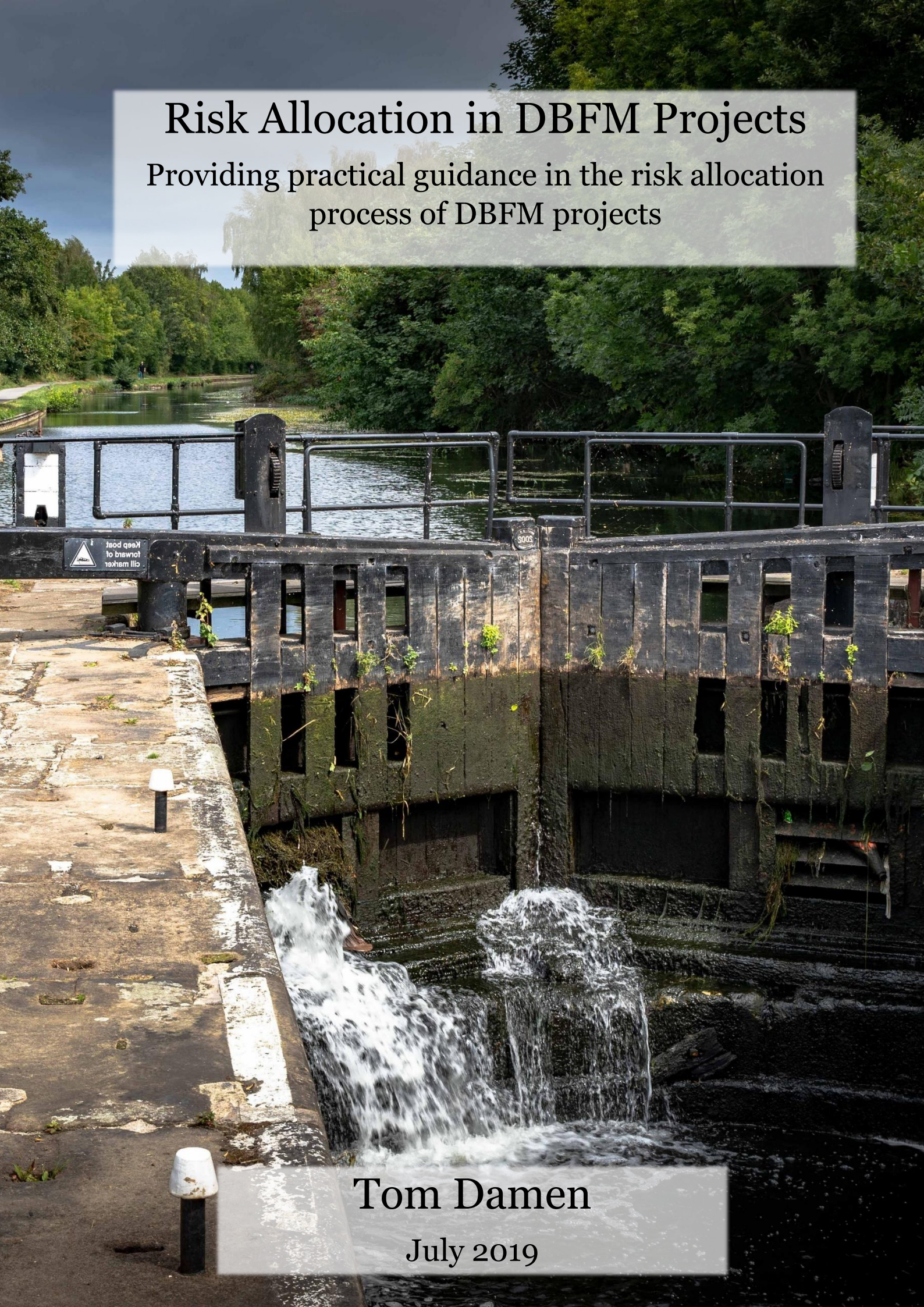


Risk Allocation in DBFM Projects

Providing practical guidance in the risk allocation process of DBFM projects



Tom Damen

July 2019

Risk Allocation in DBFM Projects

Providing Practical Guidance in the Risk Allocation Process of
DBFM Projects

By

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12 July 2019

Preface

During my studies I was always interested in large construction sites and how eventually everything came together into a bridge, a tunnel or a lock. Because of this, I developed my interest in the DBFM contract since this required a whole different approach from contractors than they were used to. All of a sudden, they had to think of lifecycle costs, financial risks and availability of the object. I found and find this a very fascinating way of constructing a project. Therefore, I am content that I had the opportunity to incorporate DBFM projects in my graduation research.

Before I started with this research, I was doing an internship at the construction of the new lock at IJmuiden, executed with a DBFM contract and part of the Sluizenprogramma. I must add that I was not really looking forward starting with my graduation, mainly because during my internship I was constantly working in a team and during my graduation, I would be on my own island that is called thesis life. However, luckily there were a lot of people supporting me and I would like to thank all of them.

First my graduation supervisors, who really helped to improve this research. To start off, Marcel Hertogh. I would like to thank him not only being the chair of my graduation committee but also for the insights of practice, for focussing this research and to make it stand out. Next my first supervisor, Leon Hombergen. I would like to thank him for all the conversations we had, not only regarding the subject of this thesis but way broader. After each of these talks, I always had to remind myself what was regarding the research and what not and subsequently implement the feedback. Subsequently my second supervisor, Martijn Leijten. He ensured that the research design and the methodology of this research were up to scientific standards and if I had any questions regarding that he was always willing to answer them. Lastly my company supervisor, Florens Kneepkens. I would like to thank him for encouraging me to make my own decisions in this research. Maybe that was not always the easiest, cause sometimes I would have liked if he pointed me in the right direction but I learned a lot from your way of working. Thereby he was always willing to take time for me, even if I needed more time than I said I needed.

I would also like to thank all the respondents that were involved in this research. Without their insights, their views and their opinions on the projects and risk allocation in DBFM projects in general, this research could not have been conducted. Thereby it is said that people working in the construction industry are proud of what they do and that they are more than willing to talk about it, this is definitely true for all the respondents I met with.

Next to the people who had a direct influence on my research, I would like to thank some other people who helped me during my thesis. First, the colleagues of PACER. Fridays at the office were maybe not the most productive days, but I really enjoyed these days. They provided me with the motivation to keep on going and the willingness to start with the working life. Thereby I learned a lot of the practical insights the colleagues provided. During the other days of the week, it was really nice to have the 'Afstudeerhok' and the fellow graduating students as a place to go, which provided me with enough coffee, tips and motivation to keep on going.

And last, but definitely not least, I would like to thank my friends and family. Especially my girlfriend, Liset, who was always there for me. During my thesis, I wasn't always that positive or excited, but she was always there to get me back up, let me relax and helped me to put the thesis life into perspective.

Tom Damen
Delft, 3 July 2019

Summary

Introduction

Risks are inherently related to the construction industry. Risks are present in every construction project in every country. These risks can be managed or minimized; however, they cannot be excluded. Therefore, the question is how to deal with these risks. There are two processes related to that question, namely the risk allocation and the risk management. The risk allocation determines which party is responsible for the risk management of a certain risk. The risk allocation is connected to the type of contract chosen for the specific project. The contract type that transfers the most risks from the client to the contractor are the public-private partnerships (PPP). In the Netherlands, the most used form of PPP is the DBFM contract, whereby the contractor is responsible for the design, the construction, the financing and the maintenance of the project. The risk allocation in this contract type is black-and-white, namely, all the risks are allocated to the contractor unless clearly specified in the contract.

Many research has been conducted regarding the risk allocation in public-private partnerships. The primary focus of these researches is the preferred risk allocation in a specific country. There are two flaws in this focus, namely that this kind of research is not performed in the Netherlands and, more importantly, these preferred risk allocations do not take the specific characteristics of a project into account. Hence, there is a need for research that provides practical guidance in the risk allocation process of public-private partnerships that is applicable in the Netherlands and takes the project-specific characteristics into account.

Thereby, from a market analysis performed by Rijkswaterstaat in cooperation with McKinsey, it is concluded that in complex infrastructure projects in the Netherlands, like the DBFM contract among other things, too many risks are allocated to the contractor (Koenen, 2019a). Therefore, both from the scientific viewpoint and the practical viewpoint there is a need to improve the risk allocation in DBFM projects.

Hence, the objective of this research is to improve the risk allocation in DBFM projects, by providing practical guidance for the risk allocation in these projects and to analyse which lessons can be learned from practice to improve the risk allocation. This leads to the main research question, which is:

*How can the process of **risk allocation** in **DBFM projects** be improved through **design principles** from literature and **lessons learned** from practice?*

Research approach

This research consisted of three phases, namely a literature phase, a practice phase, and a combination phase. In the first phase, the literature phase, the focus was on finding design principles that would enhance the risk allocation and on gaining insight in the risk allocation process of Dutch DBFM projects. The practice phase of this research comprises of a case-study research, in which three similar cases are investigated. These three cases are the construction of the new flood gate at Limmel, the construction of the second lock chamber at Eefde and the construction of the third lock chamber at the Beatrixsluis. From these cases a total of 20 respondents were interviewed, both from the client and the contractor. In the combination phase, the outcomes of the two other phases are synthesised to develop a solution that enhances the risk allocation in DBFM projects.

Literature review

The most used form of the public-private partnership in the Netherlands is the DBFM contract, whereby the contractor is responsible for the design, the execution, the financing and the

maintenance of the project. This type of contract is an integrated contract since it integrates different stages in the lifecycle of the object. The procurement of the DBFM projects comprises a so-called competitive dialogue, whereby a maximum of three parties discuss their solutions and their views on the project with the client. A DBFM contract is not awarded to solely one contractor but is awarded to a special purpose vehicle (SPV), which is specially created for the project. In this SPV multiple companies have their interest, such as financial institutions, construction companies and maintenance companies. Since the SPV is required to finance the project during the design and construction phase and since the project mainly generates a cash flow based on the availability of the project, there is a need for the financial institutions. To lower the transaction costs involved in the procurement of DBFM projects, a standardized model agreement has been made. In this model agreement, a set-up for the risk allocation is stated in three groups of events, namely the events of delay, the events of compensation and the events of force majeure. If an event is listed in one of these events, the client is (partly) responsible for the risk. If it is not listed in one of these events, the contractor is responsible for the risk. This is the risk allocation of how it is set up in the current practice.

According to the literature, the risk allocation should be based on design principles, whereby a total of 15 design principles are identified. This research has selected the top 6 design principles that are, according to the scientific literature, the most important principles that should be taken into account. A risk should be allocated to a party if:

- The party has the capacity and expertise to control, monitor and minimize these risks.
- The party has identified, understood and evaluated the risk.
- The party has the resources to deal with the risk if it fires.
- The party has the right risk attitude and wants to accept the risk.
- The party accepting the risks can charge the right premium for this risk
- The party has the best capability to control the events that might trigger the risk.

Case-study results

As is stated before, there are three cases analysed in this research. The process of risk allocation is mainly based on the risk distribution as stated in the standard agreement DBFM. There is room for project-specific input, which is provided by risk sessions of different disciplines of the project of Rijkswaterstaat. The proposed risk allocation is input for the dialogue, from which the final risk allocation is determined.

The respondents were asked to score the risk allocation in their projects. It can be seen that most of the client respondents indicated that in their project there was a proper risk allocation and the contractor wasn't bearing too many risks. However, the respondents from the contractor side indicated that too many risks were allocated to them. Thereby there are five lessons regarding the risk allocation that can be learned from these projects, namely:

- The risk allocation is mainly determined in the contract, however, in the execution there is room for changes.
- The collaboration between the client and the contractor influenced the risk allocation.
- The Sluizenprogramma added value to the individual projects and their risk allocation.
- The risk allocation can be improved by an increased focus on risks during the dialogue.
- The acreage data contained inadequacies.

Generic results

The respondents are not only asked about their view on the cases but are also asked about their general view on DBFM contracts and more specific the risk allocation in DBFM projects. The vast majority of the respondents, both from the client and the contractor side indicate that in DBFM

projects too many risks are allocated to the contractor. Thereby it is interesting to note that the respondents from the client side are agreeing with the statement that in DBFM projects in general too many risks are allocated to the contractor. Meanwhile, some of the respondents from the client side indicate that in their specific project this isn't the case. Both the respondents from the client and the contractor side indicate that it is possible to have an optimal risk allocation in the current set-up of DBFM.

The respondents also indicated the positive and negative aspects of the DBFM contract. All of the respondents were positive about the integration of the design, the construction and the maintenance in one contract. Thereby it is indicated that this increased the efficiency, made room for lifecycle optimizations, improved the quality of the used materials and introduced a long-term relationship between the client and the contractor. Regarding the financing, the opinions were more diverse. Some respondents indicated that it ensured that the contractor has a proactive attitude due to the pressure of the financial institutions, it provides reoccurring payments for the contractor and it creates a relatively easy payment regime for the client. However, the respondents also indicated some negative aspects, like the increased costs for the construction of the project, the high amount of advisors required to complete the project and the difficulty when it comes to changes in the milestones.

Practical guidance

To improve the risk allocation in DBFM projects, this research has indicated six design principles and four lessons learned. These aspects and the corresponding phase in which they should be implemented can be seen in Figure 1.

The design principles should be in mind at everyone that deals with the risk allocation in DBFM projects. These design principles can be used over the lifespan of a project to determine where a risk should be allocated. Thereby one can use these principles to motivate why he is or isn't able to bear a risk.

In the preparation phase of a new project, the insights of similar projects should be used. To implement that a programme structure can be used, in the same way as the Sluizenprogramma is set up. From other projects, the positive and the negative aspects of the risk allocation can be exchanged in the programme. Besides, the data provided by the client should be analysed, to ensure a suitable risk allocation regarding data inadequacies. This can be done in four steps:

1. Analyse the data regarding the project and determine what is actual, trustworthy and complete and what not.
2. Determine in the dialogue what can be made actual, trustworthy and complete.
3. Determine a proper risk allocation between the client and the contractor.
4. Update the risk allocation if in practice it is different than thought on forehand.

During the competitive dialogue in the procurement of new projects, there should be an open discussion on the risk allocation, whereby every party should motivate why he is or isn't able to bear a risk. Thereby the design principles indicated in this research can be used. Not every small risk should be discussed, but it should be based on the specific characteristics of the project.

In the execution phase of the project, the aspect that requires attention is the focus on the collaboration between the client and the contractor, which can be enhanced by the implementation of the trust enabling factors, which are the joined experience, the processes for problem-solving, the shared goals, the reciprocity principle, and reasonable behaviour.

The overview of the practical guidance, the different focus points and in which stage of the project they should be implemented can be seen in Figure 1.

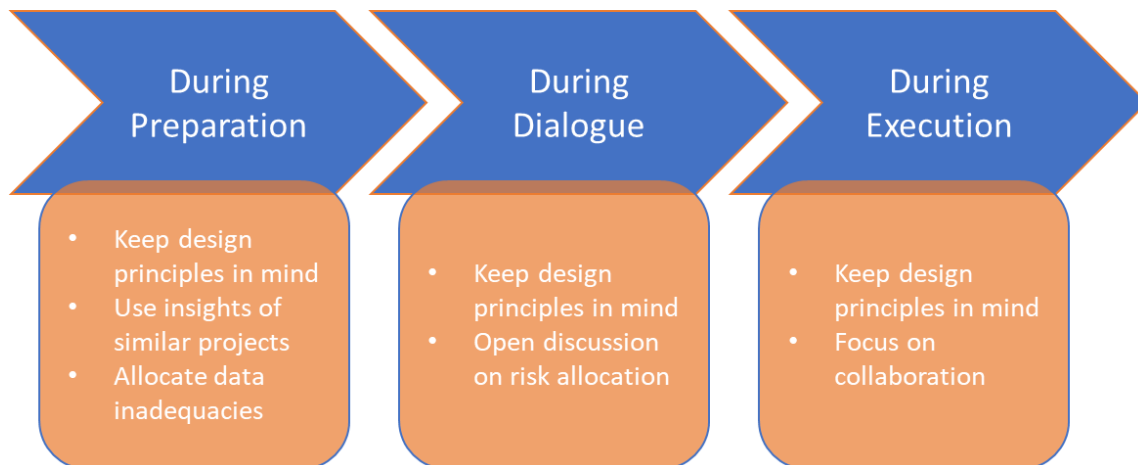


Figure 1: Practical guidance (own image)

Advice

Next to the scientific part of this report, there is also an advisory part. This part is based on the information gathered in this research combined with the view of the author. Since the three cases of this research are relatively successful, it is shown that the DBFM contract can deliver successful projects. Therefore, the characteristics of the cases might enhance successful DBFM projects. The overlapping characteristics are the mono-disciplinary approach, the budget between the €60 and €500 million euros and a relatively stable scope over time. These three factors can be favourable or unfavourable for the implementation of the DBFM contract. The overview of the aspects and if they are favourable or unfavourable are combined in the assessment framework that is shown in Figure 2. If a project is unfavourable according to the assessment framework, the advice of the researcher is to separate the project based on the three characteristics.

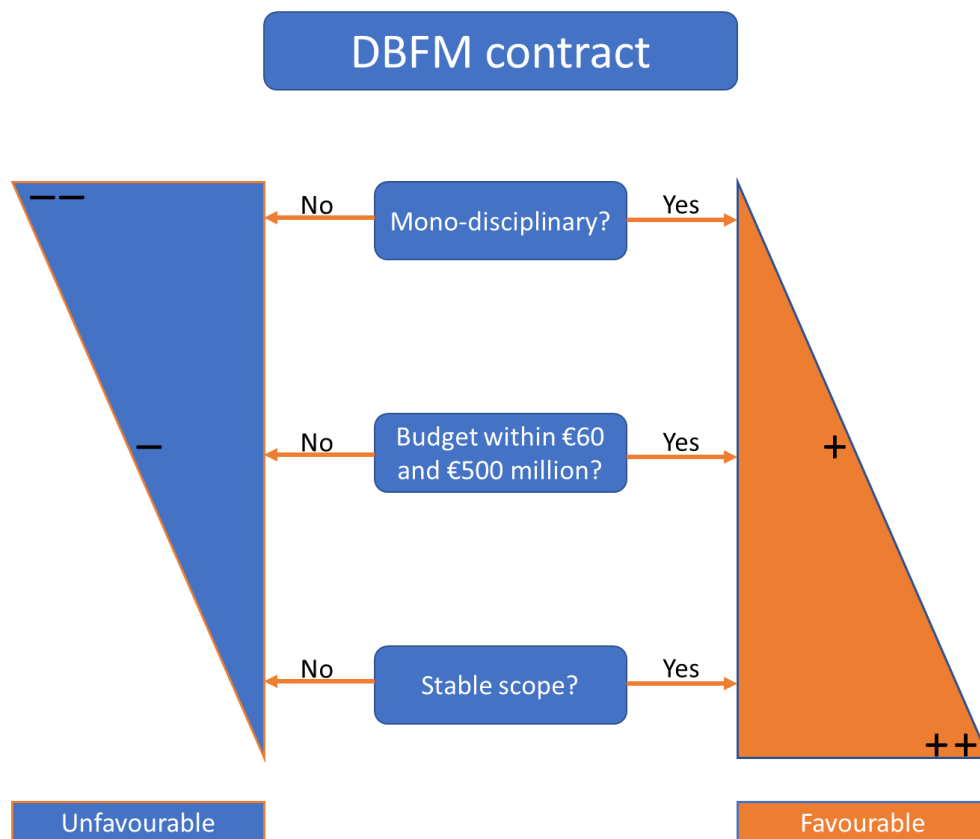


Figure 2: Assessment framework for new projects (own image)

Samenvatting

Introductie

Risico's zijn inherent aan de bouw sector. In elk project en in elk land zijn risico's aanwezig. Deze risico's kunnen gemanaged of geminimaliseerd worden, maar ze kunnen nooit helemaal worden weggenomen. Daarom is de vraag hoe je met de risico's om moet gaan. Er zijn twee aspecten die een rol spelen in die vraag, namelijk de risico allocatie en het risico management. De risico allocatie bepaalt welke partij verantwoordelijk is voor het managen van een risico. De risico allocatie is verbonden met het type contract dat gekozen wordt voor een project. Bij publiek-private samenwerkingen worden de meeste risico's gealloceerd bij de marktpartij. In Nederland is de meest gebruikte vorm van een publiek-private samenwerking een DBFM contract, waarbij de aannemer verantwoordelijk is voor het ontwerp, de bouw, de financiering en het onderhoud van het project. In een DBFM contract is sprake van een zwart-witte risico allocatie, waarbij alle risico's bij de aannemer zijn gealloceerd, tenzij uitgesloten in het contract.

Er is veel onderzoek gedaan naar de risico allocatie in publiek-private samenwerking. Deze onderzoeken richten zich vooral op de voorkeur waar welk risico zou moeten liggen in een specifiek land. Er zijn twee gebreken in deze focus, namelijk dat een dergelijk onderzoek (nog) niet in Nederland is uitgevoerd en, wat nog belangrijker is, de voorkeur voor een risico allocatie houdt geen rekening met de specifieke kenmerken van een project. Vandaar dat er behoefte is aan een onderzoek dat praktische handvatten aanbiedt voor het risico allocatie proces van publiek-private samenwerkingen, dat van toepassing kan zijn in Nederland en dat rekening houdt met de project specifieke eigenschappen.

Daarnaast is er een rapport gepubliceerd door Rijkswaterstaat, waarin de huidige marktomstandigheden zijn omschreven. Een van de conclusies van dit rapport is dat er, onder andere in DBFM contracten, te veel risico's worden gealloceerd bij de aannemers. Daarom is er de behoefte, zowel vanuit wetenschappelijk oogpunt als vanuit praktisch oogpunt, om de risico allocatie in DBFM projecten te verbeteren.

Het doel van dit onderzoek is om de risico allocatie in DBFM projecten te verbeteren, door het geven van praktische handvatten voor de risico allocatie in deze projecten en om te analyseren welke lessen er kunnen worden geleerd vanuit de praktijk om de risico allocatie te verbeteren. Dit doel leidt tot de volgende onderzoeksvraag:

*Hoe kan het proces van de **risico allocatie** in **DBFM projecten** verbeterd worden door de implementatie van **ontwerpprincipes** vanuit de literatuur en **lessen** die geleerd kunnen worden van de praktijk?*

Onderzoeksopzet

Dit onderzoek bestond uit drie fases, namelijk een literatuurfase, een praktijkfase en een combinatiefase. In de eerste fase, de literatuurfase, lag de focus op het vinden van de ontwerpprincipes die de risico allocatie kunnen verbeteren. Daarnaast lag de focus op het in kaart brengen van het proces van de risico allocatie van Nederlandse DBFM projecten. De praktijkfase van dit onderzoek bestaat uit een case studie onderzoek, waarin drie vergelijkbare casussen zijn onderzocht. De drie casussen zijn de nieuwe keersluis bij Limmel, de aanleg van de tweede kolk bij Eefde en de aanleg van de derde kolk bij de Beatrixsluis. Van deze drie cases zijn in totaal 20 respondenten geïnterviewd, van zowel de opdrachtgever als de opdrachtnemer. In de combinatiefase zijn de uitkomsten van de eerste twee fases samengevoegd en geanalyseerd om tot een oplossing te komen om de risico allocatie in DBFM projecten te verbeteren.

Literatuuronderzoek

De meest gebruikte vorm van publiek-private samenwerking in Nederland is het DBFM contract. Hierin is de opdrachtnemer verantwoordelijk voor het ontwerp, de bouw, het financieren en het onderhouden van een project. Dit type contract is een geïntegreerd contract, omdat het meerdere onderdelen van de levenscyclus van een project omvat. De aanbesteding van DBFM contracten verloopt via een concurrentiegericht dialog, waarbij een maximum van drie partijen hun voorstellen bediscussieren met de opdrachtgever. De opdracht wordt vaak niet gegund aan een aannemer maar aan een zo genoemde special purpose vehicle (SPV). In de SPV hebben meerdere partijen een belang, zoals financiële instellingen, bouwaannemers en onderhoudsaannemers. Omdat de SPV het project moet voorfinancieren tijdens de ontwerp- en bouwfase en omdat het project pas een geldstroom oplevert op basis van de beschikbaarheid van het project, is er de behoefte aan de financiële instellingen. Om de transactiekosten te verlagen in de aanbesteding van DBFM projecten, is er voor gekozen om een modelcontract op te stellen. In dit modelcontract is de risico allocatie geregeld in drie gevallen, namelijk een geval van vergoeding, een geval van uitstel en een geval van overmacht. Als een gebeurtenis is gekwalificeerd als een van deze gevallen dan is de opdrachtgever (deels) verantwoordelijk voor het risico. Als een gebeurtenis niet is omschreven als een van de gevallen, dan is de opdrachtnemer verantwoordelijk voor het risico.

