen van het onderzoek
- Deelnemer zijn/haar rechten vertellen
- Vragen of de deelnemer anoniem wil blijven, zo ja: of ik zijn of haar functietitel mag gebruiken (bijvoorbeeld ‘projectmanager’ of pseudoniem (bijvoorbeeld ‘respondent + nummer’)
- Vertellen hoe ik de data behandel, en dat ik altijd eerst toestemming vraag om bepaalde citaten te gebruiken zodat de deelnemer hier op kan reageren
- Vragen of ik het gesprek kan opnemen voor het transcriberen
- Vooraf vragen of de deelnemer al vragen heeft voor mij of over het onderwerp

Blok 1: Achtergrond en rol

- Kunt u mij iets vertellen over uw achtergrond en huidige functie bij [bedrijf / instantie / organisatie]?
    - In welke fases van de ontwikkeling van een project bent u vooral betrokken?
    - Bent u bekend met geintegreerde contractvormen zoals D&C en DBFM?
    - Bent u persoonlijk betrokken geweest bij zowel D&C als DBFM projecten?

Blok 2: Effect Risicoverdelingen in het contract en innovatie

- Hoe ervaart u de risicoverdeling tussen de opdrachtgever en opdrachtnemer in D&C contracten? Wat zijn de grootste verschillen met DBFM?
- Wat is het effect van de contractvorm op het risicomanagement in deze projecten?
- Heeft dit volgens u invloed op de mogelijkheid om te komen tot innoverende oplossingen?
- Hoe ervaart u de risicoverdeling tussen de opdrachtgever en opdrachtnemer als het gaat om innovaties?

Blok 3: Invloed op Innovatie

- Hoe zijn de verantwoordelijkheden binnen de verschillende ontwikkelingsfases verdeeld?
    - Worden er vooraf bepaalde eisen gesteld aan het ontwerp? Zo ja:
    - Hoe heeft dit in uw ervaring u de mogelijkheid om te innoveren beïnvloed?

    - Kunnen er tijdens de realisatiefase nog bepaalde optimalisaties/innovaties worden gedaan?
- Wanneer worden innovaties daadwerkelijk toegepast in een project?
    - Worden oplossingen of ideeën in de ontwikkelingsfase ook altijd daadwerkelijk toegepast in de realisatie fase?
- Hoe vrij is de opdrachtnemer om innovatieve methoden of experimenten toe te passen in het ontwerp/product → valt dit te wijten aan de contractafspraken of de contractvorm?
- Wat zijn de grootste incentives/prikkels om tot innovatieve oplossingen te komen in uw ervaring?
- Wat zijn volgens u de grootste barrières om innovatieve oplossingen te bereiken in infrastructuur projecten?
- Hoe zijn beide aspecten (barriéres en prikkels) zichtbaar in specifieke projecten waarbij u betrokken bent geweest?

[AFSLUITING]

- Heeft u nog vragen of opmerkingen over het onderwerp?
- Wilt u een eindversie van de thesis ontvangen?
- Bedanken voor zijn/haar tijd en voor de deelname aan het onderzoek.

Appendix 2: Coding scheme