Volgens de wetenschappelijke literatuur zou de risico allocatie gebaseerd moeten worden op ontwerp principes, waarbij een totaal van 15 principes zijn geïdentificeerd. Dit onderzoek heeft de top 6 ontwerp principes geselecteerd, die volgens de wetenschappelijke literatuur het meest belangrijk zijn om rekening mee te houden. Een risico moet bij een partij gelegd worden als:

- De partij de capaciteit en expertise heeft om het risico te controleren, te monitoren en te verkleinen.
- De partij het risico heeft geïdentificeerd, begrepen en geëvalueerd.
- De partij de resources heeft om met het risico om te gaan als het zich voordoet
- De partij de juiste instelling heeft en het risico wil accepteren
- De partij die het risico krijgt toebedeeld de juiste premie hiervoor kan vragen
- De partij het meest geschikt is om de gebeurtenissen te controleren die invloed hebben op het risico.

Case studie resultaten

Zoals eerder is beschreven, zijn er drie casussen geanalyseerd in dit onderzoek. Het proces van de risico allocatie is voornamelijk gebaseerd op de risico verdeling zoals hij in het model contract DBFM is opgeschreven. Er is ruimte voor project specifieke input, welke wordt geleverd door risico sessies van verschillende disciplines bij Rijkswaterstaat. De voorgestelde risico allocatie is de input voor de dialoog, waarin de uiteindelijke risico allocatie wordt bepaald.

De respondenten zijn gevraagd om de risico allocatie te scoren voor hun specifieke project. Deze scores laten zien dat de respondenten van de opdrachtgever gematigd positief zijn over de risico allocatie in hun project en dat het niet zo zeer het geval was dat de opdrachtnemer te veel risico draagt. De respondenten van de opdrachtnemer daarentegen geven aan dat er te veel risico's bij hen gealloceerd zijn. Daarnaast zijn er vijf leerpunten van deze projecten, namelijk

- De risico allocatie wordt voornamelijk bepaald in het contract, maar er is in de praktijk ruimte voor aanpassingen.
- De samenwerking tussen de opdrachtgever en opdrachtnemer beïnvloedde de risico allocatie.
- Het Sluizenprogramma heeft waarde toegevoegd aan de individuele projecten en hun risico allocatie.

- De risico allocatie kan worden verbeterd door meer focus te hebben op risico's tijdens de dialoog.
- De areaalgegevens in deze cases bevatte tekortkomingen.

Generieke resultaten

Er is niet alleen gevraagd naar de mening van de respondenten over het project waar zij aan werken, maar ook naar hun algemene mening over DBFM contracten en de risico allocatie daarin. De grote meerderheid van de respondenten, zowel van opdrachtgever als opdrachtnemer, geven aan dat in DBFM contracten te veel risico's bij de opdrachtnemer worden gelegd. Daarbij is een opvallend verschil merkbaar bij de respondenten van de opdrachtgeverskant. Die geven aan dat in hun project de opdrachtnemer niet te veel risico draagt, terwijl dat in het algemeen wel zo is. Daarnaast geven de respondenten van zowel de opdrachtgever als de opdrachtnemer aan dat het mogelijk is om een optimale risico allocatie te hebben in de huidige opzet van DBFM contracten.

De respondenten hebben ook positieve en negatieve aspecten van DBFM aangegeven. Alle respondenten waren positief over de integratie van het ontwerp, de bouw en het onderhoud in een contract. Zij geven daarbij aan dat dit zorgt voor meer efficiëntie, dat dit ruimte geeft voor optimalisaties in de lifecycle, dat het de kwaliteit van de gebruikte materialen verbeterd en dat dit zorgt voor een langdurige relatie tussen de opdrachtgever en opdrachtnemer. Met betrekking tot de financiering zijn de meningen meer verdeeld. Sommige respondenten geven aan dat de financiering zorgt voor een proactieve houding bij de aannemer door de druk van de financiële instellingen, dat het zorgt voor periodieke betalingen voor de opdrachtnemer en het zorgt voor een relatief eenvoudig betalingsregime voor de opdrachtgever. De respondenten hebben ook een aantal negatieve kanten van de financiering aangegeven, namelijk dat het extra kosten met zich meebrengt, dat er relatief veel adviseurs nodig zijn om een project te voltooien en dat de financiering het lastig maakt om mijlpalen te veranderen.

Praktische handvatten

Om de risico allocatie in DBFM projecten te verbeteren heeft dit onderzoek zes ontwerpprincipes en vier leerpunten aangedragen. Deze punten en wanneer ze zouden moeten worden toegepast is grafisch weergegeven in Figure 3.

De ontwerpprincipes zouden bij iedereen die te maken heeft met de risico allocatie in DBFM projecten in het achterhoofd moeten zitten. Deze ontwerpprincipes kunnen worden gebruikt om, over de gehele levensduur van een project, te bepalen waar welk risico gealloceerd zou moeten worden. Daarnaast kan men deze principes gebruiken om te motiveren waarom hij een risico wel of niet kan dragen.

In de voorbereidingsfase van een nieuw project moeten de inzichten van andere projecten worden gebruikt. Om dat voor elkaar te krijgen kan een programma structuur worden geïmplementeerd, op dezelfde manier als het Sluizenprogramma is opgezet. Binnen dit programma kan er geleerd worden van positieve en negatieve aspecten wat betreft de risico allocatie. Daarnaast moeten de gegevens die aan een opdrachtnemer verstrekt worden, en waar hij zijn aanbieding op baseert, geanalyseerd worden en het risico op onvolkomenheden in de data moet juist gealloceerd worden. Dit kan gebeuren in de volgende vier stappen:

1. Analyseer de gegevens van het project en bepaal wat is actueel, betrouwbaar en compleet (ABC) en wat niet.
2. Bepaal in de dialoog wat ABC gemaakt kan worden.
3. Bepaal een gepaste risico allocatie tussen de opdrachtgever en opdrachtnemer.
4. Update de risico allocatie als in de praktijk de situatie anders blijkt te zijn dan op voorhand gedacht.

Tijdens de concurrentiegerichte dialoog in de aanbesteding van nieuwe projecten, moet er een open discussie komen over de risico allocatie, waarbij elke partij zou moeten motiveren waarom hij wel of niet in staat is om een bepaald risico te beheersen. Bij deze motivatie kunnen de ontwerp principes worden gebruikt. Nu moet er niet over ieder klein risico een discussie plaatsvinden, maar dit moet gebaseerd worden op de specifieke karakteristieken van het project.

In de uitvoeringsfase van een project is het leerpunt wat de meeste aandacht vereist de samenwerking tussen de opdrachtgever en opdrachtnemer. Dit kan verbeterd worden door de implementatie van vertrouwenwekkende factoren, namelijk gedeelde ervaringen, processen voor probleem oplossing, gezamenlijke doelen, het wederkerigheid principe en redelijk gedrag.

Het overzicht van de praktische handvatten, de verschillende aandachtspunten en in welke fase van het project ze moeten worden geïmplementeerd is weergegeven in Figure 3.

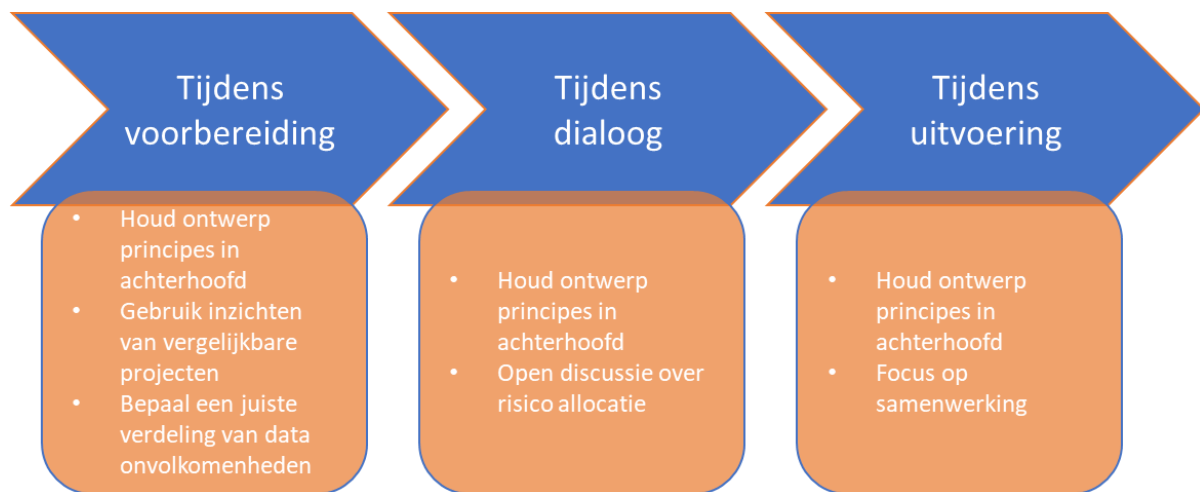


Figure 3: Praktische handvatten (own image)

Advies

Naast het wetenschappelijke gedeelte van dit rapport, is er ook een advies gedeelte. Dit gedeelte is gebaseerd op de informatie verkregen in dit onderzoek, gecombineerd met de inzichten en interpretaties van de schrijver. Omdat de drie casussen van dit onderzoek relatief succesvol zijn, is het laten zien dat je met een DBFM contract succesvolle projecten kan hebben. Daarom kunnen de eigenschappen van de casussen een succesvol project mogelijk maken. Deze karakteristieken zijn de monodisciplinaire aanpak, het budget tussen de €60 en €500 miljoen euro en de relatief stabiele scope over de tijd. Deze drie factoren kunnen gunstig of ongunstig zijn bij de implementatie van DBFM contracten. Het overzicht van de aspecten en of ze gunstig of ongunstig zijn is gecombineerd in een afwegingskader dat is weergegeven in Figure 4. Als een project ongunstig is volgens het afwegingskader, is het advies van de schrijver om het project op te knippen op basis van de drie aspecten.

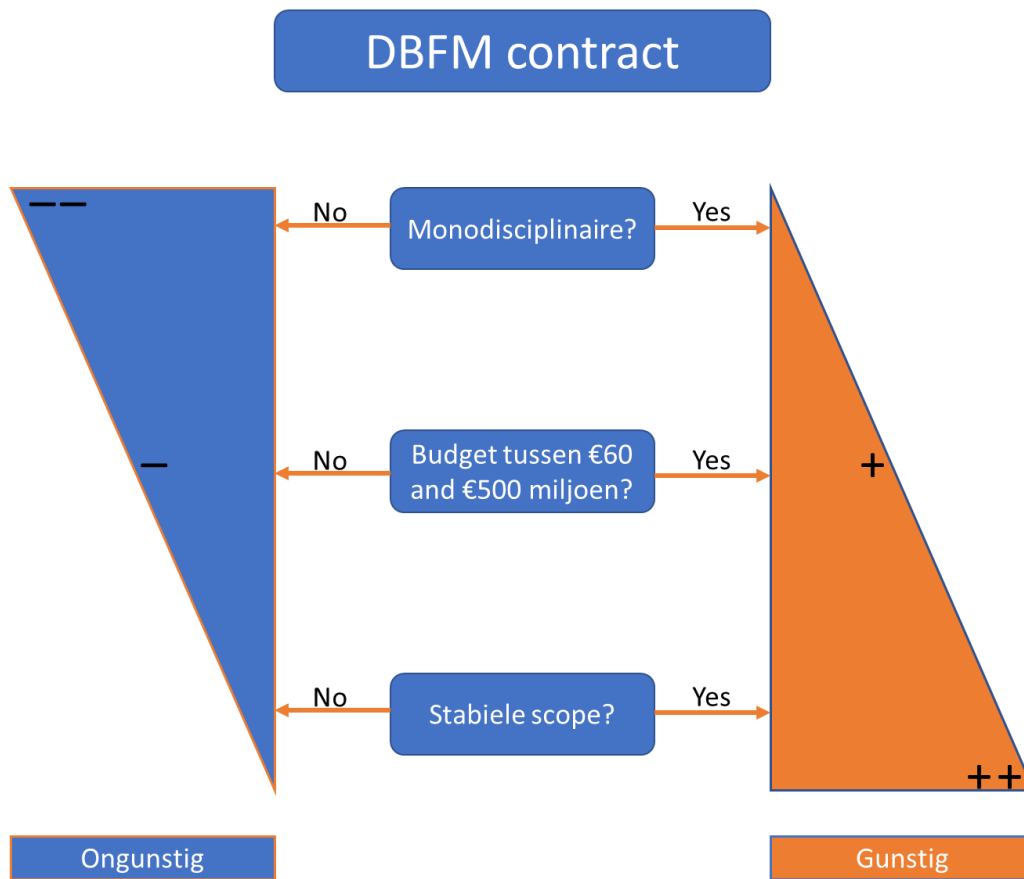


Figure 4: Afwegingskader voor nieuwe projecten (own image)

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Part 1

Introduction & Research design

1 Introduction

“I have never signed off a PFI (Private Finance Initiative) contract as Chancellor, and I can confirm today that I never will.” As stated by Philip Hammond, the Chancellor of the Exchequer of the United Kingdom (Hammond, 2018). The Private Finance Initiative is one of the forerunners of the widely used public-private partnership, in which the private sector is involved in the provision of public infrastructure (Davies, 2018; Smyth & Edkins, 2007). One of the reasons to abolish the PFI was that in these projects the government of the UK has transferred unmanageable amounts of risks to the private sector, who weren't able to bear these risks (UK House of Commons Public Administration and Constitutional Affairs Committee, 2018).

The situation as it is illustrated above is the central theme in this research, namely the risk allocation between the client and the contractor in a public-private partnership. To be more specific, this research focusses on the design principles to derive an optimal risk allocation and on the lessons that can be learned from practice to improve the risk allocation.

1.1 Research context

One of the unique aspects of the construction sector is the relatedness to risks. Some of the unique features of construction projects are the one-off factor, the long lifespan of over 100 years, the technological complexity and the diverse interests of the stakeholders, which are all risk inducing factors (Zou, Zhang, & Wang, 2007). Thereby it must be noted that project risks and the allocation of these risks have a substantial impact on the project performance (Ward, Chapman, & Curtis, 1991; Zaghoul & Hartman, 2003). It is even indicated that a proper allocation of risks is one of the critical success factors in infrastructure projects (Osei-Kyei, Chan, Javed, & Ameyaw, 2017). However, these risks cannot be eliminated and therefore the question is how to handle these risks.

In the handling of the risks, two factors play a role, namely the risk allocation and subsequently the risk management. These two are intertwined since the risk allocation determines which party is responsible for the risk management. The risk allocation always occurs when there is more than one party involved in the project and is determined based on the type of contract and thereby the type of responsibilities that are transferred to the contractor (Zaghoul & Hartman, 2003). For example, the client bears most of the risks in the traditional procurement, whereby the contractor is only responsible for the execution of the design of the client (Idoro, 2012). This in contrast to a public-private partnership, where the contractor bears most of the risks (Grimsey & Lewis, 2004).

It used to be that the government was the provider of the infrastructure. However, one of the recent developments in the infrastructure sector worldwide is the implementation of public-private partnerships (PPP), in which the public sector is involved in the provision of infrastructure. The reasons for the implementation of the PPP are the budgetary stringencies of the governments and at the same time the need to expand the infrastructure (Chou & Pramudawardhani, 2015; Grimsey & Lewis, 2004). Thereby the public sector can make use of the technical know-how and the managing skills of the private sector (Shrestha, 2015). In public-private partnerships, the private sector is committed to a long lasting contractual arrangement to deliver the service of the infrastructure to the government (Grimsey & Lewis, 2007).

According to the research of Zhang (2005), there are five critical success factors and a total of 47 subfactors. The five critical success factors are a favourable investment environment, economic viability, a reliable contractor with strong technical strength, sound financial package and appropriate risk allocation. The subfactors include governmental support, promising economy, long term demand for the service, a good collaboration between the client and the contractor. These critical success factors determine the success or failure of a public-private partnership in

terms of the objectives, i.e. budget, planning or quality (Zhang, 2005). This research focusses on the appropriate risk allocation.

In public-private partnerships, the most far-reaching risk transfer from the client to the contractor is implemented (Ball, Heafey, & King, 2003). In the Dutch version of the PPP, the DBFM, whereby the design, the execution, the financing and the maintenance are outsourced to a contractor, it is even the case that all risks are allocated to the contractor, unless specified in the contract (van den Boogaart & Dröge, 2015; Verhees & Verweij, 2016). Thereby, it is noted that a clear framework for risk allocation is missing, which results in the transfer of risks from the public to the private sector (Koppenjan, Broekhans, Steenhuisen, & Cremer Eindhoven, 2012).

1.2 Research motivation

The motivation of this research can be divided into the scientific motivation and the practical motivation. Each of these two causes will be discussed, starting with the scientific motivation followed by the practical motivation.

1.2.1 Scientific motivation

Many research has been conducted into risk allocation in public-private partnerships, which is legitimated since it is one of the critical success factors in the partnerships (Zhang, 2005). However, the primary focus of these researches is regarding the preferred risk allocation between the client and the contractor. Examples of these studies are Chou, Ping Serng, Lin & Yeh (2012) in Taiwan, Hwang, Zhao & Gay (2013) in Singapore, Li, Akintoye, Edwards & Hardcastle (2005) in the United Kingdom and Roumboutsos & Anagnostopoulos (2008) in Greece. However, there are two downfalls of these studies. First, this kind of study isn't performed in the Netherlands and these researches all have some differences, thereby the results cannot be projected on the Dutch infrastructure sector. Second, these preferred risk allocations do not take the project specific issues into account but are more general risks that could apply to all projects. To conclude, these preferred risk allocations can only be used limitedly in the risk allocation of Dutch DBFM projects.

Thus, there is a need to have more general design principles that are applicable in the Netherlands on which the risk allocation can be based. One of the criteria that is named in scientific literature to allocate a risk is that a risk should be allocated to the party best able to manage the risk (Cooper, Grey, Raymond, & Walker, 2005, p. 79; Li et al., 2005). This principle provides the first general applicable guideline that can provide guidance in the risk allocation process. However, other researches have indicated three remarks on this principle, namely:

- If the risk emanates from a party this party is best able to manage this risk, but may not control the risk in the optimal way (Ke, Wang, Chan, & Lam, 2010; Medda, 2007).
- This principle leads, in practice, to the principle that the risk is allocated to the party least able to refuse the risk (Hanna, Thomas, & Swanson, 2013; Jin & Zhang, 2011).
- The principle isn't providing a route to come to the best risk allocation but is only focused on the outcome (Oudot, 2005; Thomas, Kalidindi, & Ananthanarayanan, 2003).

Therefore, it can be concluded that solely the principle of the risk should be allocated to the party best able to manage the risk is not satisfying. Hence, there is a need to have more design principles that provide guidance in the risk allocation process. Several studies have mentioned these design principles, for example, Loosmore & McCarthy (2008), Lam, Wang, Lee & Tsang (2007) and Abednego & Ogunlana (2006). However, these researches are conducted in different countries, but these are not tested for the Dutch situation.

1.2.2 Practical motivation

In the nearby history of large infrastructure projects in the Netherlands, four projects had to deal with withdrawals in the procurement, whereby only two competitors remained. These projects are the Blankenburgtunnel, the Zuidasdok, the ViA15, which is the connection between the A15 and the A12 nearby Arnhem and the A9 between Badhoevedorp and Holendrecht. The contractors who withdrew from these procurements indicated that there were too many risks allocated to the contractor in these projects (Doodeman, 2019; Koenen, 2017a, 2018c).

In response to the withdrawals in the procurement of these large infrastructure projects, Rijkswaterstaat and a consultancy firm, McKinsey, performed a market analysis. One of the main conclusions of this report was that in large and complex infrastructure projects, too many risks are allocated to the contractor (Koenen, 2019a). To decrease the risks in these projects, they indicated three possible steps, namely to introduce two-phase projects whereby the design and the execution phase are separated, to introduce portfolio contracts, whereby similar projects are bundled and to have more contractual requirements on innovation, circularity and sustainability (Koenen, 2019a). However, these steps do not immediately provide an implementation plan to improve the risk allocation in DBFM projects and thus practical guidance is needed to enhance the risk allocation in these projects.

1.3 Research objective and research questions

The research objective describes the goal of the research. Since this research was practice focused the general goal of this research is to provide knowledge that leads to an intervention, which can change the current situation (Verschuren & Doorewaard, 2013). This research was a design-oriented research. In general, it means that there is a mismatch between the current situation and the desired situation and that this research is focussed on how to get to the desired situation (Verschuren & Doorewaard, 2013). The nature of this research and the described problem definition lead to the following research objective:

“The objective of this research is to improve the risk allocation in DBFM projects, by providing practical guidance, consisting of design principles from literature and of lessons that can be learned from practice.”

Following the research objective, the following research question is defined:

*How can the process of **risk allocation** in **DBFM projects** be improved through **design principles** from literature and **lessons learned** from practice?*

To be able to find an answer to the research question, four sub-questions are formulated. The goal of these sub-questions is to provide a partial answer to the main question, while combined the sub-questions provide the answer to the main question. The following sub-questions have been defined for this research:

1. What are, according to literature, the design principles that should be followed in the risk allocation process of DBFM projects?
2. In what phases is the risk allocation in the current Dutch DBFM projects executed?
3. Which lessons can be learned from practice to improve the risk allocation in DBFM projects?
4. In what way could the design principles and lessons learned be implemented in the current process of risk allocation in DBFM projects?

1.4 Scope

The scope of this research is geographically bounded by the borders of the Netherlands. The main subject for this research is the risk allocation in DBFM contracts. To narrow the scope, the risk

allocation between the client and the contractor is key and not within the contractor or within the client. Furthermore, the research focuses on the Sluizenprogramma of Rijkswaterstaat, which is a programme in which the update of six locks is combined in order to share knowledge and experiences. An elaborate description of the Sluizenprogramma and the construction works of the different locks are shown in Appendix C. Within the Sluizenprogramma, three projects are analysed, namely the construction of the floodgate at Limmel, the construction of the second lock chamber in Eefde and the construction of the third lock chamber at the Beatrixsluis. These projects are selected since they are more or less similar based on the work that needs to be done, the location within the already existing lock complex, the budget and the phase the projects are in. Therefore, it is chosen to research these projects.

1.5 Outline

The structure of this report is as follows. After this chapter, the introduction, Chapter 2 follows with the research design. In this chapter, the methodology for this research is elaborated on. Chapter 3 describes the public-private partnerships and elaborates on how this is implemented with the DBFM contract. The aspects that are described of the DBFM contract are the set-up of the special purpose vehicle, the private financing component, the service delivery, the risk allocation, the value for money, the legal aspects including the model agreement, and the procurement. Risk allocation, in general, is the key aspect of Chapter 4, of which the focus is on the design principles that should be taken into account in the risk allocation process. Subsequently, in Chapter 5, the three cases are described, starting with the flood gate at Limmel, followed by the second lock chamber at Eefde and lastly the third lock chamber at the Beatrixsluis. In Chapter 6 and 7, the results of this research are presented. Chapter 6 focusses first on the results of the individual case-studies and thereafter focusses it on the lessons that can be learned from these projects. Chapter 7 provides more generic results regarding the risk allocation in DBFM projects, DBFM contracts in general and provides an insight into the importance of the design principles. Chapter 8 provides practical guidance for the risk allocation process in DBFM projects, based on the lessons learned and the design principles. This is followed by the discussion in Chapter 9, the conclusion in Chapter 10 and the recommendations in Chapter 11. Lastly, in Chapter 11, an advice is provided. This advice is regarding the implementation of DBFM contracts and subsequently this research is compared with the market analysis of Rijkswaterstaat in collaboration with McKinsey.

2 Research Design

This chapter describes the strategy that was followed in order to find the answers to the sub-questions, which, if they are combined, provide the answer to the main research question. The chapter starts with the research approach, in which the combination is made between the sub-questions and the followed methodology to find an answer. Subsequently, the methodologies of this research are elaborated on. Lastly, the research framework is presented.

2.1 Research approach

This research was divided into three phases and in each of these phases, one or more sub-questions were answered. The phases, in chronological order, are the theory phase, the practice phase and the combination phase. In the practice phase, the focus was on the first two sub-questions, thus on the design principles that are prescribed by literature and on the theory of the risk allocation in DBFM projects in the Netherlands. The theory phase was based on a literature review. The next phase, the practice phase, was focused on gathering the information by the cases, on the subjects of how the risk allocation is going on in practice and on the lessons that could be learned from these projects. The information of this phase is retrieved by means of case-study research. The last phase, the combination phase, was about finding a way to combine both the design principles and the lessons learned into practical guidance for the risk allocation. The overview of the phases and how they are connected to the sub-questions can be found in Figure 5.

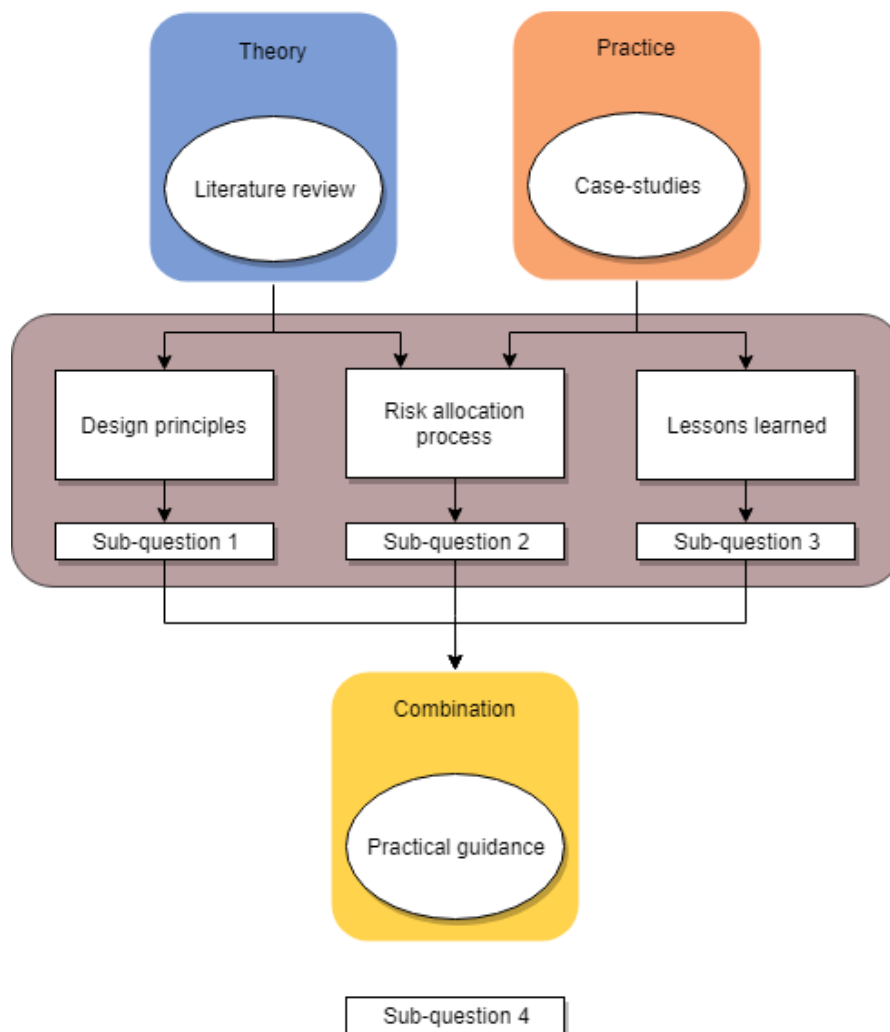


Figure 5: Research approach (own image)

2.2 Research methodology

To derive a proper approach for this research the book *Designing a Research Project* by Verschuren and Doorewaard (2013) was used as a guideline. The first choice to be made was the decision between theory-oriented research and practice-oriented research. As can be derived from the problem statement, this research was practice-oriented research, which means that this research provided knowledge that could lead to an intervention in the current situation to improve it. In practice-oriented research, the intervention cycle could be a helpful instrument. The intervention cycle consists of five stages, namely: the problem analysis, the diagnosis, the design, the intervention and the evaluation (Verschuren & Doorewaard, 2013). This research focussed on the design part of the intervention lifecycle. As it is described in the problem statement, the goal of this research is to provide practical guidance, which can be seen as an implementation plan on how the risk allocation can be improved.

2.2.1 Literature review

The first methodology used in this research is a literature review. This method is used to gain insight into the current practice of both DBFM contracts, including the characteristics of such a contract and risks, both risk management as well as risk allocation principles and processes. In this case, the sources of information were media, documents and most important scientific literature. The main focus was to come to an overview of the design principles to follow regarding the process of risk allocation.

The relevant scientific literature was retrieved through Google Scholar, Scopus and the library of the TU Delft. The keywords used to gather the articles were, amongst others, phrases like public-private partnerships, value for money, DBFM, special purpose vehicle, risk construction project, risk management, RISMAN, ISO31000, risk allocation, risk allocation principles, risk allocation process, risk allocation guidelines and risk allocation model.

2.2.2 Case studies

The second research methodology was case-study research. According to Schell (1992) and Yin (2003), there are three reasons to opt for the case study methodology, namely:

- The type of research question is in the form of a how or why question.
- The researcher does not have control over behavioural events.
- The study focusses on contemporary events.

Since the main research question of this research starts with how are, the first criterion required to perform case-study research was met. The second criterion, that the researcher doesn't have control over the behavioural events, was in place in the projects of this research. First, the researcher was not directly involved in the projects available for this research and this research was of a retrospective nature. Therefore, the researcher didn't have control over the behavioural events. The last criterion, that the study focusses on contemporary events, suited this research. Currently, all the DBFM projects in the Netherlands are not beyond the maintenance phase and therefore the focus is on contemporary events (Ministerie van Financiën, 2016). Another reason to opt for the case study methodology is that there was a limited amount of projects that could be analysed and to be able to answer the research question there was in-depth information required, which was the easiest accessed by use of the case study research.

Case study selection criteria

To derive a proper composition of the different case studies, the main criterium was that the cases need to be similar. Each case still had its own characteristics, but they needed to be similar in the following aspects:

- Similar in budget;
- Similar in type of project, i.e. infrastructure;
- Similar in contract, i.e. a DBFM contract;
- Similar in construction phase, i.e. in execution or maintenance phase;
- Similar in location, i.e. located in the Netherlands.

Combining these aspects and projecting these on the projects in the Netherlands, it arose that multiple projects were suited. However, there was one programme that catches the eye, namely the Sluizenprogramma of Rijkswaterstaat. The reason that the projects of the Sluizenprogramma were a good fit for this research was that three of the projects match the criteria stated before and they were combined in a programme for knowledge exchange and collaboration. An overview of the Sluizenprogramma and the projects in the programme can be found in Appendix A.

If one combines the projects of the Sluizenprogramma and the criteria stated before, there were three projects that do not match. The construction of the new lock at Terneuzen doesn't have a DBFM contract and was therefore not selected for this research. The renewal of the Afsluitdijk is not only about construction a lock but entails a lot of construction work on the dike and was therefore not similar to the other projects, both based on the type of project and of budget. The construction of a new sea lock in IJmuiden was also not selected for this research since the budget of this lock is more than 4 times the budget of the other projects. The other three projects, the new floodgate at Limmel, the construction of the second lock chamber in Eefde and the construction of the third lock chamber at the Beatrixsluis, were therefore selected for this research. These projects are similar in budget, i.e. €60 million, €80 million and €133 million, they were similar in type of project, construction of a new lock, similar in contract, all have a DBFM contract, similar in construction phase, two in the maintenance phase and one at the end of the execution phase, and they were all located in the Netherlands. Therefore, these three cases were selected.

Data gathering

The data of the case study is gathered with the use of semi-structured interviews. The reason for this method was that, as indicated by Cohen and Crabtree (2006), the best use of a semi-structured is when there is only one chance to meet up with the interviewee. Also, the interviewee and the researcher are not restricted by the predefined questions, but the questions can develop while the interview is going on to get to the core of the cases. As with every methodology, the semi-structured interviews also have their limitations. Yin (2003) identified four of the weaknesses of the interviews in case-study research, namely a response bias, interviewees providing the answer the interviewer wants to hear, inaccuracies due to poor recall of the events and a bias due to badly constructed questions. In order to overcome these weaknesses, the following actions have been implemented. To overcome the response bias and the inaccuracies due to poor recall of the events a total of 20 respondents are interviewed. The combination of the answers is the input for this research and therefore if one respondent had a bias or provided inaccuracies, this would not influence the outcome of this research. To overcome that the interviewees provide the answer the interviewer wants to hear and the bias due to badly constructed questions, the interview protocol is checked by three supervisors with experience in these particular matters. The interview protocol is updated multiple times until there were no inaccuracies or suggestive questions to be found.

Data analysis

Each of the interviews is transcribed and these transcriptions were the basis for both the individual case analysis as the cross-case analysis. In both analyses, the interviews were compared to find similarities and differences. The three cases were analysed using the hierarchic method for comparative case-studies. This means that multiple cases were analysed in two stages. In the first

stage, the three cases were analysed as if they belong to single case-study research. Subsequently, the cases were cross-case analysed to find similarities in these projects (Yin, 2003).

Data combination

The results of both the literature review and the case study research are combined into one practical guidance that can be used in future DBFM projects. Thereby a division is made in which phase of the project which focus point should be taken into account.

2.3 Research framework

The goal of the research framework is to provide a structure, which helps to answer the main research question. According to Verschuren and Doorewaard (2013), the research framework is constructed out of the research objective, the research object and the theoretical framework.

The research framework starts with the theoretical framework, which is based on the literature study that can be found in Chapter 3 and 4. From the literature review, the questions that are asked in the interviews of the case-studies are based. The case studies provide an overview of how the current process of risk allocation is designed and they provide an insight into the lessons that can be learned from these cases. The three steps are combined to develop a solution to enhance the risk allocation in DBFM projects. The research framework can be found in Figure 6.

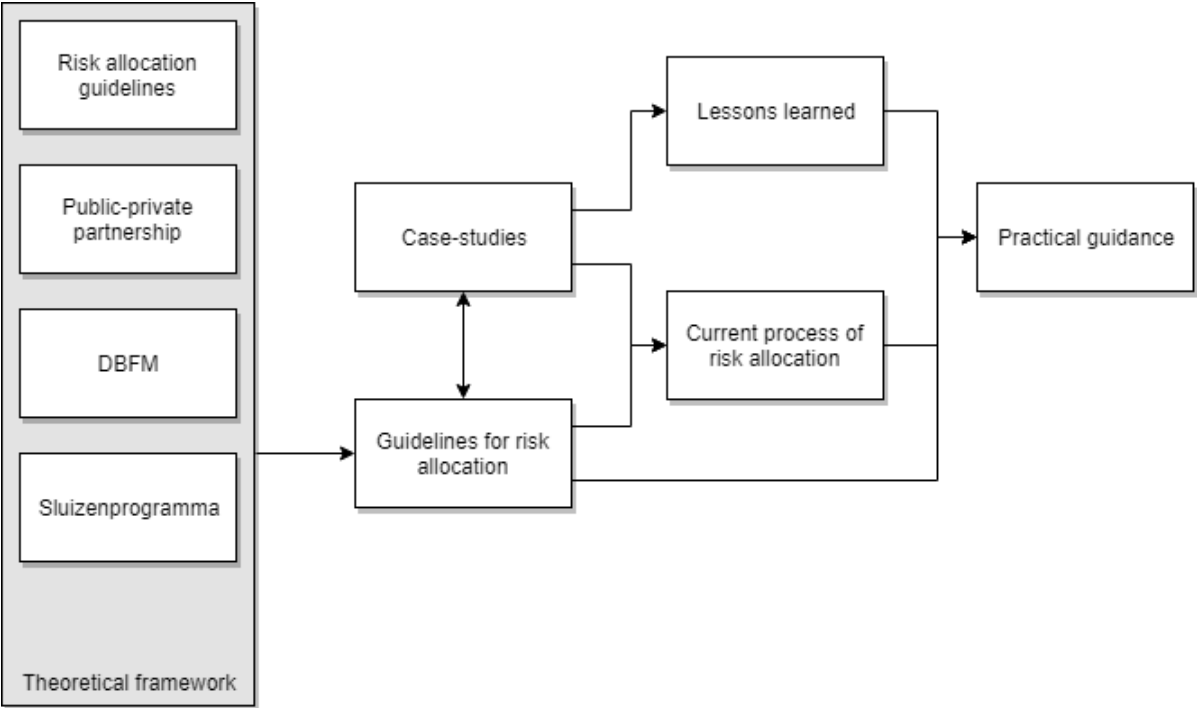


Figure 6: Research framework (own image)



Part 2

Literature review

3 Public-private partnerships

This chapter first describes integrated contracts. Subsequently, the history of public-private partnerships is shown after which the focus shifts to the DBFM contract, which is the most used form of a public-private partnership in the Netherlands. First, the latest developments regarding the DBFM contract are illustrated, next to several aspects of the DBFM contract are described, like the private financing, the delivery of a service, the special purpose vehicle, the value for money principle and last but not least the risk allocation.

3.1 Integrated contacts

Public-private partnerships always make use of integrated contracts. The term integrated contract is actually an umbrella term for a range of different contracts. These contracts have in common that more tasks and responsibilities are handed over from the client to the contractor. An example is a design & construct contract, which is also known as a design-build contract, in which the design phase and the construction phase are integrated into one contract and awarded to one party (Chao-Duivis, Koning, & Ubink, 2013). There are a lot of different forms of integrated contracts, examples of these contracts are Design & Construct, Engineer & Construct, Design Build Finance Maintain Operate, Build Own Transfer and Build Own Operate Transfer. An overview of the different forms can be found in Figure 7.

FULLY PUBLIC SECTOR		PUBLIC/PRIVATE PARTNERSHIP			FULLY PRIVATE SECTOR		
Traditional public contracting Design Build Maintain		1. Service contracts Operate Maintain Lease	2. Build, operate and invest Concessions		3. State-owned enterprises and joint ventures Corporatization Private finance Co-ownership Alliances	Full divestiture Privatization	
Public service provision	Passive private investment Government bonds		2a DBFM/O Government defines project	2b BOT Private party develops project		Passive public investment Equity Debt guarantees Grants	Private service provision
Public	←----- investment responsibility ----->			----->		Private	
Provider	←----- government role ----->			----->		Enabler	

Figure 7: Overview of different types of contracts (Verhees, van Marrewijk, Leendertse, & Arts, 2015)

Since one of the central themes in this research is the DBFM contract as it is applied in the Netherlands, the other contracts are left out of the scope. In the DBFM contract, the Design phase, the Building phase and the Maintenance phase are integrated into one contract and it also contains a financing component. Examples of DBFM projects in the Netherlands are the construction of the Tweede Coentunnel, the upgrade of the N50 to the A59, the widening of the N33, the construction of the office of the tax and customs administration and the construction of the National Military Museum (Ministerie van Financiën, 2016).

3.2 History

The use of public-private partnerships is nothing new under the sun. It is indicated that these forms of service delivery were already in use in the Roman Empire. (Public-Private Infrastructure Advisory Facility, 2009; Walker & Dart, 2011) In this time postal offices, which were, in fact, small communities including hotels, warehouses and military barracks, were constructed by private institutes. Besides the construction, the institute was also responsible for the management of the community and sometimes even included the maintenance of the highway which connected the community (Public-Private Infrastructure Advisory Facility, 2009).

Throughout history, there are several examples of the implementation of public-private partnerships, like the concession for the supply of drinking water in Paris in the 18th century, the Suez channel and the Trans-Siberian Railway in the 19th century (Tang, Shen, & Cheng, 2010). The use of public-private partnerships is not solely in the domain of infrastructure as is shown by the VOC, the Dutch East-Indian Trading Company. This company, founded in 1602, was financed by private merchants for performing trade activities in the east and was owned for 50% by the municipality of Amsterdam. However, it took public-private partnerships until 1986 to be first mentioned in an official document from the Dutch government. It was mentioned in the coalition agreement in 1986, where it was discussed that public-private partnerships could be used for several projects, like tunnels, highways and railroads (Klijn, 2009).

3.3 DBFM

Since the year 1999, the Ministry of Finance has been working to implement a form of public-private partnership in the Netherlands (Algemene Rekenkamer, 2013; Ministerie van Financiën, 2010). The most commonly used form is the DBFM(O) contract (Ministerie van Financiën, 2016). DBFM(O) is a contract, in which the different phases of a project are integrated and transferred from the public client towards one single contractor. Within these projects, the Design phase, the Building phase, a Financial part, the Maintenance phase and, optional, the Operating phase are outsourced to one contractor.

3.3.1 Latest developments

The Minister of Finance is responsible for the overall coordination of DBFM and for the policy frameworks. The civil services are responsible for the execution of their projects, which in practice means that Rijkswaterstaat, for infrastructure, and Rijksvastgoedbedrijf, for buildings, are responsible, since they are the only civil services implementing DBFM contracts (Algemene Rekenkamer, 2013; Ministerie van Financiën, 2016). The DBFM contract is applied on infrastructure projects and on building projects. Since the costs in the tender phase, the contract is not applicable for smaller projects. The financial demarcation is for infrastructure set on €60 million and for building projects on €25 million (Algemene Rekenkamer, 2013).

The first projects executed with a DBFM contract are the high-speed railway (HSL) in 2001 and the N31 in 2002. In October 2016 there were a total of 21 infrastructure projects of Rijkswaterstaat either in the exploitation phase, in the realisation phase or in the decision-making phase. Examples of these projects are the widening of the A15 between junction Maasvlakte and Vaanplein, the construction of the Tweede Coentunnel, the A12 between Utrecht Lunetten and Veenendaal, the new sea lock in IJmuiden and the construction of the third lock chamber at the Beatrixsluis nearby Utrecht. In 2016 there was a total of 16 building projects of Rijksvastgoedbedrijf either in the exploitation phase, in the realisation phase or in the decision-making phase. Examples are the new prison in Rotterdam, the building of the Tax and Customs Administration in Doetinchem and the building of the Supreme Court (Ministerie van Financiën, 2016).

However, these projects are executed with mixed results. One of the most well-known projects that had trouble in the execution is the widening of the A15 between the Maasvlakte and junction Vaanplein, including the construction of a new Botlek bridge. The total budget, which was first set at 1.2 billion euros, was exceeded by 300 million euros (Houtekamer, 2015; Koenen, 2016b). One of the central issues was the risk allocation between the client, Rijkswaterstaat, and the contractor, a combination of Ballast Nedam, Strukton and Strabag. In the tendering process, Rijkswaterstaat used so-called list risks (in Dutch: lijstrisico's) whereby the contractor could earn a bonus if it took responsibility for the risks (Rijkswaterstaat, 2011). In researches into this project, it is concluded that there was a suboptimal risk allocation (Koenen, 2016c; Neerlands diep, 2016).

The project of the A15 was one of the projects that led to the so-called Marktvisie. The reason for the Marktvisie is that there were struggles between the client and the contractors. One of the reasons for these struggles was the economic crises, during which the bidding prices of the contractors was too low and there was a lot of hassle on infrastructure works, of which the A15 was one of the projects. The origin of the hassle was, among other things, the increase in costs of projects, losses for the contractors and the suboptimal allocation of risks (Kernteam Marktvisie, 2016).

To overcome these problems Rijkswaterstaat organised several meetings together with Bouwend Nederland, NLIngenieurs and several other agencies to generate ideas. The ideas of these meetings were the input for the Marktvisie, of which the output five principles were. The main goal of these principles and of the Marktvisie, in general, is to improve the relationship between the clients and the contractors in the Netherlands and to increase the innovation in the construction sector, combined with viable profit margins (Kernteam Marktvisie, 2016; Koenen, 2018a). The five main principles are:

- Human factors: The goal of the collaboration between the client and the contractors is to increase the proudness and craftsmanship in order to achieve a successful project. The basis is mutual trust and reliability.
- Tendering: The goal during the procurement of a project is always a successful project for all the parties involved.
- The Economical Most Advantageous Tender 2.0: The selection criteria for the quality of the works need to be a fair match between price and quality and therefore contractors can distinguish oneself.
- Risks: Risks are allocated to the party that is best able to control the risk. Both parties, client and contractor, have a shared obligation to handle the risks professionally, which includes having transparency in the dialogue between the parties.
- Bidding price: The margins are profitable, and the risk premiums are cost-effective. The contractors should not bid for a project if the margins and premiums are not profitable (Kernteam Marktvisie, 2016).

However, three years after the launch of the Marktvisie there are still dissatisfied contractors (Koenen, 2018a, 2019b). This is most visible on three projects, in which multiple contractors quitted during the procurement. These projects are the Blankenburgtunnel, the Zuidasdok and the ViA15, the connection between the A15 and the A12 nearby Arnhem. At the Blankenburgtunnel there were only two bidders in the final stage of the procurement (Koenen, 2017a). The same was the case for the Zuidasdok, which entails the design and the construction of the tunnel that will become part of the ring of Amsterdam and of the new public transport services. Besides, the construction is already delayed due to the complexity of the project (Doodeman, 2019). The last project, the connection between the A15 and the A12, had two competitors who decided not to bid for the project due to the risk allocation in these projects,

whereby a large number of risks was allocated to the contractor. These competitors are large contractors in the Netherlands, namely BAM, Volkerwessels, Boskalis, TBI and Heijmans, which are listed as numbers 1, 2, 3, 5 and 7 on the list of the largest contractors in the Netherlands (Cobouw, 2018; Koenen, 2018b, 2018c).

In response to these withdrawals in the procurement of these large infrastructure projects, Rijkswaterstaat together with the consultancy firm McKinsey performed a market analysis. The central theme of this analysis is to find solutions for the problems until 2030 (Koenen, 2019a). One of the most important conclusions of this report was that in large complex infrastructure projects too many risks were allocated to the market (Koenen, 2019a). This in combination with the low margins is said to be a threat for the market (Koenen, 2019b).

Around the same time that the problems occurred in the Netherlands, decided the government of the UK to abolish the use of the private finance initiative. The decision didn't come from anywhere, since there was an ongoing debate since the bankruptcy of Carillion, one of the largest contractors in the UK and involved in many PFI projects (UK House of Commons Public Administration and Constitutional Affairs Committee, 2018). After the insolvency, a number of investigations have been conducted into how this could happen. Subsequently, a committee of the House of Commons examined five issues that are essential in the outsourcing of services from the government to the private sector. One of these issues is the behaviour of the government as a customer, in which the transfer of risks plays a key part. In this part, severe criticism is expressed on the practice of risk transfer. Some quotes to indicate this criticism are: "there is evidence that successive governments have sought to transfer risk inappropriately" "Government has started transferring unmanageable amounts of risk into the private sector" "the experience of recent years has been that procurement teams are aggressively seeking to maximise risk transfer" (UK House of Commons Public Administration and Constitutional Affairs Committee, 2018).

3.3.2 Legal aspects

Where there are two regulations applicable in the traditional contracting, one for the contract between the client and the consultant (DNR 2011) and one for the contract between the client and the contractor (UAC 2012), there is only one regulation applicable in integrated contracts, namely the Uniform Administrative Conditions for the Execution of Works and Technical Installation Works for Integrated Contracts 2005 (UAC-IG 2005). However, these conditions are only applicable to design & construct contracts and not to DBFM contracts.

For DBFM contracts there is only a standardized contract, in which the conditions and requirements are stated. There are no uniform conditions that apply to the DBFM contract. The model agreement divides the projects into three phases of which each is ended with the handover of a certificate. The phases are the preparation phase, ended with the starting certificate, the realisation phase, ended with the availability certificate and the exploitation phase ended with the handover certificate. Besides these certificates related to a specific phase, there are also the certificates of completion. This certificate is awarded when the project is completely finished and if it meets the requirements (Janssen, Orobio de Castro, & de Groot, 2010; Rijkswaterstaat, 2018).

There are legal obligations by the client that are connected to the certificates. The client is obliged to pay a predetermined percentage of the availability payments from the moment the starting certificate is signed. Furthermore, they are obliged to pay the full availability payment from the end of the realization phase and thus when the availability certificate is signed. When the certificate of completion is awarded, the client has to pay the bullet payment, as is described in Chapter 3.3.4. These are the only obligations the client has according to the standardized contract DBFM (Janssen et al., 2010; Rijkswaterstaat, 2018).

This implies that the contractor has no other rights than the right to be paid by the client. However, there are three categories of risks that in principle are allocated to the client, which are the special circumstances. There are three categories, namely the events of compensation, the events of delay and the events of force majeure. The events are set, however, the risks that can be qualified as special circumstances differ per project (Janssen et al., 2010; Rijkswaterstaat, 2018).

3.3.3 Special Purpose Vehicle

In the DBFM contract the Design phase, the Building phase, the Maintenance phase and a financing component are integrated into one contract. A single construction firm doesn't have the capabilities and the financing to be able to execute these large projects on their own. Therefore, a so-called special purpose vehicle (SPV) is set up. The goal SPV, also called the special purpose company (SPC), is solely to execute the project over the entire lifespan of the contract. The SPV is a shell company, which holds the grant for the project, however, the project is executed by other companies involved in the consortium. Each of the companies involved in the project has their own agreement with the SPV and thus the SPV acts as the legal representation of the consortium (Chowdhury & Chen, 2010; Demirag, Khadaroo, Stapleton, & Stevenson, 2011). The main companies involved in the consortium are the construction firm, the debt providers, the equity providers and some consultants. These parties and the relationship they have with the SPV are pointed out in Figure 8 (Rijksgebouwendienst, 2009).

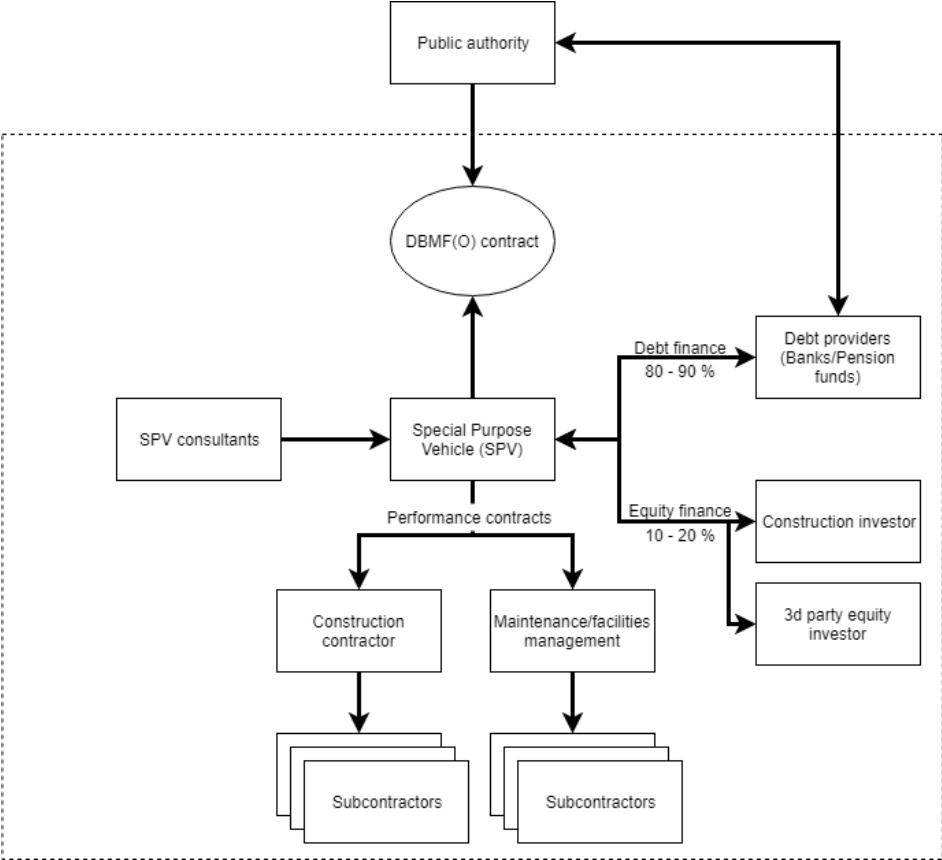


Figure 8: Set-up of a SPV ¹

¹ Adapted from: Chowdhury, A. N., & Chen, P. (2010). Special Purpose Vehicle (SPV) of Public Private Partnership Projects in Asia and Mediterranean Middle East : Trends and Techniques. International Journal of Institutions and Economies, 2(1) and Rijkswaterstaat. (2009). Geïntegreerde contractvorming - een introductie.

3.3.4 Private financing

As explained in the previous paragraph, the SPV is involved in the financing of the project. However, a distinction must be made between the financing of the project, provided by the equity and debt providers of the SPV, and the funding of the project, provided by the client. The Commissie Private Financiering van Infrastructuur states that financing consists of the financial resources that are needed to pay for the investment and that the funding is about which party eventually pays the expenses of the investment. In the events of the DBFM structure, the private parties invest their money to gain a return, while the project is actually paid by the public client (Ruding et al., 2008; World Bank, 2017, p. 21).

The public authority, in the Netherlands mostly Rijkswaterstaat, doesn't provide the funding all at once, but over the lifespan of the project. The SPV is paid based on the availability of the project. A special payment the SPV acquires is the bullet payment. The bullet payment is paid when the certificate of availability is signed. From this moment on the project is available to be used by the end users. The other payments are so-called availability payments, which means that there is a certain maximum amount to be paid by the public client over the maintenance period of the project. However, if the project is unavailable, for example when maintenance is needed, a certain predefined amount is extracted from the payment. Due to this mechanism, there is an optimization of the availability of the project (Beek, Bisschop, Klein, Post, & Staats, 2010; HM Treasury, 2006; Van Garsse, De Muyter, Schutyser, & Verlinden, 2009). An example of the payments and costs in a DBFM contract can be found in Figure 9.

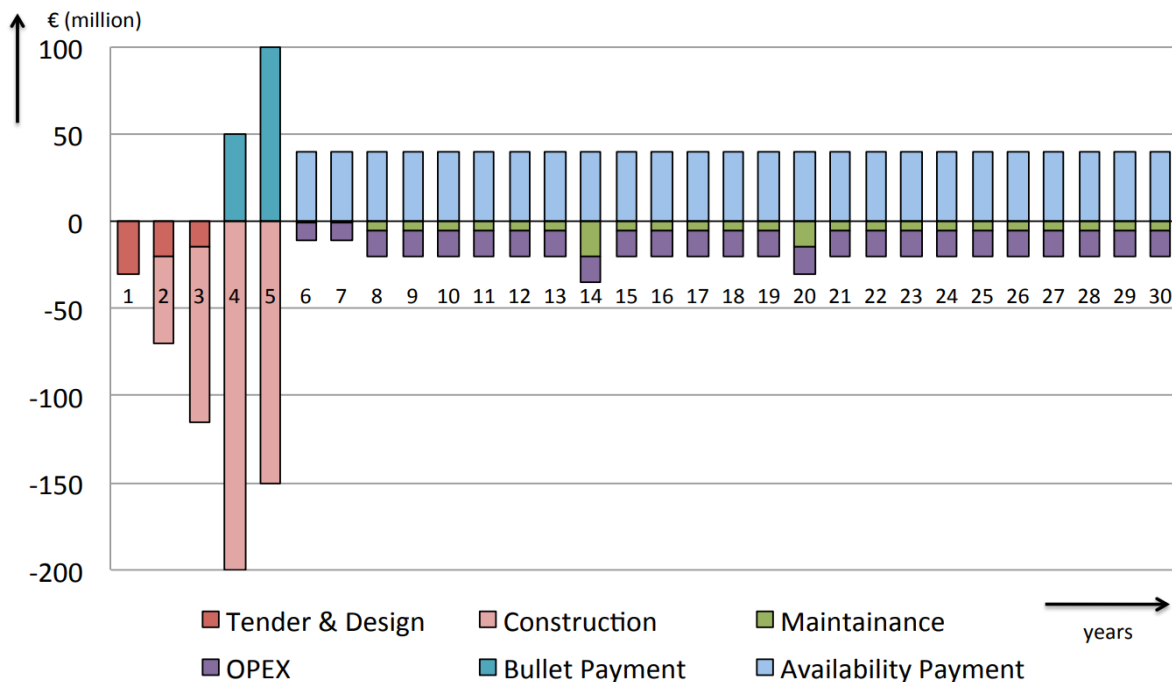


Figure 9: Cash flows in a DBFM project (Hofstra, 2013)

3.3.5 Service delivery

DBFM is a contract type where the different parts of a project are transferred from the public client towards one contractor. Within these projects, the Design phase, the Building phase, the Financial part, the Maintenance phase and optional the Operating phase are outsourced to the contractor. Over a defined period, mostly 25 to 30 years, the contractor provides a service to the public client instead of a product. For example, the contractor provides the service of a certain amount of cars over a road instead of delivering the product, which in this case would be the road (Janssen et al., 2010; Ministerie van Financiën, 2016).

3.3.6 Value for money

The principle of value-for-money is one of the core principles in a PPP and thus in a DBFM contract. Value-for-money is defined by Grimes & Lewis (Grimsey & Lewis, 2004, p. XV) in their book on public-private partnerships as: “The optimum combination of whole-of-life cycle costs, risks, completion time and quality in order to meet public requirements.” To state it in layman’s terms: to increase quality for less or the same amount of money.

Pitt, Collins and Walls (2006) performed a literature review on factors that create value-for-money in PFI projects. Since the Dutch DBFM is based on the PFI, the drivers are probably equal for both contracts (Klijn & Twist, 2007). The factors indicated by Pitt et al (2006) are first named and subsequently they are explained:

- The optimal allocation and valuation of risks;
- The focus on output instead of inputs;
- Competition in the tender;
- Contract scope and duration;
- The high costs for the bids;
- Innovation;
- Private financing costs;
- Management skills of the private sector;
- Management skills of the public sector;
- Performance measurements;
- Flexibility in the contract. (Pitt et al., 2006)

It is indicated in many researches that the central factor in achieving value for money is the risk allocation. It is even indicated that for six projects in the UK the achievement of value for money is solely based on the risk transfer from the client to the contractor (Ball et al., 2003). However, achieving the optimal allocation of risks is ambiguous. The principles and the mechanism of risk allocation are in more detail described in Chapter 3.3.8 and 4.1.

The focus on outputs enables the bidders to be innovative in how to be able to meet the output specifications. Therefore this could increase the value for money achieved in these projects (Grimsey & Lewis, 2004, p. 84; Pitt et al., 2006). The competition in the tender is an added value the client has during the negotiation phase of the tender, thereby possibly decreasing the costs of the project, however, it must be noted that this needs to be balanced (Pitt et al., 2006). The contract scope and duration of the maintenance phase increases the efficiency that contractors can implement in the project to optimize the lifecycle costs (Eversdijk & Korsten, 2009; Pitt et al., 2006; Ruding et al., 2008; Yescombe, 2007, p. 21). The high costs for the bids are derived from the lengthy procedure for PPPs, for example, the average procurement time in the UK was found to be 22 months. The reason is that it takes a long time to agree on the payments, the risk allocation and the different terms (Grimsey & Lewis, 2007). Therefore, this is a factor that negatively influences the value for money. The next factor is innovation, as it is said that the private sector has a better potential for innovation than the public sector and therefore enhancing the value for money (Ismail, Takim, & Nawawi, 2011). The costs of private financing are higher than the costs for public financing and thus the value for money decreases with the use of private finance. However, the efficiency gained by the usage of the private sector should weigh out the costs of private financing (Sarmiento & Renneboog, 2014).

3.3.7 Procurement

There are nine different procedures for the tendering of projects, these procedures are:

- Open procedure;
- Restricted procedure;
- Competitive dialogue;
- Negotiated procedure with prior publication of a contract notice;
- Negotiated procedure without prior publication of a contract notice;
- Direct agreement procedure;
- Concession procedure;
- Framework agreement;
- Design contest (Chao-Duivis et al., 2013).

For the procurement of DBFM contracts in the Netherlands, the competitive dialogue is chosen as the procedure. In the competitive dialogue, a selection is made from possible contractors and a dialogue is conducted with these parties. The number of bidders can gradually be reduced based on award criteria to eventually award the contract to one of the bidders.

The procurement of a DBFM contract is set out in the nationwide tendering guidelines DBFM for infrastructure projects. There are two variants possible, however, the procedure is more or less the same. The competitive dialogue in the procurement process in the Netherlands consists of four phases, namely the selection phase, the dialogue phase, the registration phase and the contract and financial close (Rijkswaterstaat, 2012a, 2012b).

The procedure starts with the announcement of the project and thereby starts the selection phase. The goal of this phase is to select possible candidates that are suited for the project. The selection is based on grounds for exclusion and suitability requirements. After the selection of candidates, the dialogue phase starts, which consists of three phases (Rijkswaterstaat, 2012b, 2012a).

The first phase of the dialogue is to inform the contestants about the tender documents. Thereby it is possible, depending on which variant is chosen, to select the three best contestants based on a plan of action provided by the bidders, which is evaluated on the economically most advantageous tender (EMAT) criteria. In the next paragraph, a more elaborate explanation of the EMAT criteria can be found. The next step in the dialogue phase is to discuss the tender documents and, if the contract uses list risks (in Dutch: lijstrisico's), the risks are discussed and valued. The third phase of the dialogue is focussed on establishing the DBFM agreement (Rijkswaterstaat, 2012b, 2012a).

The list risks are an interesting factor for the risk allocation in these projects since the allocation of these risks is not predetermined. Each risk on the list will be priced by the contracting authority and by the contractor. The prices of both parties are compared and when the price of the bidding contractor is lower than the price of the contracting authority, the risk will be allocated to the contractor and vice versa. However, this means that the risk allocation can differ between the different possible contractors. If the list risks are not used, which is the case in the more recent DBFM projects, the risk allocation is predetermined, however, the risks can be a subject during the dialogue from which Rijkswaterstaat can decide to change the risk allocation (Rijkswaterstaat, 2012a).

After the dialogue phase, the registration phase starts. In this phase, the contestants provide their final bid to the contracting authority. The bids are scored based on the economical most advantageous tender (EMAT) criteria (in Dutch: beste prijs kwaliteit verhouding (BPKV)). The goal of the EMAT is to award the contract not solely based on the lowest price but to have a combination between the price and the quality of the project. For every criterion, a certain maximum discount price is set and based on the score on the criterium a fictional discount is applied to the total price of the bid. The bids are compared based on the fictional price, thus the price minus the fictional discounts, and based on that the winner is selected. Examples of these criteria are risk management, aesthetic quality and sustainability (Rijkswaterstaat, 2017a).

After the winner is selected, the final steps are the contract close and the financial close. There will be no changes anymore to the DBFM documents. After the contract close, the financial close needs to take place. The financial close is the contract between the SPV and the financiers, which needs to be signed within the stated time in the contract (Rijkswaterstaat, 2012b, 2012a).

3.3.8 Risk allocation

An important aspect of a DBFM contract is the risk allocation. In general, it can be stated that all the risks are allocated to the contractor unless it is stated otherwise in the contract (Janssen et al., 2010; Verhees & Verweij, 2016). In the DBFM contract, the risk can be allocated either to the contractor (risk contractor), to the client (events of compensation) or it can be shared between both parties (events of delay and events of force majeure). The three group of events, compensation, delay and force majeure, are predefined in the DBFM contract and a number of events are divided over the different events. The model agreement provides a setup for the different events; however, these events are modified to fit the project-specific characteristics. If an event is not listed in one of these events it is a risk that is taken by the contractor (Rijkswaterstaat, 2012a, 2018). An overview of which events are part of each event in the model agreement can be found in Appendix D.

If an event that qualifies as an event of compensation takes place, the contractor is being compensated and the deadlines are being postponed with the delay caused by the event. If an event that qualifies as an event of delay takes place, the deadlines for the certificates is postponed with the delay caused by the event and the contractor has the right on limited compensation, namely the compensation of certain financing costs that are inherent with the delay. If an event that qualifies as a events of force majeure takes place, the contractor has more or less the same rights as in the events of delay, however if the contractor can't meet the obligations due to the events of force majeure, the contractor still has to be paid the availability payments minus the conservation costs (Janssen et al., 2010).

3.4 Summary

The most used form of a public-private partnership in the Netherlands is the DBFM contract. In this contract, the design, the build and the maintenance phase are rewarded to one contractor. Besides that, the contract also consists of a financing component. This financing is based on private financing of the design and construction phase, where the contractor is being paid over the time of the maintenance period, based on the availability of the project. Therefore, the contractor is not only a construction firm but is a special purpose vehicle, in which banks, equity providers and construction firms are combined. This SPV delivers the service that the client asked for in the contract.

An important aspect is the risk allocation, which is stated in three events, namely the events of compensation, in which the risk is allocated to the client, the events of force majeure and the events of delay, in which the risk is shared between the client and the contractor, and the risk contractor in which the risk is allocated to the contractor. The allocation of risks is one of the most important factors in achieving value for money, which can be formulated to achieve the best quality for the least amount of money. There are two tools that are being used to calculate the value for money of DBFM projects, namely the public-private comparator and the public sector comparator. These comparators calculate if the value for money can be achieved with the DBFM contract and are the basis for the decision to choose a DBFM contract.

For the procurement of a DBFM project, there is a standardized model agreement available. However, there are no uniform conditions that apply, which is the case for other contract types. In this model agreement, the duties of both the contractor and the client are stated. In short, it can be said that the contractor only has the right to be paid, except when there is a specified event. The procurement of the DBFM contract follows the procedure of the competitive dialogue, in

which the bidders' price the list risks and based on that the risk allocation is determined. Eventually, the bids are scored on different criteria to find the economically most advantageous tender.

4 Risk allocation

One of the key features of the construction industry is the subjectivity of the business in relation to risks. The nature of the industry makes it challenging to handle risks, like the changes in the building environment, the increased complexity over the years, the long life span of the objects and the large number of activities needed to complete a project (Zeng, An, & Smith, 2007). Thus, risks are insurmountable. However, the question is how to deal with these risks.

The two main processes related to risks are the risk allocation and the risk management. These processes determine which party is responsible for which risks, the risk allocation, and what to do with a risk if it is allocated to a certain party, the risk management. For an overview of the two main risk management processes, one can find these in Appendix E. An appropriate risk allocation is said to be one of the critical success factors for public-private partnerships (Jefferies, 2006). However, there are currently indications that this appropriate risk allocation is not achieved in practice (Koenen, 2019a).

In order to have a mutual understanding of what is meant with a risk in this research, the following definition is used: “An event that might occur and that could lead to higher costs, delay of the project or not complying to the requirements.” (van Well-Stam, Lindenaar, van Kinderen, & van den Bunt, 2008) The reason that this definition is selected is that it is the definition of the RISMAN method, the method that is mostly used in the Netherlands for risk management.

This chapter focusses on how to derive the best risk allocation by focussing on identifying the most important design principles that should be taken into account in the risk allocation.

4.1 Risk allocation

The process of risk allocation can be explained fairly simple, namely as the decision which party will be responsible for which risk. However, it may be clear that this process is in reality much more complicated than it is stated before (Medda, 2007). Since, as a client, it is easy to transfer all the risks to the contractor, but this usually is increasing the budget the contractor needs to construct the object. So, the question is where to allocate a certain risk.

In general, it can be stated that the definition of risk allocation is: “the definition and division of responsibility associated with a possible future loss or gain, seeks to assign responsibility for a variety of hypothetical circumstances should a project not proceed as planned.” (Lam et al., 2007)

The question that arises is which process should be followed to derive a proper risk allocation. To have a good process, the right principles should be in place. These principles are the subject of the next paragraph.

4.1.1 Principles of risk allocation

The common view on the process of risk allocation is that the risks should be allocated to the party best able to manage and control the risks (Cooper et al., 2005, p. 79). In other words, it can be stated that the risks should not be all passed towards the contractor, but risk allocation is about finding a solution for minimizing the total costs for both the public client and the private contractor. However, it is indicated that this criterion might cause contrasting results, since it may happen that risks emanating from a partner, and thus this partner is the best party to manage this risk, while they may not be able to control the risks in the most efficient way (Ke et al., 2010; Medda, 2007).

Another remark on the principle that the risks should be allocated to the party best able to manage the risks is that this principle is implemented in the current practice. However, it is shown that the transfer of all the risks to the private sector is still prevalent in many countries.

Thereby there is a tendency that the primary contractor pushes the risks towards the subcontractors. This leads to the principle that risks are allocated to the party least able to refuse them, which causes an allocation based on power, which could lead to a indecent risk allocation and thereby decreasing the chance of a successful project (Hanna et al., 2013; Jefferies, 2006; Jin & Zhang, 2011).

A third remark on the view that risks should be allocated to the party best able to manage the risks is that this principle doesn't indicate how to get to the best risk allocation, but only what the outcome should be (Oudot, 2005; Thomas et al., 2003). It can be concluded that solely this principle isn't satisfying and therefore more principles are needed.

Multiple authors have indicated principles that should be considered when it comes to risk allocation. Eight of these studies are combined in order to derive the right design principles to follow in the case studies. These principles and the corresponding study mentioning them can be found in Table 1.

Table 1: Principles for risk allocation

Guideline	A	B	C	D	E	F	G	H	Total
The party has the resources to deal with the risk if it fires.	x	x	x		x		x		5
Risk should be allocated to the party with the best capability to control the events that might trigger its occurrence.		x	x	x	x		x		5
The party has the capacity and expertise to control, monitor and minimize risks.	x		x				x	x	4
Risks must be properly identified, understood and evaluated by all parties.	x	x	x				x		4
The party has the right risk attitude and want to accept the risk.	x		x		x		x		4
The party accepting the risks can charge the right premium for this risk	x	x			x				3
The risk should be borne by the agent able to bear the risk at the lowest cost.				x		x			2
The economic benefit of the risk rests with that party.		x						x	2
It is more efficient to put the risk on that party.								x	1
If the risk eventuates, the loss falls on that party and there is no valid reason to try to transfer it								x	1
Whether the party is able to foresee the risk		x							1
They can transfer this risk in an economically beneficial way								x	1
The party should be best able to manage the risk						x			1
The party to which the risk is allocated can support the agent's development						x			1
The party is best able to control the impact on the project outcomes				x					1

A: (Loosemore & McCarthy, 2008), B: (Lam et al., 2007), C: (Abednego & Ogunlana, 2006), D: (World Bank, 2017), E: (Ward et al., 1991), F: (Oudot, 2005), G: (Heravi & Hajihosseini, 2012) H: (Mead, 2007)

The design principles that are selected for this study are the design principles that are at least named by three studies. The main factor for choosing three studies is that the more frequent a design principle is named; the more authors endorse the importance of the principle and the more generalizable the principle is. Thereby a minimum of three is selected to have a baseline of importance according to scientific literature. When a principle is only named once it could be that the principle is specific for the country in which the research is conducted. When a principle is named twice, the chance of it being a coincidence is lower but still possible. If a principle is named thrice, there is almost no chance of it being a coincidence. Therefore, the division is made at three times. Hence, there are six principles, which are named and explained below. The principles are numbered based on their aggregate amount of studies naming the principle.

1. **The party has the resources to deal with the risk if it fires.** Not every risk can be prevented from happening, so there must be a principle in place that deals with the situation if a risk fires. This principle states that the party should have the resources to deal with it, both in terms of money as well as in terms of human capital. This ensures that the party to whom the risk is allocated is able to sustain the consequences if the risk fires and therefore is able to bear the risk.
2. **The party has the best capability to control the events that might trigger the risk.** This principle deals with the events that might cause a risk to fire. A risk is not an independent event, but there are always events that cause the risk to fire. Thereby it is stated in the definition of a risk that with every risk there is uncertainty. The chances that a risk fires are influenced by the events happening before the risk and that is what this principle is about. Therefore, the risk should be allocated to the party with the best capability to influence events that might trigger the risk, since this party can influence the chance of the risk firing in a positive manner.
3. **The party has the capacity and expertise to control, monitor and minimize risks.** This principle focusses on the resources before the risk fires. Where the first named principle is focussing on the resources after the risk fires, this principle deals with the resources before the risk fires. This principle speaks of capacity, which can be explained as the people available, and the expertise, which can be explained as the people that are available have the right knowledge. These two factors influence the risk either on the possibility of happening or on the magnitude of the consequences.
4. **The party has identified, understood and evaluated the risk.** The underlying thought of this principle is that if one hasn't identified, understood and evaluated a risk, the party is not able to say if it wants to accept the risk and can charge and let alone calculate a right premium for this risk. Therefore, a party should first analyse the risk in order for principle 5 and 6 to be in place.
5. **The party has the right risk attitude and wants to accept the risk.** This principle ensures that the risk is not allocated to the party least able to refuse the risk, which can be the case with the principle of that the risk should be allocated to the party best able to manage it as is stated before. There must be a true willingness to accept the risk in order to achieve the optimal risk allocation. This principle is connected to the principle that the party accepting the risk can charge the right premium for this risk since if the premium for a certain risk rises, the willingness to accept a risk also increases.
6. **The party accepting the risks can charge the right premium for this risk.** What underlies this principle is that if a risk is transferred from the client to the contractor, the contractor should get a fair price for accepting the risk. This premium should be based on the impact the risk can have and the chance the risk is going to fire. However, the premium is also influenced by the risk attitude of the involved parties. Thereby it is a consideration of the client if the premium is accepted or that for that price the risk is being retained.

Within these six principles, three different groups can be identified, namely, the analysis principle, the control principles and the willingness principles. Each of these groups and their corresponding principles are discussed in the following section.

Analysis principle

The rationale behind the principle that the party has identified, understood and evaluated the risk (principle 4), is that if a party doesn't understand the risk he is taking on, it is uncertain that the other principles are in place. For example, if a party doesn't understand a certain risk, how can he assess if he is willing to accept the risk and how could he calculate a premium that he requires.

Control principles

The principles focussing on control over the risk, which are principle 1, 2 and 3, is based on the thought that the party bearing the risk should be able to control the risk before and after it fired. Before the risk fires, the question is if the party can control the events triggering the risk, principle 2 and if the party has the expertise to monitor and minimize the risk, principle 3. After the risk fired the party should be able to sustain the consequences, principle 1. These three principles together ensure that the party to whom the risk is allocated is able to control the (consequences of the) risk.

Willingness principles

The last group of principles is the willingness to take the risk. This willingness can be subdivided into the risk attitude and the risk premium. These risks are intertwined since the premium charged for a risk is dependent on the risk/return trade-off. This trade-off is influenced by the preference of the bidder and therefore the willingness to accept the risk. In other words, if a party is not eager to accept a risk, the premium asked for will probably a high one. The reason for the willingness group is that the willingness of a party to accept a risk affects the response to the risk (Lam et al., 2007).

The reasoning is that if one follows these design principles, the right incentives are made to have a proper risk allocation.

4.2 Summary

Risk allocation itself is quite simple, namely, to make either the contractor or the client responsible for certain risk. However, it is ambiguous to have the optimal risk allocation. It is argued that a risk should be allocated to the party best able to manage the risks, however, this principle is not easily adopted into a process. The principles that lead to the optimal risk allocation are as follows:

- The party has the capacity and expertise to control, monitor and minimize these risks.
- The party has identified, understood and evaluated the risk.
- The party has the resources to deal with the risk if it fires.
- The party has the right risk attitude and wants to accept the risk.
- The party accepting the risks can charge the right premium for this risk
- The party has the best capability to control the events that might trigger the risk.

These principles are the most important principles in the risk allocation process.

4.3 Conclusion of literature review

The two main foci of the literature review were to provide the input for the questions to be asked in the case study research and to find an answer to the first sub-question, which is: what are, according to literature, the design principles that should be followed in the risk allocation process of DBFM projects?

The input for the questionnaire is based on four aspects that are explained in the previous two chapters. These aspects are the model agreement, the procurement, the report of Rijkswaterstaat and McKinsey and the six principles that are selected to be used in this research. Each of these aspects is shortly elaborated in the following section.

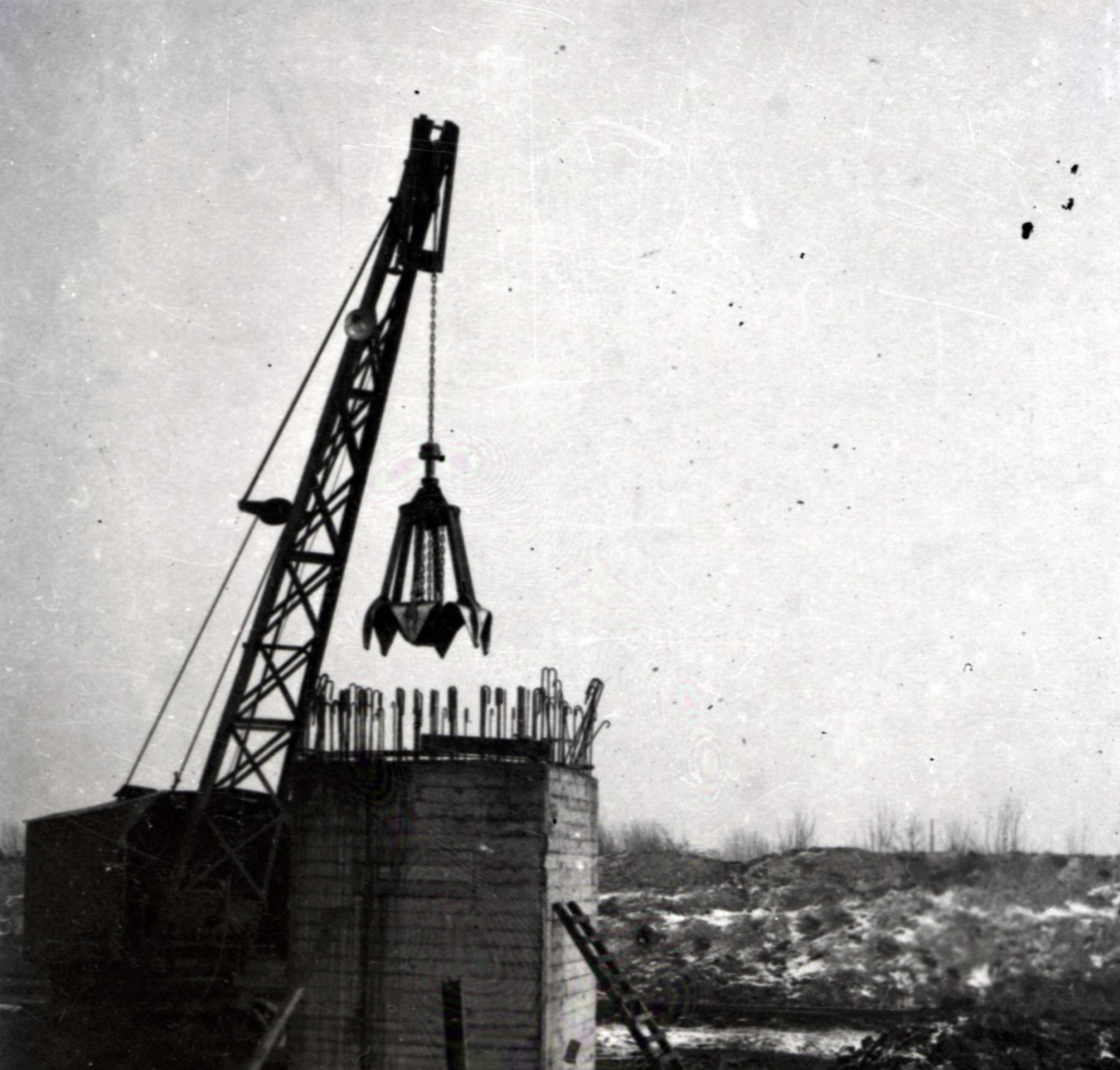
The contracts of a DBFM project are based on the model agreement DBFM. In this contract, a set-up of the risk allocation is provided in three cases, namely the events of compensation, the events of delay and the events of force majeure. The risk allocation in the model agreement is black-and-white, in other words, every risk is allocated to the contractor unless it is explicitly stated in the contract. The cases as they are in the model agreement can be adjusted in the procurement of the

project, especially in the competitive dialogue. In this dialogue, the final risk allocation is determined, either by list risks or by questions asked and comments by the contractor. Lately, the risk allocation has been under scrutiny, whereby Rijkswaterstaat and McKinsey investigated the current problems in the infrastructure sector. One of the main conclusions of the report was that too many risks are currently allocated to the contractors.

Scientific literature has named 15 different design principles that could be taken into account in the risk allocation process. There are six principles that are named by at least 3 different authors, which are:

- The party has the capacity and expertise to control, monitor and minimize these risks.
- The party has identified, understood and evaluated the risk.
- The party has the resources to deal with the risk if it fires.
- The party has the right risk attitude and wants to accept the risk.
- The party accepting the risks can charge the right premium for this risk
- The party has the best capability to control the events that might trigger the risk.

These design principles should be followed in the risk allocation process of DBFM projects.



Part 3

Results

5 Overview of cases

This chapter provides an overview of the specifics of the three cases selected for this research. These descriptions are structured in the same way, starting with the characteristics of the old lock system, followed by the characteristics of the new lock system and lastly the unique aspects of the new lock are described. The overview of the selected cases and their location in the Netherlands can be found in Figure 10.

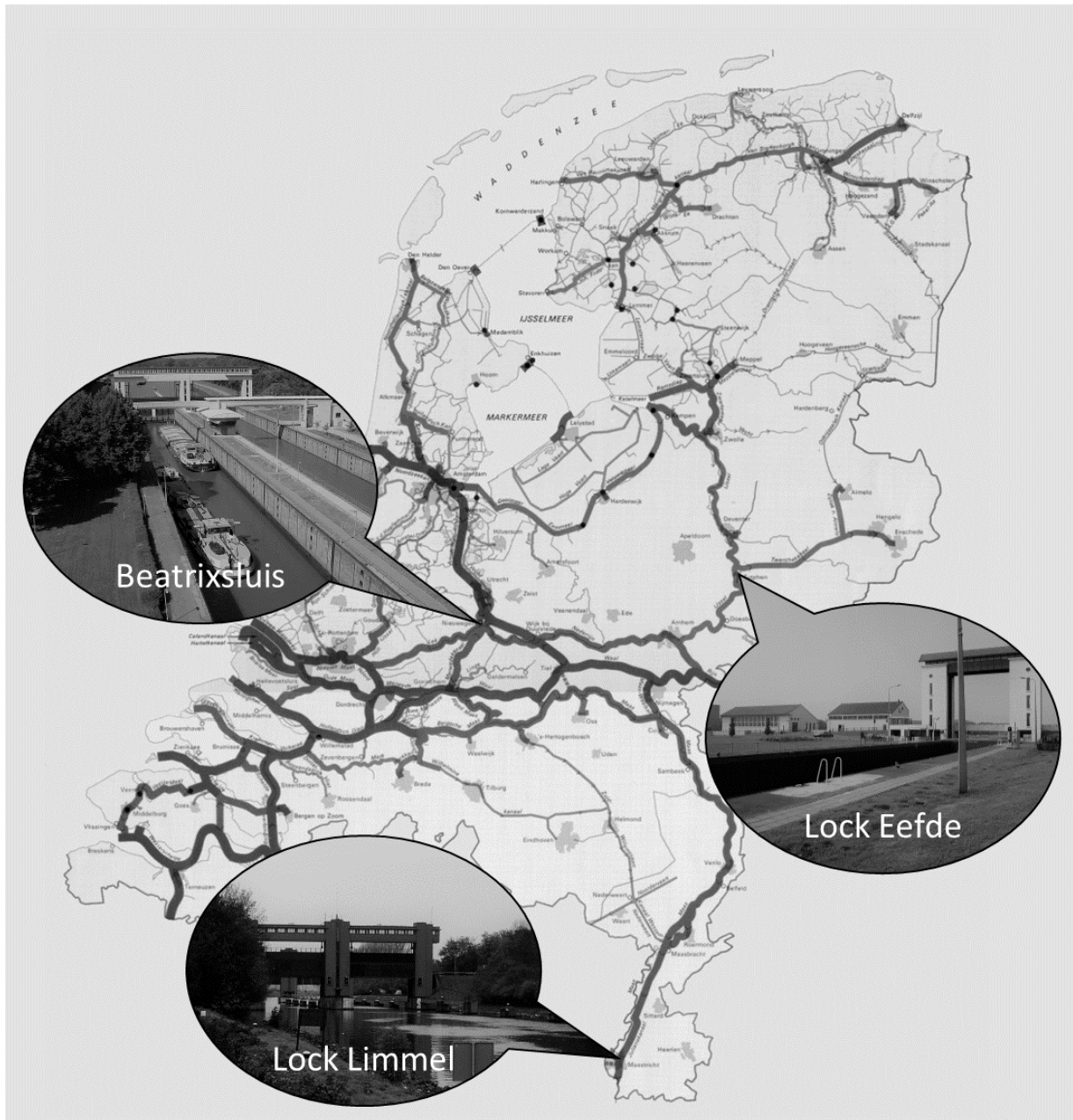


Figure 10: Overview of the selected cases and their location in the Netherlands²

5.1 Lock Limmel

The old lock was constructed in the period between 1930 and 1935. The lock is the connection between the Julianakanaal and the Meuse. The lock chambers were 136 by 16 meters. The lock would only function if the discharge of water in the Meuse would rise above 1300 m³/s. This

² Adapted from: <http://avn.geo.uu.nl/12infrastructuur/31/31.jpg> and <https://beeldbank.rws.nl>

ensures that the water level in the Julianakanaal would not be too high (Rijkswaterstaat, 2009). However due to the increase in the size of inland vessels, the lock isn't large enough to encompass this grow and thus a new lock is needed (Rijkswaterstaat, 2015a; Wansink, 2015).

The new lock is constructed in a different way than the old lock. The old lock consisted of two lock chambers, where the new lock only consists of a single steel liftgate. Due to this new design, the lock can fit inland vessels with a length of maximal 190 meters a width of 11.4 meters and a depth of 3.5 meters. The liftgate will only close if the water discharge in the Meuse rises above 1300 m³/s, just like the old lock. (Rijkswaterstaat, 2015a; Wansink, 2015). The contractor of this new lock is a combination of the Belgium construction company Besix and Rebel, a Dutch investment and advisement company. The construction started in mid-2015 and was completed in May 2018 with a total budget of 60 million euros (Rijkswaterstaat, 2015a).

The uniqueness of this project is that this is the first so-called wet DBFM project, which means that this project is the first hydraulic project in the world which is constructed via a public-private partnership. The difference between the dry projects like a road and the wet projects like this flood gate lays in the functional specifications. The functional specification of a road is mainly the passing of the traffic, however, the functional specifications of a lock are defending against floods, passaging of ships, flushing of water, maintaining the separation of water level and the separation of salt and fresh water (Vonck, 2014).

5.2 Second lock chamber Eefde

The lock at Eefde was constructed between 1930 and 1933 and it is located in the Twentekanaal, which forms the connection between the IJssel and cities like Almelo and Enschede. The lock consists of one chamber with a size of 133 long and 12 meters wide. The lock is the only connection between the IJssel and the Twentekanaal and uses liftgates to lock the ships. The lock, including the pumping station, is a national heritage site of the Netherlands. However, due to the increase in traffic over the water and that there is only one lock chamber, the waiting time for inland vessels rose over the last years to more than 30 minutes, which makes the travel times unreliable. Furthermore, due to the fact that there is only one lock chamber, the lock is vulnerable to malfunctions (Bierman Henket Architecten, 2012; Ministerie van Verkeer en Waterstaat, 2004; Rijkswaterstaat, 2017b).

To make the lock less vulnerable and to reduce the waiting time, a new lock chamber is being constructed. This chamber is suited for ships of 110 meters long, 11.4 meters wide and 3.5 meters deep. The chamber has two types of doors, a mitre gate on the side of the IJssel and a Tainter gate on the Twentekanaal side. The Tainter gate for this lock is the first Tainter gate applied in the Netherlands. An important aspect of this lock is that this lock is energy-neutral due to the incorporation of solar panels in the design. The new lock chamber is constructed by a Dutch Contractor TBI and started in 2017 and has a planned completion date in the summer of 2020. The total costs for this chamber are scheduled to be 80 million euros (Koenen, 2017b; Ministerie van Verkeer en Waterstaat, 2004; Rijkswaterstaat, 2017b).

The uniqueness of this project lays in the combination of different factors. The combination of the Tainter gate, the energy neutrality of the lock and the use of the DBFM contract make this project unique. The Tainter gate is for the first time in the Netherlands used in a lift-lock but was already used as a flood gate. There are more energy neutral locks in the Netherlands, as the lock in Stavoren (Croonwolter&dros, n.d.). There are also more locks that have a DBFM contract, like the other cases in this research. However, there is only one lock that has the combination of the three aspects, which makes the second lock chamber at Eefde unique.

5.3 Third lock chamber Beatrixsluis

The current lock of the Beatrixsluis is built around the year 1939 and is located in the Lekkanaal, which connects the Lek and the Amsterdam-Rhine channel. This route is the main connection between the ports of Rotterdam and Amsterdam. The old lock consists of two lock chambers, each with a length of 225 meters and a width of 18 meters (Rijkswaterstaat, 2019b). A unique aspect of this lock is that it is the largest monumental inland shipping lock in the Netherlands (Koenen, 2016a). However, this lock doesn't satisfy anymore, due to the low capacity of the lock and the relatively small lock chambers. The expectation is that the average waiting time of inland vessels will increase to more than 30 minutes, which is the limit on this kind of infrastructure (Rijkswaterstaat, 2014).

To increase the capacity there has been chosen to construct a 3rd chamber. This chamber is 276 meters long and 25 meters wide and has four rolling doors, two on each side. The advantage of the four rolling doors is that if one of the doors fails, there is always immediately a back-up door available. Furthermore, if only the outer doors are used the length of the chamber becomes 300 meters, which enables two ships of 135 meters long to be locked at the same time. Besides the construction of the third lock, the former dwellings of the lockkeepers are being transformed into the lock operation centre and the Lekkanaal is being widened. The new chamber, including the extra activities, is constructed by the combination Sas van Vreeswijk, which consists of Besix, Rebel, TDP, Heijmans and Jan de Nul. The construction started in 2016 and it is planned that the construction and the restoration of the other two chambers are finished in 2019. The net present value for this contract is 133 million euros (de Leeuw, 2018; Koenen, 2016a; Rijkswaterstaat, 2014, 2015b)

The uniqueness of this project is that this project is the only project where the already existing lock is part of the scope of the DBFM contract. This entails that first the third lock chamber is constructed, after that the already existing two lock chambers are renovated and subsequently the maintenance period, which is in this contract 30 years, is both for the newly constructed chamber as well as the already existing chambers. When the lock is handed over, all the three chambers must satisfy the same performance regime and the same availability requirements. Another unique aspect is that this project is situated next to the Hollandse Waterlinie, whereby bunkers of the former defence system of the Netherlands needed to be replaced. During the preparation of this project, the Hollandse Waterlinie was about to become nominated for the UNESCO World Heritage, which caused that the bunkers needed to be replaced correctly since otherwise, it would be a too large infringement in the system and thereby there was a risk that it would not be nominated anymore.

6 Case-specific results

This chapter describes the scores that the respondents from the cases have given and the views the respondents showed during the interviews. The first project discussed is the new flood gate at Limmel, after which the second lock chamber at Eefde is presented and subsequently the third lock chamber at the Beatrixsluis is described. The projects are all described in the same manner, where first the risk allocation process is described, after which judgement of the final risk allocation is shown. This chapter ends with an overview of the similarities between the projects and the lessons that can be learned from these projects.

6.1 Flood gate Limmel

This section describes the risk allocation process and the judgement of the respondents of the construction of the flood gate at Limmel.

6.1.1 Risk allocation process

Since this project was the first ever hydraulic DBFM project, the contract needed to be adjusted to fit the project. One of the most eye-catching differences between a dry and a wet DBFM contract is the performance regime and, connected with that, the determination of the availability payments. On a road it can easily be seen whether it is available; if there is a red cross above a lane it is unavailable. Therefore, the availability of the road is a quantitative function. However, at a lock, and especially a flood gate, it is a qualitative function and therefore less convenient to measure. Therefore, the availability payments are based on the defence against floods, for which the test closures are used, and the passing of ships.

Respondents (#1, 2, 4 and 5) indicated that the changes they made to fit the contract for a hydraulic project were mainly in the different specifications that are part of the appendices of the standardized agreement, like the demand specification, the output specification and the management specification. The respondents (#1, 3, 4 and 5) stated that in the actual risk allocation as is stated in events of the standardized DBFM agreement, was adopted from the dry projects and only small changes took place.

6.1.2 Judgement of final risk allocation

The respondents, in this case, posed a different view, where the contractor indicates that too many risks are allocated to them, indicate the respondents from the client that they were content with the risk allocation. The respondents from the client side (#1 and 2) indicated that in this project the risks are correctly allocated and that they had a positive feeling of this project. The respondents from the contractor side (#3, 4 and 5) indicated that even though they were content, they still had the feeling too many risks were allocated to the contractor. The scores on these statements can be found in Figure 11, the scores are based on two respondents from the client side and three from the contractor side.

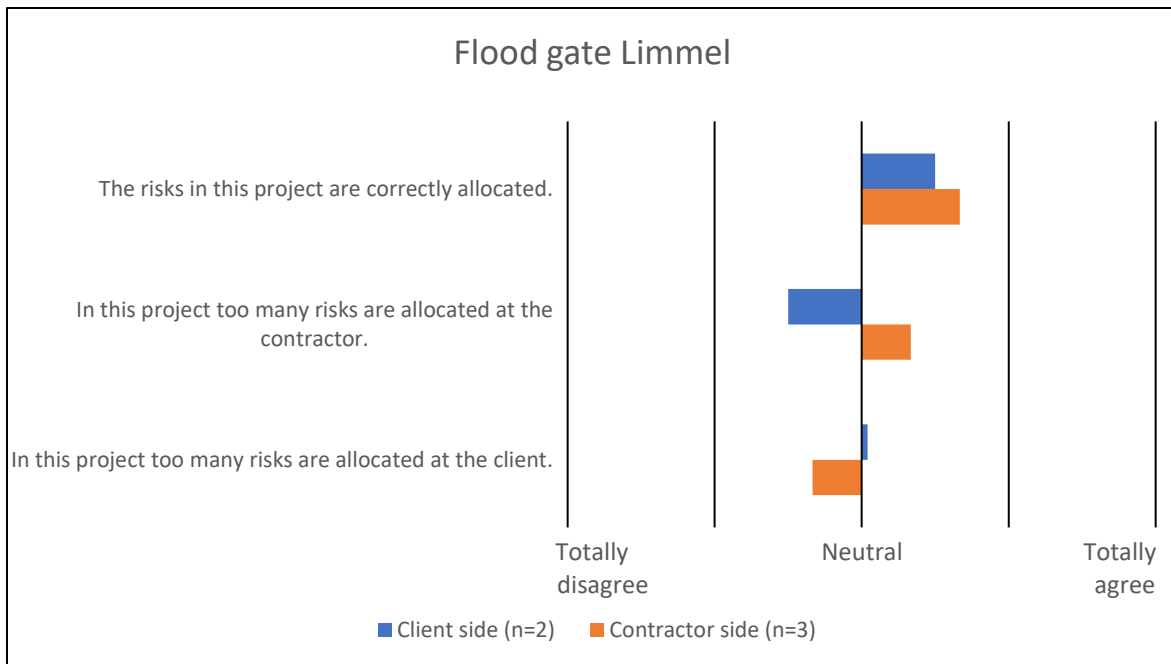


Figure 11: Scores of the respondents regarding the flood gate Limmel (own image)

The respondents from the contractor side (#3, 4 and 5) indicated that in general, they were content with the risk allocation, whereby they indicated that there was a good risk profile in this case. There are two aspects that play a role in this statement, namely that it was the first hydraulic DBFM project and that relatively it is a small project. Due to that, it was the first hydraulic DBFM project, the respondents from the contractor side indicated that there was a lot of room for discussion about the hydraulic aspects of this project and the payment mechanism, in which they joined together with Rijkswaterstaat to determine the risk allocation. The other aspect, that it was a relatively small project, influenced the risks that are associated with the project since this project was relatively small and the risks in this project were controllable.

However, the respondents from the contractor side (#3, 4 and 5) also indicated some exceptions to the general view. These exceptions are not merely concerning this case but are more related to the specific characteristics of DBFM contracts and the relation with other contract types. The aspects are related to acreage data and soil conditions. These risks are in the DBFM contract allocated to the contractor, whereby the respondents of the contractor side indicated that they would rather see those risks allocated to the client.

The respondents from the client side indicated that they were quite content with the risk allocation in this project. However, the respondents both indicated that since the project is part of the flood defence system of the Netherlands, there is always a certain residual risk for Rijkswaterstaat. This residual risk wasn't always in line with the risks and risk perception of the contractor and therefore there have been some contractual changes, that reallocated some risks to the client. But in general, the respondents were satisfied regarding the risk allocation.

In this project, respondents (#2, 4 and 5) indicated that there was a good collaboration between the client and the contractor and that this influenced the risk allocation. For example, the plan was to do a part of the demolishing during the night, in the first instance, this increased the downtime, however since it was during the night, there would be more availability of the lock system. Nevertheless, it was more unsafe to do the work in the night and thus in collaboration between the client and the contractor, it is decided to do the work during the day. Contract wise this would include a penalty for the contractor, but in the collaboration and since the client agreed that safety was more important, it was decided to skip the penalty.

6.2 Second lock chamber Eefde

This section describes the risk allocation process and the judgement of the respondents of the construction of the second lock chamber at Eefde.

6.2.1 Risk allocation process

Since this project was the fourth project of the Sluizenprogramma, after Limmel, IJmuiden and the Beatrixsluis, the standardized contract was already developed and made fit for purpose for the lock. Thereby, according to the respondents from the client side (#6, 7 and 9), the risk allocation of the standardized contract was the starting point. However, in order to determine the risks that were specific for this project, there have been risk sessions with the different disciplines of the IPM model, which are project management, contract management, stakeholder management, technical management and project control. From these sessions, the project-specific risks have been determined.

During the tender, there was a competitive dialogue, as it is described in Chapter 3.3.7. Before the dialogue, a setup of the risk allocation was made by Rijkswaterstaat. The starting point was that all the risks were allocated to the market, unless the risk was uninsurable by the contractor or if the contractor indicated that he could not manage the risks. However, the respondents from the client side (#6 and 7) indicated that during the dialogue the contractors were merely focused on what would score on the focus points of Rijkswaterstaat. Since the contractors provide the agenda for the meetings during the dialogue, the client indicated that there was the possibility to discuss the risk allocation, and there had been some discussion and some risks are taken back, but this changed only a little in the risk allocation.

6.2.2 Judgement of final risk allocation

The general view of the respondents on this project is diverse. From the client side, they indicate that it may be the case that the contractor is carrying many risks, but not too many. Since if it were too many risks, the contractor should not have signed the contract. From the contractor perspective, they state that too many risks are allocated to them. The scores on the statements can be found in Figure 12, whereby the scores are filled in by two respondents from the client side and four from the contractor side. Three other respondents from the client side were interviewed, however, they were reluctant to fill in the score since in their view the statements were too black-and-white. However, they did provide their view on the statements in the interview. Thereby they indicated that they were content with the risk allocation and that the contractors had many opportunities to withdraw from the procurement and only one to hand in their offer.

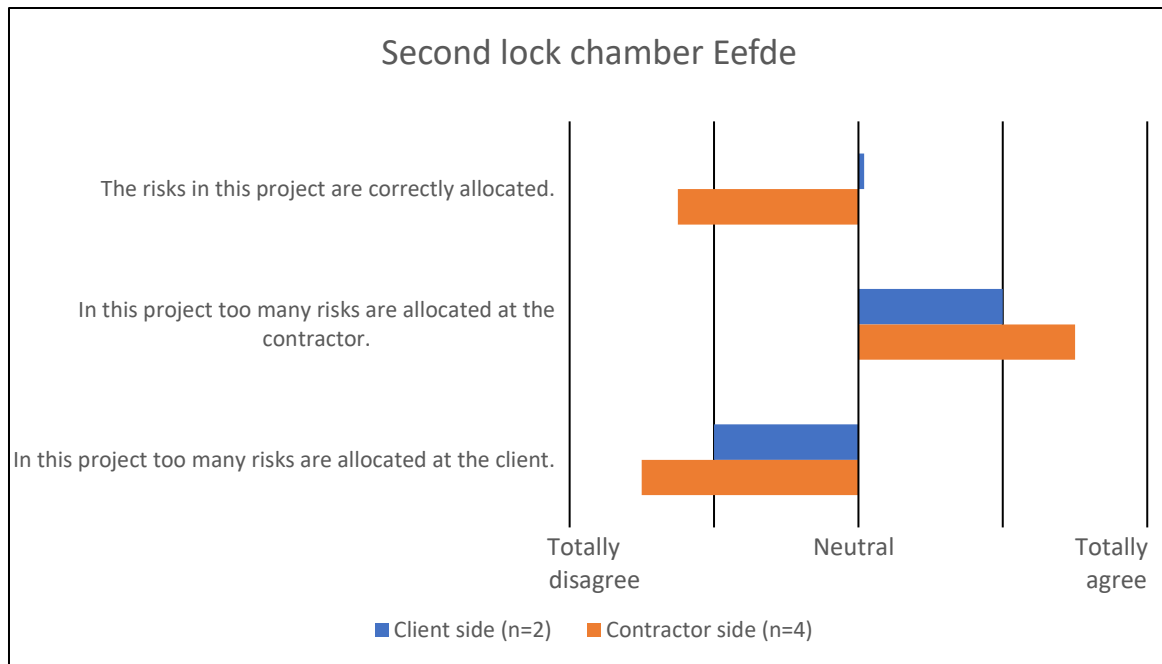


Figure 12: Scores of the respondents regarding the second lock chamber at Eefde (own image)

The respondents from the contractor side indicated that in this project too many risks were allocated to the client. An example of these risks is what happened after the summer of 2018. The summer of 2018 was one of the driest summers in the Netherlands. In order to reduce the salinization, Rijkswaterstaat chose to lower the water level in the IJssel. Due to that decision, the supply of goods via the water of the contractor was influenced. Where normally the ships would only have to sail only once, now the ships needed to sail thrice. The respondents from the contractor side (#11, 12 and 14) indicated that they could not see this risk coming nor they were able to influence the risk. Thus, they conclude that this risk couldn't be allocated to them. Another example is that the contractor is responsible for the soil conditions up to 20 meters deep. However, the soil is part of the area of Rijkswaterstaat, whereby the respondents from the contractor side (#11, 12, 13 and 14) stated that it was the ground of Rijkswaterstaat so they should know what is in there. However, this risk had been allocated to the contractor and there were some troubles with unforeseen objects in the ground. In general, the contractor stated that there were risks, of which they were responsible, but that was out of their influence.

The respondents from the client side (#6, 7, 8) indicated that they were content with the risk allocation in this project. They indicated that they went through the dialogue phase, which took over a year, and in that dialogue, they had the starting point that every risk would be allocated to the market, unless the risk was not insurable or if the market indicated that they were not able to carry the risk. These two factors were taken into account in the dialogue and led eventually to the final risk allocation. Based on that risk allocation the contractors made an offer and thereby they accepted the risk allocation. So, they stated that in their view the risks were correctly allocated.

Even though the risk allocation is black-and-white in DBFM contracts, whereby every risk is allocated to the client unless stated otherwise, the respondents from both the client and the contractor side indicated that the reality was different (#8, 9, 10, 11, 13 and 14). From the start of the project, the focus of the contractor was to have a good relationship between the client and the contractor. They focused on the shared goal, namely the construction of the lock. Thereby was the practice of the risk allocation not as black-and-white as in the contract, but the issues that came up were handled together. They also had a shared office once a week, whereby the contractor and the client were together in one office. The respondents indicated that this helped the cooperation and had a major influence on project success.

6.3 Third lock chamber Beatrixsluis

This section describes the risk allocation process and the judgement of the respondents of the construction of the third lock chamber at the Beatrixsluis.

6.3.1 Risk allocation process

The process of the risk allocation in this project was according to the model agreement. It is stated by respondents (#4, 16, 18, 19 and 20) that the process was quite standard. Rijkswaterstaat started with an estimation of the costs of the project. Subsequently, they conducted a risk analysis, whereby all the risks that were identified by Rijkswaterstaat were the input for the risk file. The risks from the risk file were allocated to either the client or the contractor, which came about in a severe procedure from Rijkswaterstaat. From every risk that was identified, Rijkswaterstaat analysed which party was better able to control the risk. So far, the risk allocation process was quite standard.

However, since this project is not solely about the construction of a new lock chamber, but also incorporates the renovation of the existing lock chambers, there was an unknown component for Rijkswaterstaat. Since the condition of the existing lock chambers could not be determined, Rijkswaterstaat initiated a dialogue with the bidding consortia in order to find out what they thought of it, how they would handle it and what risks they indicated. The input the consortia provided was used in the risk allocation and eventually also found its way into the contract. Respondents (#4 and 20) indicated that they liked the openness and the attitude of Rijkswaterstaat and this improved the risk allocation.

6.3.2 Judgement of final risk allocation

The scores of this project show that the contractor has a different view of the risk allocation than the client has. Where the respondents from the contractor (#4, 19 and 20) clearly indicate that too many risks were allocated to them, are the respondents from the client side more diverse in their answers. Two of the respondents (#16 and 17) were satisfied with the risk allocation and two respondents (#15 and 18) agreed to the statement that too many risks were allocated to the contractor. The scores can be found in Figure 13, the scores are based on four respondents from the client side and three from the contractor side. In the following paragraphs, the views of the will be elaborated on.

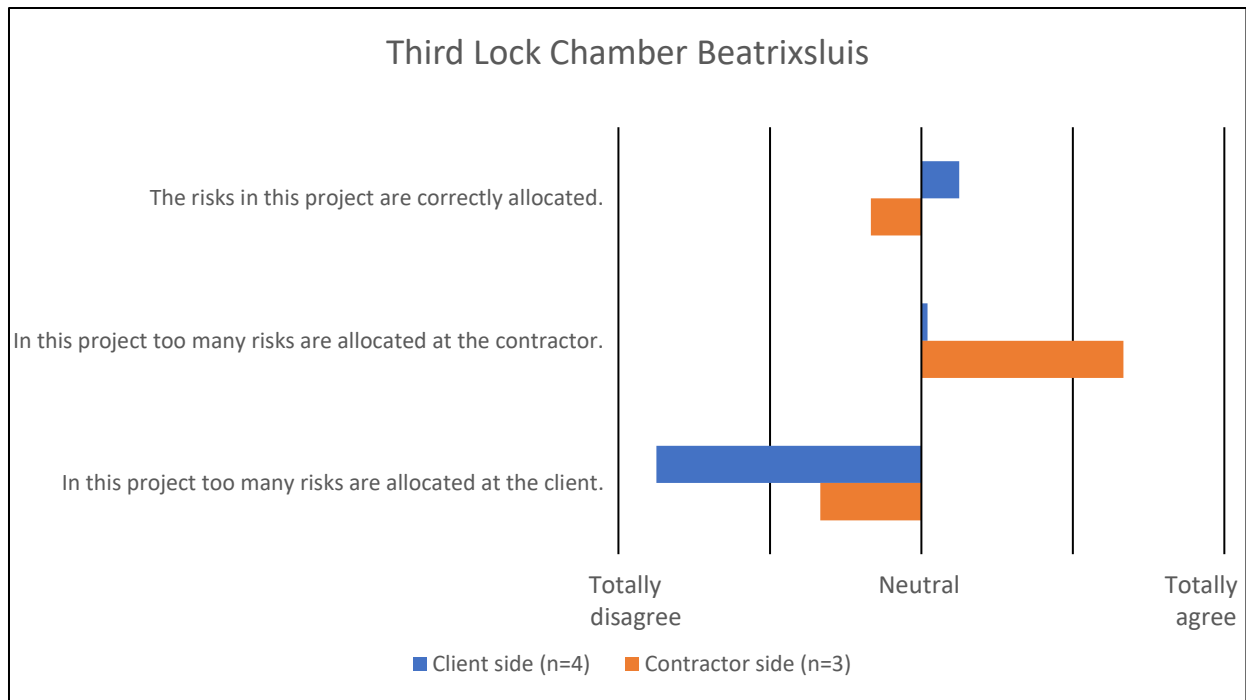


Figure 13: Scores of the respondents regarding the third lock chamber of the Beatrixsluis (own image)

There are different views regarding the risk allocation from the client’s perspective. Two respondents (#16 and 17) showed that they were content with the risk allocation, whereby it is stated that in practice there are no large issues in the risk allocation and that the issues that came up were handled correctly. One respondent (#16) indicated that this project was seen as an example project for other projects. Thereby the respondent indicated that the risk allocation played a role in the success of the project. However, two other respondents (#15 and 18) from the client side indicated that too many risks were allocated to the contractor. Risks that are named to be allocated to the contractor, while they should have been allocated to the client, are regarding the acreage data.

From the contractor side (#4 and 19) there have been some remarks about the acreage and the documents about it provided by Rijkswaterstaat. Based on the documents provided by Rijkswaterstaat in the tender, the contractor made an offer. In the realization phase, it was showed that the documents did not match what was happening in reality. This risk is contractually allocated to the contractor since they accept the existing lock as it is after the zero measurement. However, the zero measurement and the documents provided cannot provide the full picture. Therefore, the compensation of the contractor is at the mercy of the client. The risk of the acreage data wasn’t up to date is one of the risks that is allocated to the contractor of which the respondents (#4 and 19) state that this actually should be allocated to the client.

6.4 Lessons learned

The general view of the respondents from the contractor side is that too many risks are allocated to the contractor, whereby the respondents from the client side are more neutral regarding the statement that too many risks are allocated to the contractor. Nevertheless, there are some factors that are both named by multiple projects as well as they are named by respondents from the contractor and the client side. These factors are the ongoing process of risk allocation, the collaboration between the client and the contractor that influenced the risk allocation, the added value of the Sluizenprogramma, the extra focus on risk during the dialogue and the acreage data that wasn’t up to date. All these factors will be elaborated on in the next sections.

6.4.1 Ongoing process

In Section 3.3.8, it is explained that the risk allocation is very clear, either a certain risk is named in the agreement and thereby it is a shared risk or a client risk, or it is not named in the agreement and thus it is a risk for the contractor. It is said that this risk allocation is very black-and-white in contractual terms. However, when it comes to practice, there is more than meets the eye. In practice, the risk allocation is not set in stone after the contract closes. Respondents (#1, 2, 4, 6, 7, 10, 11, 13, 17, 18 and 20) indicated that the risk allocation is an ongoing process, that doesn't end at the contract close. During the execution of the project, there might be things that are unclearly specified, or that if the client doesn't want to accept a certain residual risk, a risk can be taken back by the client by means of a contract change. The main risk allocation is determined in the contract, but there are adjustments possible in the execution.

6.4.2 Collaboration

One of the factors influencing the risk allocation in the execution of the three cases is the collaboration between the client and the contractor. In all the three projects respondents (#1, 2, 4, 5, 6, 7, 9, 10, 11, 13, 14, 18 and 20) indicated that they were satisfied with the collaboration. The team members in the three projects focussed on the construction of the lock and if there were any problems, they tried to find the best solution for the project, instead of looking at the contract and focussing on who needs to do what and who should pay what amount.

Another example that was given by Eefde is the shared office they had, which means that once a week the client and the contractor were both in the site office of the contractor. During the meetings they had together, they indicated what was coming in the next period and who they want to discuss it with. The issue was discussed, and everyone was informed about the outcome. This provides a shared feeling of responsibility, where the focus is on finding the best solution for the project instead of who was to pay what.

A third point that was indicated is that the contractors involved in the three projects didn't focus on the exact juridical explanations and interventions of the contract. They saw the contract merely as a starting point and only if they couldn't agree, they would look in the contract what contract wise would be the solution.

To conclude the collaboration between the client and the contractor, some respondents (# 1, 2, 4, 5, 10, 11, 14 and 18) stated that the good collaboration between the client and the contractor was of major influence for the success of the three projects.

6.4.3 Sluizenprogramma

Since the three projects in this research are part of the Sluizenprogramma, the respondents are also asked about their view of the added value of the programme and if this should be applied more. It must be stated that the programme is actually a clustering of multiple projects, which explicitly learn from each other. Multiple respondents (#1, 2, 6, 10, 13, 15 and 17) indicated that they saw the added value of the programme, mainly aiming at the learning component. The respondents indicated that the learning effect took place on multiple aspects, like the contract, technical issues, experiences of people and risks. This learning effect ensures that the wheel isn't reinvented at the projects. Especially respondents from the client side (#1, 2, 6, 10, 15 and 17) indicated that they would like to have this way of working on more project, such as a tunnel programme or a road programme. Thereby it must be noted that it is logical that this is mainly indicated by respondents from the client side since the programme is a Rijkswaterstaat programme, whereby the learning component is mainly for the persons on the client side. Related to the risk allocation in these projects, the respondents (#1, 2, 6 and 17) indicated that in the first place this didn't change the risk allocation in the contract, but it did change the way they handled the risks. Examples of these risk are the way they handled the acreage data, the soil conditions, and the objects in the soil.

6.4.4 Focus on risk during dialogue

Another aspect that is named by multiple respondents (#1, 2, 6, 7, 10, 14, 16, 17 and 20) is that there could be a more open conversation about the risks of the project during the dialogue. During the dialogue, the agenda is set by the contractors. Their focus is sometimes too much on getting a legally correct bid and to see how they can increase their score on the EMAT criteria. In that case, they are focussing on what the client thinks of their solution. If this is the case, the focus is thus not on the associated risks, while this is something that the client is willing to talk about. Respondents (#1, 2, 6, 7 and 16) from the client side indicated that in the first instance all the risks will be allocated to the contractors, however, if a risk is uninsurable or if the contractor indicates that he isn't able to bear a certain risk, the risk is taken back.

In this dialogue, there are two aspects that play a role, namely that the contractor should not only be focussing on what the client thinks is a good solution, but also discuss the risks openly and indicate which risks he is able to bear and which risk he isn't. But on the other hand, the client should be willing to have the conversation about the risks and should be open to take back risks if the contractor isn't able to bear them.

6.4.5 Acreage data

The last aspect that comes forward in the three cases is the acreage data that wasn't up-to-date or conforming reality. This was especially relevant on the Beatrixsluis since there the maintenance of the existing lock chambers is added to the maintenance of the new lock chamber. Rijkswaterstaat is stating that the acreage data is actual, trustworthy and complete, however, in the cases, it is shown that certain aspects were not in the data provided by Rijkswaterstaat. For example, at Eefde, a part of the chain links of the old lock were replaced every quarter year, however, this was not indicated in the monitoring or performance documents of the old lock. Another example is at the Beatrixsluis, where the state of the old lock was worse than was stated in the documents provided by Rijkswaterstaat.

So in short, there are four aspects that could be learned from these three projects, namely the influence of a good collaboration on the risk allocation, the added value of the Sluizenprogramma, a better risk allocation if there is more focus on risks during the dialogue and that in these cases the acreage data wasn't up to date.

7 Generic results

This chapter provides an overview of the views of the respondents about the risk allocation in DBFM projects, not specifically regarding the case but more generic. Subsequently, the opportunity of sharing risks between the contractor and the client is discussed. Next, the positive and negative aspects of DBFM contracts that are named by the respondents are expressed. Lastly, the view of the respondents on the principles of risk allocation as they are stated in Chapter 4.1.1 are described.

7.1 Risk allocation in DBFM projects

All the respondents were not only asked to score a set of statements about their specific project but also on a set of general statements regarding the risk allocation in DBFM projects. The scores can be found in Figure 14, these scores are based on 8 respondents of the client side and 9 respondents from the contractor side. On each of these statements, including the score, will be elaborated on in the next sections.

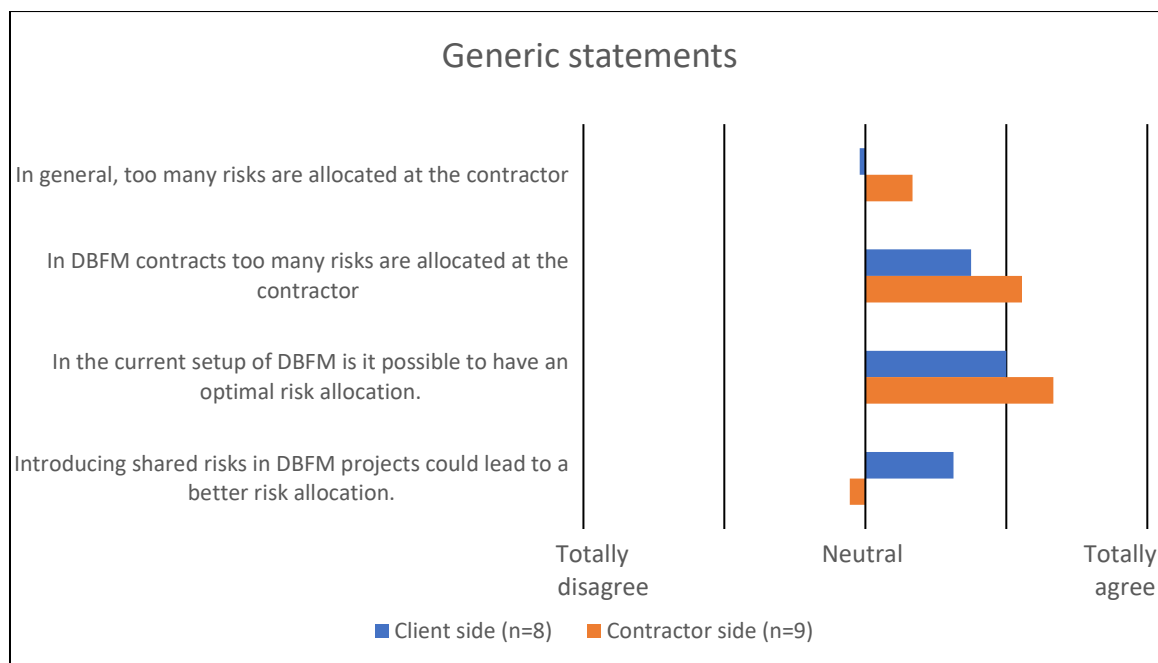


Figure 14: Scores of the respondents on statements regarding the general risk allocation in DBFM projects (own image)

7.1.1 Risk allocation in general

The first statement they scored was the statement that in general, which means over all the different contracts, too many risks are allocated to the contractor. The scores of this statement indicate that the respondents were neutral regarding this statement. In interviews, it is stated that it might be the case several years ago, but in the current market that was not the case. Some respondents indicated that because of the Marktvisie the risk allocation, in general, has been shifting to fewer risks for the contractor and more to the client. It is also indicated that due to the risks that have fired in other projects over the last 5 to 10 years, the contractors are currently more experienced and have a better insight in which risk they are accepting and which not.

7.1.2 Risk allocation in DBFM contracts

Where the previous statement was about all the different contracts, the respondents were also asked to score the statement specifically for the DBFM contract. Hereby it is interesting to see that the general view of respondents on the client side and the contractor side is that in DBFM contracts too many risks are allocated at the contractor. A general remark hereby, that was made

by multiple respondents (#3, 14 and 19), is that the data provided by Rijkswaterstaat regarding the subsurface or the condition of the existing area was not according to the actual condition. In the three projects, it became clear that in practice there was more maintenance required and executed than as it was stated in the documents provided at the tender. This risk is according to the contract allocated to the contractor, however, the respondents (#3, 4, 14 and 19) from the contractor side posed the question how is it possible that the contractor is responsible for something that is one of the core businesses of Rijkswaterstaat? They operate the existing area and they are responsible for that, so how can the contractor become legally responsible for the bad documentation of Rijkswaterstaat.

Another statement (#3, 14 and 19) is that the contractor is required for every requirement that isn't SMART (Specific, Measurable, Achievable, Realistic and Time-bound) should be made SMART in consultation with the stakeholders of the project. However, it is stated that this creates a blank cheque for the stakeholders to fulfil their wishes, even if their wishes were declined during the tender. This is a risk for the contractor, whereby they are stating that they are willing to fulfil some wishes without increasing the budget, but it provides a huge risk for the contractors if they want to fulfil all the wishes.

The respondents from the client side (# 6, 7, 16 and 17) indicate that first there was a wish of the market parties to have more responsibilities and thereby more risks. Rijkswaterstaat facilitated this wish by implementing the DBFM contract. However, the respondents from the client side also indicated that they might have allocated too many risks in previous DBFM contracts and that they learned from that. Currently, they are pointing at the tendency to have a good cooperation with the market and that during the development of the DBFM contract the risk distribution became more equal between the client and the contractor. Another remark on this aspect is that it might be the case that the contractors didn't realise that in DBFM contracts there is a different risk allocation than in the UAC-IC. This is also endorsed by a respondent from a contractor (#12) that for example, the risk of low water at Eefde is a risk that in a Design & Construct is allocated to the client and in DBFM is allocated to the contractor. Thereby it must be noted that the market conditions have changed over the last years. During the financial crisis and during the aftermath of it there was a limited margin on construction projects and contractors were more keen to accept a risk allocation that was in their disadvantages, mainly due to the need to obtain a certain project (Rijkswaterstaat, 2019a; Zwet, 2010). Another aspect that is related is that during the transition from traditional contracts to integrated contracts the contractors didn't adapt their bidding method enough to accommodate the changed risk allocation, whereby more risks are allocated to the contractor (Rijkswaterstaat, 2019a).

7.1.3 Case versus generic

If one compares the scores of the respondents from the client side, it is interesting to see that there is a difference between how they score their own project and how they score the general statement. This is visualised in Figure 15. The general opinion among respondents from the client side is that in their project there are not too many risks allocated to the contractor, whereby in general they state this is the case. In the discussion of this research, which can be found in Chapter 9, this result is more elaborated on.

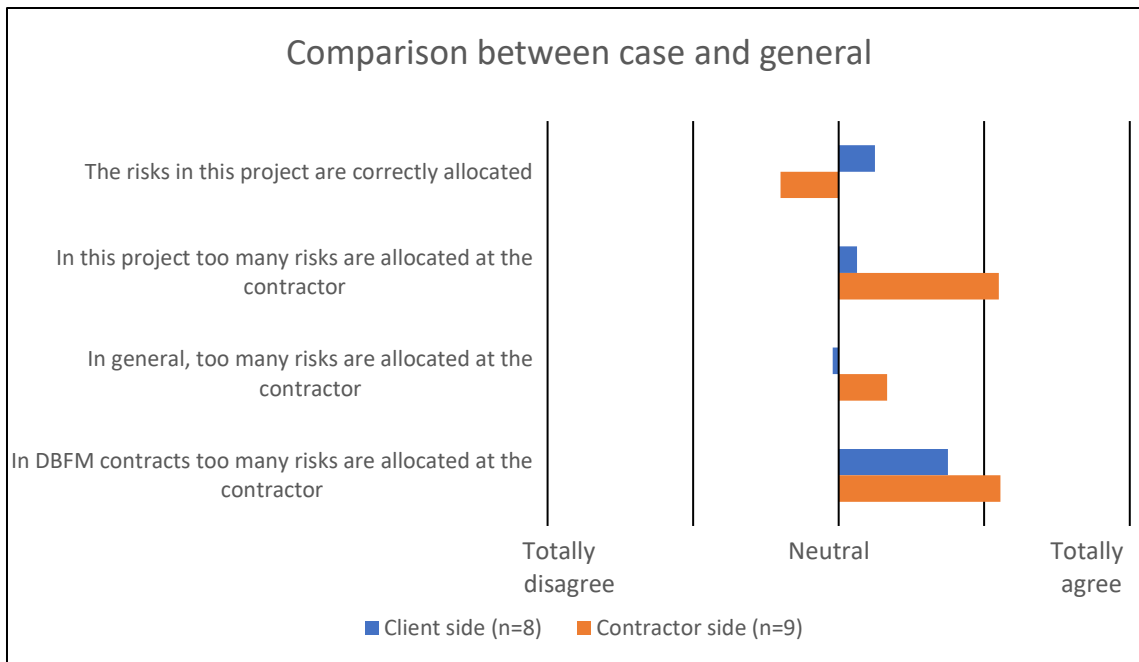


Figure 15: Comparison between scores about project and in general (own image)

7.1.4 Optimal risk allocation

The general opinion of the respondents is that in the current set-up of the DBFM contract it is possible to have the optimal risk allocation and therefore the dissatisfaction is mainly due to the current risk allocation and the process of the risk allocation and not focused on the DBFM itself.

7.1.5 Risk sharing

The last statement is about sharing risk in a DBFM contract. On this statement, there are many different opinions and therefore the average of the combined perspective of the client and the contractor is a 3, whereby it must be noted that the respondents from the contractor side are more positive than of the client side. Some respondents (#1, 2, 4, 9 and 17) indicated that a shared risk budget would be helpful to remain a certain degree of cooperation between the client and the contractor. These respondents stated that if a risk has a certain amount of uncertainty and if that risk needs effort from both the client and the contractor or if the right execution method cannot be determined that the two parties should make process agreements and if the risk fires the risk can be paid from a shared budget.

Another possibility that respondents indicated (#1, 16 and 17) to share a risk is the use of a risk limit. This limit states that up to a certain amount the contractor is liable, however above the limit the client has to pay the contractor. An example of how this can be implemented is that the contractor is liable for explosives in the ground. Based on historical data a certain number of explosives can be expected and that is for the account of the contractor, up to what reasonably could be expected. However, if there are more explosives than presumed, Rijkswaterstaat reimburses the contractor for the cleaning costs.

Of both these risks sharing mechanism it has been indicated that they might enhance the risk allocation in DBFM projects. It is stated that it enhances especially on complex situations the cooperation and increases the value of the project.

The respondents (#3, 10, 11, 12 and 15) who stated that they don't think that sharing risks leads to a better risk allocation is that when a shared risk fires there will always be a discussion. They indicate that the current black-white division of the risks, everything is for the contractor unless stated otherwise, is clear and could never lead to a discussion. If one introduces a shared risk, like

with the shared risk budget, one of the parties has to take control measures that have to be paid by both parties.

To conclude the mean score combined with the different opinions provided in the interviews, the introduction of shared risks is something that is not taken into account as a solution to improve the risk allocation in DBFM projects. However, this still might be an improvement to the risk allocation, but there is more research necessary to implement this in the current set up of DBFM.

7.2 DBFM in general

All the respondents have been asked what their general opinion was about DBFM contracts. The answers of the respondents focused on the two aspects of DBFM, namely the integration of the design, the execution and the maintenance into one contract and the financing part. These two aspects of the DBFM contract will be explained in the following sections.

Without any exception, all the respondents indicated that they liked the integration of the design, the execution and the maintenance. They named several positive aspects of it, namely:

- The self-cleaning ability;
- Optimizations in the design;
- Increased efficiency;
- Innovation;
- Long term relationship.

The self-cleaning ability is that if the contractor uses minimalistic materials, that barely match the standards, he will have to perform more maintenance during the maintenance period, which causes more downtime for the lock and thus the availability payments will be lowered. Therefore, there is an incentive for the contractor to use long lasting materials since it reduces the maintenance required.

The next aspect that is indicated by multiple respondents is the optimizations in the design. Since the contractor is responsible for the design as well as for the execution, he can use his expertise in building methods and what could work and what not in order to improve the design. This aspect is also involved in the increased efficiency since due to the fact that the contractor has to design and construct the work the construction of the project is more efficient. Thereby the contractor can choose when and where to invest in the maintenance phase, which increases the efficiency during the operating period of 25 to 30 years. The goals of the contractor are to have an optimal availability of the lock

An example to show the innovation that is implemented due to the integration of the design phase, the building phase and the maintenance phase is at the lock of Eefde. The contractor made the decision to not have to equal doors, but to have a mitre gate on one side and a Tainter gate on the other side. Due to this decision, there is less maintenance required and if maintenance is required it is easier to conduct. So even though the Tainter gate was more expensive, the reduced maintenance made it worth the investment. This innovation would not have been implemented if the maintenance was not included in the contract.

The last positive aspect that was indicated by the respondents is the long-term relationship. With this type of contracts, there is a relationship between the client, the contractor, the administrator, the operators and the surroundings. This relationship increases the cooperation in the project, which is helpful for the success of the project.

The respondents also made remarks about the incorporation of a financing component in the contract. Where the respondents were merely positive about the integration of the D, the B and

the M, the reactions to the F component are less positive. The following aspects were named by the respondents:

- Proactive attitude of the contractor;
- Reoccurring payments for the contractor;
- Relatively easy payment regime for the client;
- Expensive;
- Required advisors;
- No direct supervision of the banks;
- Difficulty in changing the milestones.

The first factor is a combination of the integration of the design, the execution and the maintenance and the incorporation of the banks. Respondents indicated that at, for example, a D&C contract it might happen that there is a discussion between the client and the contractor, and the contractor can say we stop with the execution until the client takes back a risk or pays an extra amount. Thereby these contracts are also described by respondents as hit and run contracts. However, in a DBFM contract, the contractors will continue to work on the project. The financial incentive to meet the milestone ensures that the contractor will keep on working, even though the project might be in trouble.

A positive aspect for the contractor is that they have reoccurring payments over the period of the contract, which could be up to 30 years. These payments provide a steady cash flow for the contractors, which makes them financially less volatile. Instead of just one payment after the project is executed, the contractors have a steady cash flow, provided that there is a high availability.

Respondents from the client side indicated that the payment regime at the DBFM contract is rather easy. At the locks of Eefde and the Beatrix lock, it is rather easy to see if the lock is available, since if ships are passing it is available. The payment regime is connected to the availability, whereby a certain penalty is applied if it is not available. Compared to a DBM contract, whereby the payments are made when a work package is finished or based on progress, it is relatively simple for Rijkswaterstaat to determine what the contractor should be paid.

Respondents did not only indicate positive aspects of the financing component, but also some downsides. One respondent indicated that it is an expensive way of building, whereby a lot of costs are made that aren't connected to the building of the project. These costs are connected to the financing, like the involvement of technical advisors and lawyers of the banks. These costs do not provide a better project and one can ask if, for a country like the Netherlands, where the government can loan money at low interest, the government should use the financing capacity of the private sector, which is inherently more expensive. It is also stated by respondents that with the financing component there is the involvement of all the different advisors, that have nothing to do with the construction of a project.

In theory, the influence of the banks was that they would be strict on the contractor and that they would improve the risk management of the contractors. Eventually, it would even be possible for the banks to replace the contractor by another one. However, the reality is different. The banks are at a distance and act only if there are severe problems with the project.

Another downside of the involvement of the banks is that the milestones of the projects are set in stone, as respondents indicated. If Rijkswaterstaat and the contractor agree for example that a project can be completed earlier than the planning and thereby they want to shift the handover of the availability certificate to an earlier date, the banks might still resist it, even if it is better for the

project. When the availability payments start earlier, it changes the risk profile of the bank and therefore they might not want to change it.

7.3 Principles of risk allocation

The principles that the scientific literature have indicated and those who have been selected for this research are scored by the respondents based on how they important they thought they were in order to have the optimal risk allocation in a DBFM project. The scores can be found in Figure 16.

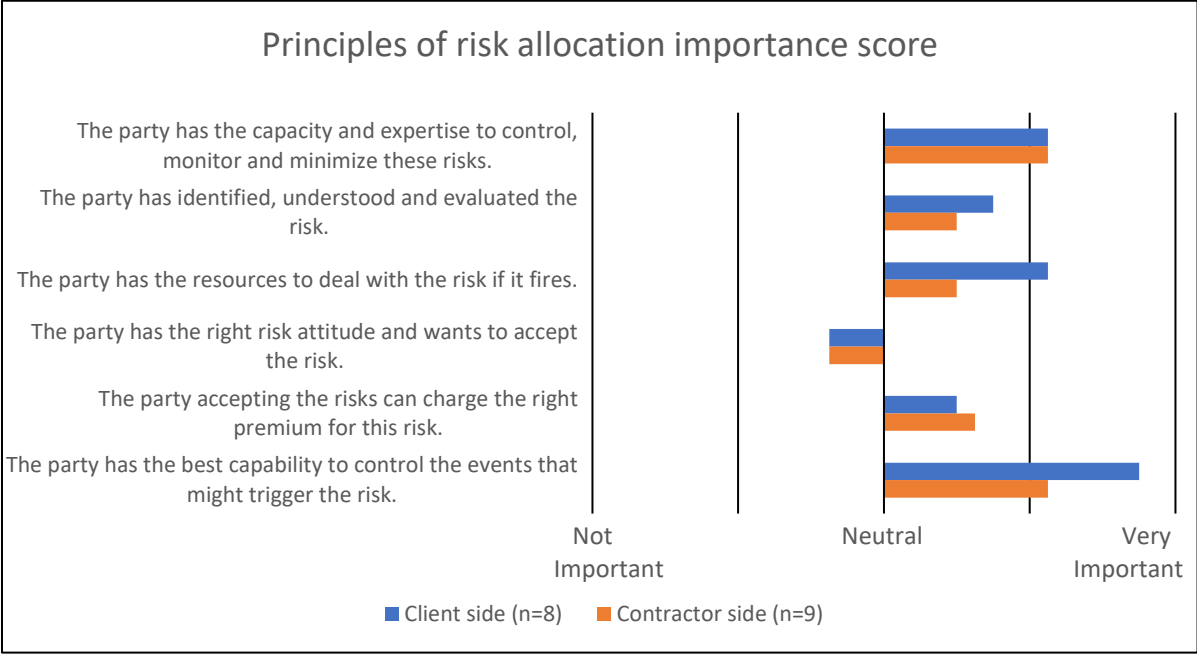


Figure 16: Importance score of principles from literature (own image)

The respondents of both the client and the contractor scored four principles more or less the same. The only two principles that have a different score over the two sides are the principles that the party has the resources to deal with the risk when it fires, which is more important for the client than for the contractor side, and the party accepting the risk can charge the right premium for this risk, which is more important for the contractor than for the client.

These scores show that the principles are not only important according to the literature, but also the respondents see the importance of the individual principles. Thereby the only principle of which is indicated that is not that important is the principle that the party has the right risk attitude and is willing to accept the risk. Of all the other principles it is stated that it is important for the risk allocation.

If one combines the scores of both the client and the contractor, the following can be made:

1. The party has the best capability to control the events that might trigger the risk.
2. The party has the capacity and expertise to control, monitor and minimize these risks.
3. The party has identified, understood and evaluated the risk.
4. The party has the resources to deal with the risk if it fires.
5. The party accepting the risk can charge the right premium for this risk.
6. The party has the right risk attitude and wants to accept the risk.

The respondents were not only asked to score each of the principles separately, but they were also asked to rank them from very important to not important in order to achieve the optimal risk allocation. This provided more insight in which principles are the most important according to

the respondents. The ranking is converted to a score by scoring the most important principle a 6 and the least important principle a 1 so that the principle with the highest score is the most important one according to the respondents. The scores shown in Figure 17 show the average score since the division between the respondents of the client and the contractor side was not one on one.

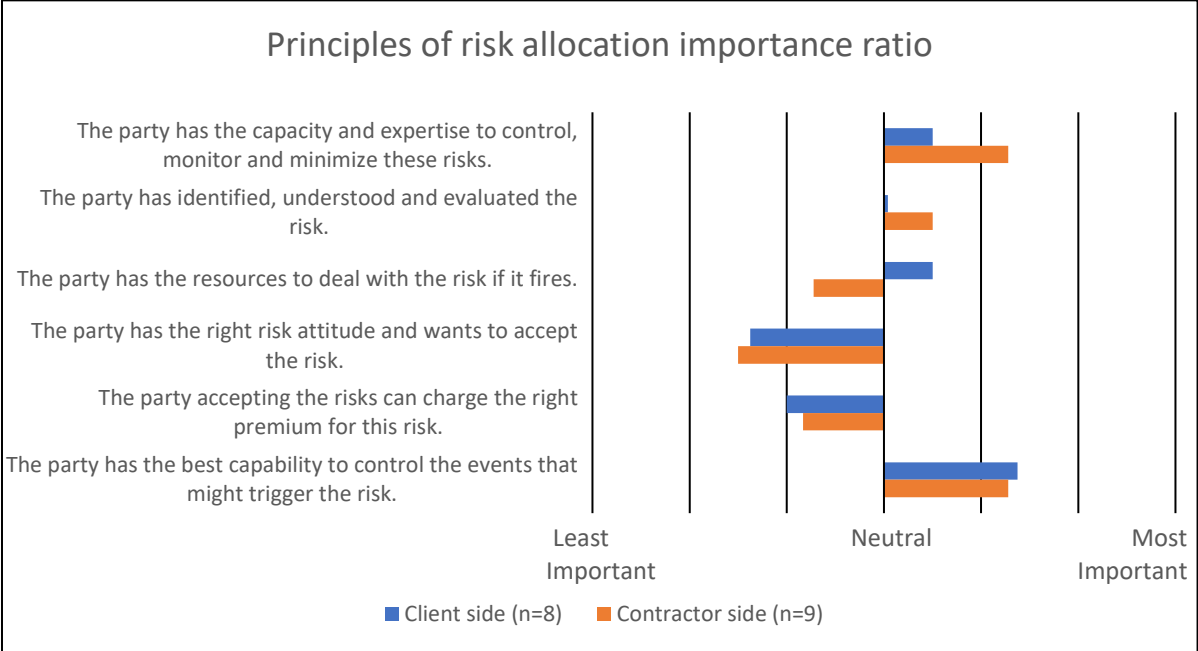


Figure 17: Importance of the principles ranked from least important to most important (own image)

If one compares the scores of the importance ratio and the individual scores, it becomes clear that the order of principles is in both cases equal. Thereby it can be concluded that the two most important principles are that the party has the capability to control the events that might trigger the risk and the party has the capacity and expertise to control, monitor and minimize the risk. The least important principles are the party has the right risk attitude and wants to accept the risk and the party accepting the risk can charge the right premium for this risk.

7.4 Conclusion

This chapter shows the view of the respondents about the risk allocation in DBFM projects, DBFM contracts in general and regarding the principles indicated in the literature review.

The general view, of both the client and the contractor, is that in DBFM projects too many risks are allocated to the contractor. Some respondents from the client side indicated that this has grown this way since there was a call from the market to give them more responsibilities and thereby more risks. The client provided that with the implementation of the DBFM contract. However, it is indicated that in the first DBFM contracts there might be too many risks allocated to the contractor and in later contracts, this is slightly adjusted. Another remark on this aspect is that contractors may not have realized that in DBFM contracts there is a different risk allocation than in D&C contracts.

The respondents were also asked about their view on DBFM contracts. The view was separated in a part focussing on the DBM and a part focussing on the financing. Regarding the integration of the design, the build and the maintenance the view was merely positive. Respondents named five positive aspects about it, namely the self-cleaning ability, whereby there is an incentive for the contractor to have a minimum level of quality, the optimizations in the design to increase the

maintainability, the increased efficiency, the innovation and the long-term relationship between the client and the contractor.

Regarding the financing the views were mixed. Positive aspects that were named are the proactive attitude of the contractors, the reoccurring payments for the contractor and thereby a constant cash flow over time and the relatively easy payment regime for the client. The negative aspects that are named are that it is expensive, it requires a lot of advisors, the direct supervision of the banks isn't in place in practice and the difficulty in changing the milestones of the project.

Sharing risks is a controversial issue among the respondents. Some respondents are very positive about it and think it would definitely improve the risk allocation in DBFM projects. However, some other respondents are very negative about it and think that it would only provide more room for discussion.

The respondents were also asked about their view on the principles as indicated in the literature study of this research and how important they thought these would be in the risk allocation. The scores the respondents provided indicate that 5 of these principles are important and one is less important. The following ranking can be made based upon the scores of the respondents:

1. The party has the best capability to control the events that might trigger the risk.
2. The party has the capacity and expertise to control, monitor and minimize these risks.
3. The party has identified, understood and evaluated the risk.
4. The party has the resources to deal with the risk if it fires.
5. The party accepting the risk can charge the right premium for this risk.
6. The party has the right risk attitude and wants to accept the risk.

8 Practical guidance

It can be concluded from the three cases subject of this research that the risk allocation is mainly determined by the different events as they are listed in the DBFM model agreement. Thereby the risk allocation is made project specific in the appendices, like the management specification and the demand specification. Eventually, the risk allocation is not set in stone after the contract close since there can be made contractual changes during the execution.

Since the formal risk allocation is mainly determined by the model agreement, this chapter doesn't focus on the "hard" risk allocation as it is stated in the contract but is focussing more on the "soft" risk allocation as how it is dealt with during the different phases of the contract. Thereby provides this chapter with practical guidance where to focus on during which phase of the project to enhance the risk allocation.

The chapter starts with the design principles, which is followed by the lessons learned from the cases. The lessons learned to start with how to implement a good collaboration, followed by the insights of other projects, subsequently, the open discussion on risks is discussed and lastly, a set-up for a suitable risk allocation regarding the acreage data is presented.

8.1 Design principles

The design principles that are according to the scientific literature of importance to the risk allocation, are according to the respondents of this research also seen as of importance for an optimal risk allocation. Thereby of only one of the six principles it is indicated that it is of minor importance, the other five are seen as important. The six design principles ranked on their order of importance according to the respondents are:

1. The party has the best capability to control the events that might trigger the risk.
2. The party has the capacity and expertise to control, monitor and minimize these risks.
3. The party has identified, understood and evaluated the risk.
4. The party has the resources to deal with the risk if it fires.
5. The party accepting the risk can charge the right premium for this risk.
6. The party has the right risk attitude and wants to accept the risk.

These design principles should be bored in mind with every professional involved in the risk allocation of DBFM projects. Based on these design principles, one can motivate why he is able to bear a risk or why he isn't able to. Thereby, when an unsuspected risk appears during the execution of a project, one can determine who should be responsible based on these principles.

8.2 Collaboration

As is stated in Chapter 1.1, a good collaboration between the client and the contractor is a subfactor of a critical success factor. However, in the research of Zhang (2005), these factors are separate factors that can make or break the project. This study has shown that good collaboration and the risk allocation are intertwined in the three cases of this research, which didn't come forward in the literature review. Therefore, in this chapter, there is new literature provided how to ensure good collaboration and thereby enhancing the risk allocation. The question arises how to implement a good collaboration into a contract since it isn't something that you just write down in a contract. One can't just state we will have a good collaboration.

A good collaboration is an ambiguous statement, since what makes a collaboration good and what factors need to be in place to have a good collaboration. Warsen, Nederhand, Klijn, Grotenbreg and Koppenjan (2018) indicated that a high level of trust is very important for the collaboration between the contractor and the client. This statement is endorsed by Wong, Cheung, You and Pang (2008), who state that successful trust improves the outcomes of the project. Therefore, the

question can be phrased differently in how to implement trust in the relationship between the client and the contractor. To establish the trust in the client-contractor relationship, research indicated five factors that are so-called trust enablers, which can be seen in Figure 18 (Kadefors, 2004; Khalfan, McDermott, & Swan, 2007; Swan, McDermott, Cooper, & Wood, 2002).



Figure 18: Trust enabling factors (own image)

Each of these factors will be explained in the next section, whereby the experiences of the cases will also be indicated. It is important to note that these experiences were not explicitly asked for and only afterwards the connections between these enabling factors and the answers of the respondents are made.

8.2.1 Joined experience

It is a common understanding that working together enhances the relationship between two persons. When two people meet each other for the first time, there is a certain level of trust, however, the proof of the pudding is in the eating. Thus, the trust needs to be proven in the relationship. Normally the client and the contractor have their own offices and they meet regularly. However, the experience of working closely together combined with workshops can enhance the joined experience and thereby the trust between the parties and the people involved.

The joined experience was most visible at Eefde, where they had a shared office once a week. This means that every week, the involved team members of both the client and the contractor came together in the office of the contractor. In the meetings they had during that day, they had the opportunities to discuss what was coming and who could help who with what. This joined experience of closely working together in the same office can improve the trust between the parties.

8.2.2 Problem-solving

One of the unique factors of the construction sector is the risks involved in the projects. These risks can cause all kind of problems, like budget overruns, delays and changes in the design. It is hard, if not impossible, to have a project without any problems. Therefore, the question is not how to make sure these problems never occur, but how to deal with the problems if they occur, since these problems may have a negative influence on the trust and thus collaboration between the client and the contractor. Thereby it must be noted that trust is not only about working together in good times, but especially how they work together in bad times.

In this enabling factor, there are two aspects that play a role, namely how the problems are handled in the first place and what if the problems can't be solved in the first place. To enhance the trust between the client and the contractor, procedures should be made up that if a problem

occurs, the involved team members know what procedure to follow. These procedures are dependent on the project and the people involved, but they have to be clear from the start.

There are two aspects that are named by respondents that play a role in this enabling factor, namely the mindset of the people in solving the problem and the procedure if they can't solve the problem. Multiple respondents (#4, 5, 10, 12, 14 and 16) indicated that the first thing they did if there was a problem was to sit together with both the client and the contractor to see how they could solve the problem. During these discussions, the focus was mainly on finding the best for the project and not on who was going to pay what and who was responsible for what.

At one of the projects, indicated by respondents 11 and 14, there was the procedure that if the problems could not be fixed by the team members, they would escalate the problem to their directors, and they had to find the solution. Thereby they made sure that whatever the outcome would be, it would not harm their collaboration.

8.2.3 Shared goals

To have shared goals in a project means that both the client and the contractor become aware of the shared interest they have in the project, which is eventually having a good project and a project to be proud of. Nonetheless, each party has his own interest, but with the shared goals in mind, the people involved in the project tend to not only focus on what is their job and what they are expected to do but are also focussing on fulfilling the shared goal, even if they have to go a little further.

Another aspect that comes forward in the shared goals, if those shared goals need to be formulated by both parties at the same time. Thereby workshops need to be organised to formulate them, which increases the joined experience, and it intertwines the shared goal formulation with team building processes.

The shared goals came forward in the answers of some of the respondents (# 2, 11, 12, 13, 14 and 18). They indicated that eventually both the client and the contractor share the same goal, in this case, the construction of a new lock. Of course, each of the parties involved has their own separate goals, like for the contractor making a profit, but in the end, it is all about having a good project and eventually a satisfied administrator.

8.2.4 Reciprocity

The aspect of reciprocity can be described as one good turn deserves another, which means that if person A does something to help person B and eventually the favour is returned by person B, this enhances the trust between them. Thereby the principle of giving and taking should be in place, so the two-way traffic of helping each other enables the trust between the two parties involved.

The aspect of giving and taking is named by 9 respondents (# 2, 5, 6, 7, 9, 10, 11, 13 and 14). All these respondents indicated that in the discussions and issues they had in the project, it was always a combination of giving and taking. In these projects, these respondents of both client and contractor, did certain things to make it easier or better for the other party, even if the contract stated otherwise.

8.2.5 Reasonable behaviour

This enabling factor focusses on the behaviour of the people involved and mainly on what the involved persons see as reasonable behaviour. So, this focusses on how the client should behave according to the contractor and vice versa. This can also be stated as behaving professionally and behaving according to what could be expected from you and a person in your role. It is also indicated that trust is more likely to be in place if the people involved like each other.

This enabling factor isn't named explicitly by the respondents of this research. However, if one interprets the answers provided by the respondents, this is, in fact, something that is shown in the cases. There are no explicit statements regarding this factor, but in the way, respondents talked about their project and their collaboration it can be extracted.

8.3 Insights of similar projects

Seven respondents (#1, 2, 6, 10, 13, 15 and 17) indicated the added value of the Sluizenprogramma, where it comes to learning from each other and not reinventing the wheel at all the projects. The Sluizenprogramma is set up to explicitly learn from each other, whereby there are regular meetings with the different IPM roles of the projects. In these projects, the experiences of for example the technical managers can be exchanged and thereby the mistakes or the inaccuracy of one project aren't transferred to the other projects. Regarding reinventing the wheel, if a certain risk allocation worked on a similar project, it can be implemented at another project and vice versa, if afterwards certain risks are taken back by the client, this can be input for the risk allocation in a new project.

Another factor that plays a role in the Sluizenprogramma is that multiple persons worked on multiple projects in the programme. Regarding the risk allocation in these projects, the insights of similar projects can be used to reflect the risk allocation of the new project on. If the risk allocation on a similar project was seen as appropriate or afterwards the involved team members would prefer a different risk allocation, this can be exchanged between projects and thereby improve the risk allocation.

To implement insights of other projects more programmes can be set up in the same way as the Sluizenprogramma. Every more or less similar type of project can be combined into a programme, such as a programme for locks in this case, or for tunnel, bridges or road projects. There could even be a programme for every type of contract, whereby the focus is on implementing lessons learned related to the contract type. This explicit knowledge exchange between the projects can increase the success of the individual projects.

8.4 Open discussion on risk allocation

Some of the respondents (#1, 2, 6, 7, 10, 14, 16, 17 and 20) indicated that there should be a more open conversation about the involved risks in the project during the dialogue. They stated that the main focus of the contractors was to make a legally acceptable offer and to see where and how added value could be achieved. The respondents indicated that some of the contractors involved wanted to discuss the risks, but not all. Thereby they noted that the open conversation could improve the risk allocation. However, for these open conversations, an open attitude is required of both parties and the client should also be willing to take back some risks during the dialogue.

To simplify the open dialogue the list of risks could be reimplemented, however not in the way they were implemented before. At for example the A15 Maasvlakte Vaanplein, the list risks was used, whereby the contractors could get a discount if they were willing to accept a certain risk of the list. So, there was a financial incentive for the contractors to accept more risks. One of the respondents (#10) indicated that the list of risks in a new form could be helpful to have an open conversation about the risks. The respondent stated that the client should analyse the main risks in the projects and place them on a list. The list of the main risks is thereby the input for the dialogue, in which an open conversation can take place where the risk should be allocated. In these conversations, the contractors should motivate why they are willing to take a certain risk and why they would prefer a certain risk to be taken by the client. For the motivation of the risk allocation, the six design principles of this research can be used. This stimulates the conversation about risks in the dialogue phase, however, this requires effort from both the contractor and the client.

8.5 Allocation of data inadequacies

The respondents (#1, 2, 3, 4, 11, 14, 15, 19 and 20) indicated that the data was not confirming the practice or the reality. Thereby the statement of Rijkswaterstaat is that the data should be actual, trustworthy and complete (In Dutch: ABC, actueel, betrouwbaar, compleet), however, the respondents indicated that this wasn't the case in all the three cases analysed in this research. This is specific regarding the acreage data, but in fact, it can be more generalized for all the data that the contractor needs to base his offer on, including the risk allocation. In the current set up of the DBFM contract, the risk that the data of Rijkswaterstaat contains inadequacies or imperfections is allocated to the contractor. However, it is questionable if this risk can be allocated to a contractor.

At Rijkswaterstaat the statement is that the acreage data should be actual, trustworthy and complete. This statement can be used for all the data that is provided to the potential contractors during the tender. The data is placed in the so-called data room where the potential contractors can derive the information from.

To ensure a proper risk allocation on this subject, the following steps should be implemented in the procurement of DBFM projects:

1. Analyse the data regarding the project and determine what is actual, trustworthy and complete and what not.
2. Determine in the dialogue what can be made actual, trustworthy and complete.
3. Determine a proper risk allocation between the client and the contractor.
4. Update the risk allocation if in practice it is different than thought on forehand.

By implementing these steps, it is ensured that the risk of data inadequacies is properly allocated.

8.6 Conclusion

This chapter provided an overview of the different focus points in the ongoing process of the risk allocation in Dutch DBFM projects. Thereby the focus was not on improving the hard risk allocation as is stated in the contract, but on the soft risk allocation on how it is dealt with in practice. This research provided insight into six design principles and four lessons learned that are important for the risk allocation in practice. These design principles and the lessons learned provide practical guidance in the ongoing risk allocation process. The practical guidance can be seen in Figure 19.

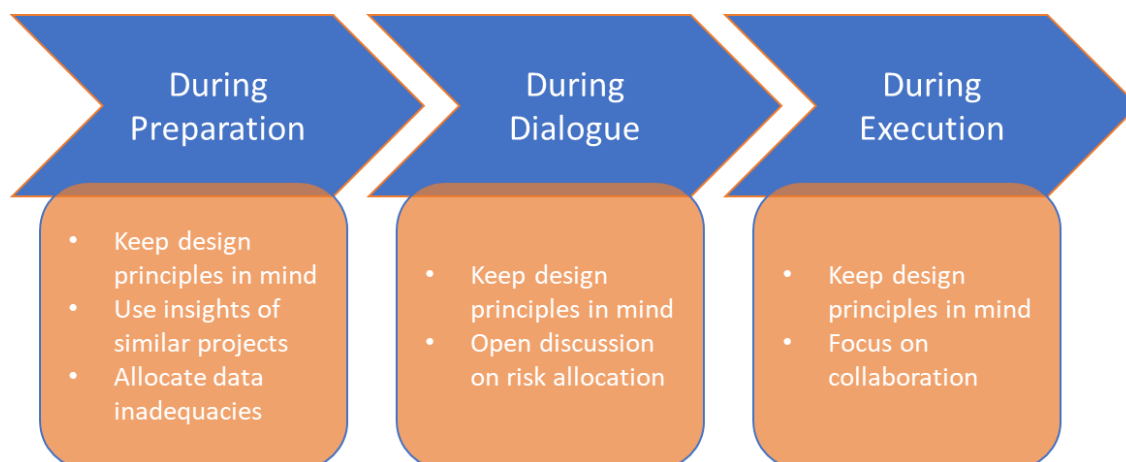


Figure 19: Practical guidance (own image)



Part 4

Discussion, conclusions, recommendations
and advice

9 Discussion

In this chapter first, the validity is discussed, starting with the internal validity and followed by external validity. Subsequently, the results are interpreted and what could have been expected and what was expected is elaborated on. After that, the limitations of this research are stated. Lastly, the applicability of the results of this research regarding the future of DBFM in the Netherlands is reflected on.

9.1 Validity

This research has been carried out as it is described in Chapter 2. However, the question is how valid the results of this research are, both internally, regarding the quality of the research design, and externally, regarding the generalizability of the results of this research. This section reflects on both types of validity.

9.1.1 Internal validity

The internal validity of research is related to the degree that the used research methods are ensuring that the results are representing the actual situation. In other words, does this report represents what was intended to be researched? Since this research is qualitative research and made use of semi-structured interviews, there is a possibility that the researcher becomes subjective. To enhance the validity of the research, every interview is recorded and subsequently transcribed. The transcriptions of the interviews are made without the subjectivity of the researcher since they are verbatim transcribed. This prevents that the notes of the researcher, which might be subjective, are seen as the view and opinion of the respondent.

9.1.2 External validity

The external validity is concerning the generalizability of the research to other situation outside the scope of the research. The external validity of qualitative research is always limited since the sample group of this kind of research is always relatively small and more selective than with quantitative research.

To increase the external validity of this research, a total of 20 respondents are interviewed, of which 11 from the client side and 9 from the contractor side. Of each project and each side, a minimum of three respondents was interviewed. The respondents all have functions in the IPM teams of these project. The interviews were, except two, one on one and face to face interviews. One interview was with three interviewees at the same time and one interview was by phone. Three respondents were also involved in multiple cases of this research, who were asked to pinpoint the differences between the two cases. Furthermore, every respondent was already experienced with infrastructure works, whereby it was for none of the respondents the first project they worked on. Thereby at the last couple of interviews, no new information was gained and only the nuances were different. This means that there was a level of data saturation achieved in this research, which increases the generalizability of this research.

9.2 Interpreting the results

The first intent of this research was to focus on the design principles as they are stated in Chapter 4.1.1 and the risk allocation in the three DBFM projects selected for this research. Thereby the researcher underestimated the effect on the risk allocation after the contract was closed, the researcher assumed that with the contract close the risk allocation was determined. Hence, the study was firstly solely focused on the stages before the contract close, since that was the moment the risk allocation was determined.

However, while executing, transcribing and analysing the interviews, two things became clear, namely that the risk allocation is an ongoing process, even if the contract is closed, and that the

data provided by the respondents was providing more information and more insights that also played a role in the risk allocation. Therefore, it was chosen to broaden the research in not only the design principles and how they could be implemented in the current practice, but also take the lessons that could be learned from these three cases into account.

If one looks in retrospect to this research to see what is new of this research and isn't indicated in other research, the main aspects are that the risk allocation is an ongoing process whereby adjustments are made during the execution of a project. Earlier publications imply that the risk allocation is solely determined in the contract (e.g. (Janssen et al., 2010; Lenferink, Verweij, Leendertse, & Busscher, 2017)). These researches state that the contractor has no other rights than written down in the contract (Janssen et al., 2010) and that there is limited to no bandwidth in the implementation of the contract (Lenferink et al., 2017). However, this research has indicated that the risk allocation is not set in stone after the contract close and that adjustments in the risk allocation are being made.

Another aspect that is new in this research is regarding the importance of the collaboration. There is much research conducted on the importance of the collaboration (e.g. (Huxham & Vangen, 2005; Poppo & Zenger, 2002; Ring & Van de Ven, 1992; Warsen, Klijn, & Koppenjan, 2019)). However, these researches do not indicate the importance of the collaboration between the contractor and the client regarding the risk allocation.

9.3 Limitations

The first limitation of this research is regarding the selected cases. These cases are selected to be more or less similar, which provides an in-depth research of these cases, however, it is questionable to what degree the results of this research are generalizable for all the Dutch DBFM projects. The cases are all about constructing a new lock and thereby the area of the project is relatively small in comparison to a road project. This study focused on so-called point infrastructure, like a lock, a tunnel or a bridge, and not on line infrastructure, such as a road. It might be the case that if this research was conducted on line infrastructure, other results may appear. Thereby it must be noted that these three cases are seen by the respondents as successful projects in terms of quality, budget and collaboration, which might have influenced the results. It must be said that both respondents from the client and from the contractor side could have an incentive to be not too critical regarding their project or DBFM in general since they may be in the running for a new project and negative publicity may harm that.

Another limitation regarding the selected cases for this research is that they are part of the Sluizenprogramma of Rijkswaterstaat and within this programme, the selected cases are performing relatively good. Thereby it must be noted that of the six projects, the projects selected for this research are the smallest three in budget. The budgets of these projects, 133 (Beatrixsluis), 80 (Eefde) and 60 (Limmel) million euros, where the budgets of the other three projects are 934 (Terneuzen), 800 (IJmuiden) and 550 (Afsluitdijk) million euros. It might be the case that the scope, which is related to the budget, of the selected cases is of influence on the risk allocation and the perception of the risk allocation of the people involved in the projects.

The second limitation is regarding the method of data gathering. The data of the three cases was collected via semi-structured interviews and therefore not only the questions that are listed in the interview protocol of Appendix A are asked, but the answers of the respondents also provided the input for new questions. Thereby the influence of the researcher cannot be separated from the results of this research. However, regarding the lessons learned, the researcher did not specifically ask about it in the first place, which means that the lessons learned were posed by the respondents. Hence, if another researcher posed the questions listed in the interview protocol, it is likely that the same lessons learned would be raised by the respondents.

The applicability of the results of this research are geographically mainly focussed on the Netherlands, however, the design principles, the collaboration and the usage of programmes are worldwide applicable. But the steps related to the acreage data and the focus on risks during the dialogue are related to the Dutch procedures for the procurement or related to especially the Dutch situation and therefore may not be applicable in other countries.

9.3.1 Case versus generic

As is stated in Chapter 7.1.3, there is a difference between the answers provided by the respondents from the client side regarding their specific case and in DBFM contracts in general. In the answers of the respondents in the in-depth interviews, two possible explanations can be found. The first factor that is named by multiple respondents is that in the history of DBFM too many risks were allocated to the contractor and that this is adjusted in the more recent contracts. The other factor that can be found is that the view of the respondents is influenced by the discussion that is currently ongoing about risks in DBFM projects, where one of the most visible facets is that large contractors are withdrawing from the tenders of large DBFM projects. The statements made by these contractors and the publications of the Cobouw about the risk allocation in large infrastructure projects are all sources that influenced the view of the respondents.

Besides the answers provided by the respondents, there are more factors that could play a role in this difference. These factors are related to the selected cases and the persons involved in this research. First, the selected cases, as is described above, the cases of this research are specific DBFM projects, namely, point infrastructure projects. This characteristic can play a role in the difference. Furthermore, the cases are part of the Sluizenprogramma and in that programme, there have been optimizations in the contract. Besides that, the managers of the projects of the Sluizenprogramma meet up regularly, so the managers see what is happening at the lock at IJmuiden for example.

Related to the respondents involved, as is stated above, they are currently involved in a DBFM project and might be in the running for a next project. Therefore they might be not too critical regarding their case since this might harm the chances for the next project. Another aspect is that they might not want to wash their linen in public. So if there are some problems with their projects, they might not be willing to share them with the researcher in order to prevent negative publicity. The last aspect related to the respondents involved is the term of cognitive dissonance. Cognitive dissonance is the mental stress or discomfort when a person is subject to two contradicting perceptions or beliefs. The mental stress or discomfort can be diminished by several actions, of which one is rationalization (Festinger, 1957). That is what might happen here. So the respondents might feel that the risk allocation in DBFM projects is not right or may be out of bounds, however on the project they are involved this isn't the case, since it is a lock, since the DBFM contract developed since they have taken back some risks or any other reason. By this rationalization, they justified why this would be different and therefore the discomfort is diminished.

9.4 Future of DB(F)M

As can be subtracted from Chapter 3.3.1 there is currently some criticism on DBFM contracts both in the Netherlands as well as in the United Kingdom. At the time of writing, there are two projects in the Netherlands being procured with a DBFM contract, of which one will be awarded in July 2019 and one will be awarded in January 2020. Besides these two projects, there are no other DBFM projects in the procurement. The general view of the respondents is that those two projects are the last DBFM projects in the Netherlands. These findings have a direct impact on this research, since this research focusses on DBFM projects and thus the question arises if there will

be new DBFM projects in which the findings, the solutions and the recommendations could be implemented.

However, the respondents indicate that the financing will probably be taken out of the contract and thus a DBM contract will be made. The question arises what influence the elimination of the financing component has on the risk allocation in general and more specifically on the outcomes of this research. Or to reverse the question, what is the influence of the financing companies on the risk allocation. Based on this research there are no hard answers for those questions and only an educated guess can be made by the researcher.

Nine of the respondents (# 1, 3, 5, 7, 9, 10, 12, 14 and 20) have indicated what kind of role the banks had in their project. The answers were that the banks were on a distance and would only have their impact if the project became in trouble. Thereby it is stated that according to theory a high impact of the banks could be expected, especially in compelling the construction firms in keeping their deadlines. However, the respondents (# 1, 3, 7, 9, 10, 14 and 20) indicated that this wasn't the case in their project. Only two of the respondents (#5 and 12) indicated that felt the pressure of the banks.

Thus, the view of the author based on the information provided by the respondents is that the influence of the banks on the risk allocation in these projects was only limited and thus that the risk allocation between a DBFM and a DBM is not of a substantial difference. The author's perspective is thus that the conclusions and the recommendations could also be applied in DBM projects, however, it must be noted that this is nothing more than an educated guess.

10 Conclusion

This chapter first provides first the answer to the sub research questions, after which the combination of the answers makes up the answer to the main research question. Lastly, some extra conclusions, which are relevant for this research but not answering a specific research question, are presented.

10.1 Sub research questions

1. *What are, according to literature, the design principles that should be followed in the risk allocation process of DBFM projects?*

The scientific literature provides 15 different design principles that should be followed in the risk allocation process, however, there are only six principles that are named by at least three studies, these principles are:

1. The party has identified, understood and evaluated the risk.
2. The party has the capacity and expertise to control, monitor and minimize these risks.
3. The party has the resources to deal with the risk if it fires.
4. The party has the right risk attitude and wants to accept the risk.
5. The party accepting the risks can charge the right premium for this risk
6. The party has the best capability to control the events that might trigger the risk.

These principles can be divided into three clusters, namely the analysis, the control and the willingness principles. The first cluster, the analysis (principle 1), focusses on the identification and understanding of a risk. If a party is unable to access the risk he is taking, it is uncertain if the other principles are in place. The principles of the control cluster (principle 2, 3 and 6) are based on the thought that the party bearing the risk should be able to control the risk before (principle 2 and 6) and after (principle 3) it fires. The willingness cluster (principle 4 and 5) is focussed on the risk/return trade-off. This is influenced by the risk appetite, the attitude and acceptance of principle 4, and the return that might be in place, principle 5.

These principles are especially fit for DBFM projects, due to three factors, namely the use of the standardized agreement and thus no uniform conditions, the black-and-white risk allocation and the competitive dialogue. Since DBFM projects don't have the uniform conditions that do apply on, for example, D&C contracts, there is room for a risk allocation that is fitted to the project and thus these principles can be implemented without changing the general conditions. Thereby is the risk allocation in DBFM projects black-and-white, every risk is allocated to the contractor unless specified in the contract. This smoothens the implementation of these principles since the client can analyse a risk using these principles and see if he or the contractor should bear the risk. The last factor, the use of the competitive dialogue in the procurement, is a two-way street and the client and the contractor can adapt the risk allocation if the risk allocation is not according to these principles. Thereby it is not only the client who determines the risk allocation, but there can be input from the contractor.

2. *In what phases is the risk allocation in the current Dutch DBFM projects executed?*

The risks in the cases investigated in this research are allocated in three phases, namely in the preparation phase, in the dialogue phase and the execution phase. The first phase is during the preparation of the contract for the project, of which the starting point is the risk allocation as it is stated in the standardized agreement. The risk allocation in the standardized agreement is divided into three groups of events, namely the events of delay, the events of compensation and the events of force majeure. In these three group of events several events are stated whereby, if they happen, the contractor can get compensation, either in extra time or extra money. These

events are generic events and are only limited adjusted to make it fit for the project. After the starting point, the risk allocation is more specified and adapted to the project by means of different specifications, such as the management specification, the demand specification and the output specification. Those two combined make the first phase of the risk allocation.

The second phase of the risk allocation is during the competitive dialogue. In the dialogue, there is room for discussion about the specifications and about the risks and events of the standardized agreement. Respondents from the client side indicated that they were open for discussion about the risk allocation, whereby the conclusion can be that a certain risk, even though it was in the first place allocated to the contractor, is reallocated to the client, or vice versa. After the discussion, the risk allocation is written down in the contract. This is the second phase of risk allocation.

The third phase of the risk allocation is during the execution of the project. Since, with the contract close, the risk allocation is not set in stone, however, the main risk allocation is determined in the contract. It is indicated that even though the risk allocation in DBFM projects is very black-and-white, whereby all the risks are allocated to the contractor unless explicitly excepted in the contract, the practice contains different shades of grey. During the construction of the project, there might be elements that are different in practice than thought in advance or elements that are not specified correctly or other elements that need to be changed. The client and the contractor can make adjustments in the contract, even if the contract is already signed. Most of the times the contract changes are made by the client connote that a certain risk was according to the contract a contractor risk, however, due to the contract change, the risk is reallocated to the client. This has happened in all three cases that were subject to this research.

So in short, the standardized agreement provides a set-up for the risk allocation, which is further specified with different specifications. This is the input for the competitive dialogue, where the risk allocation is further determined and written down in the contract. Lastly during the execution by means of contract changes the final risk allocation is adjusted.

3. Which lessons can be learned from practice to improve the risk allocation in DBFM projects?

There are four lessons that can be learned from the three projects analysed in this research, namely that the risk allocation can be adjusted after the contract close, that the collaboration influenced the risk allocation, the added value of the Sluizenprogramma and the improved risk allocation by more focus on the risks during the tender. Thereby in the three cases, the acreage data wasn't up to date. These factors will be elaborated on in the next paragraphs.

The risk allocation is not set in stone after the contract close. For the completion of the risk allocation, respondents indicated that the collaboration between the client and the contractor influenced the risk allocation on this aspect. Thereby they indicated that the focus was on delivering a good project in terms of quality and that the specific contractual arrangements were secondary. So, in other words, if there was a problem, the first focus was to find a good solution, and the second focus was the determination was made who was going to pay what percentage, based on the contractual arrangements. The respondents indicated that this eventually created a better project and that some risks were taken back due to the collaboration, whereby it is said that this wouldn't be the case if there was a bad collaboration.

The projects in this research are part of the Sluizenprogramma and it is indicated that this programme added value to the individual projects. In the programme, the focus was on learning of the different projects, which took place on several issues. The learning took place in joint sessions of the people involved in the IPM teams of the projects., by meeting regularly and sharing knowledge and experiences with each other. Respondents indicated that this explicit learning and integration of the projects create added value and should be used more often.

Regarding the risk allocation, it is said that the programme didn't change the risk allocation in the contract, but it did change the way the respondents from the client side handled certain risks.

The last lesson that is indicated by respondents is that during the tender phase and especially during the dialogues there should be more attention to the risks involved in the project. Currently, the main focus is on the EMAT criteria and how the contractors can make a legal offer. Respondents indicated that if there was more a focus on the risks in the dialogue, this would improve the risk allocation.

Another aspect that comes forward in the three cases analysed in this research is that the acreage data from Rijkswaterstaat is not confirming the reality, even though Rijkswaterstaat indicated that they were actual, trustworthy and complete (in Dutch: ABC, actueel, betrouwbaar and compleet). The area as it is becomes the responsibility of the contractor in a DBFM project and thereby the risk that the data isn't up to date is allocated to the contractor. However, since the data is of Rijkswaterstaat and Rijkswaterstaat is the owner and administrator of the area, one should be able to expect that the data is reflecting the reality. It is questionable if the risk that the acreage data should be allocated to the contractor, as long as the data is not up to date nor reflecting reality. This aspect can be more generalized to that all the data on which the contractors base their biddings should be actual, trustworthy and complete. Thereby the contractor can't be made responsible for inadequacies in the data provided by Rijkswaterstaat.

4. How can the design principles and lessons learned be implemented in the current process of risk allocation in DBFM projects?

Since the risk allocation is mainly based on the standard risk allocation as it is stated in the model agreement, the focus of the implementation of the design principles and the lessons learned is not on the "hard" risk allocation as is stated in the contract, but is focused on the "soft" risk allocation, which means how it is dealt with in practice. These focus points can be seen as practical guidance in the process of risk allocation in DBFM projects.

To implement the design principles, everyone that deals with the risk allocation of DBFM projects should know about these principles, should understand these principles and should be able to assess a risk based on these criteria. These design principles provide guidance in who is able to bear a risk on six different aspects, whereby the combination of the aspects provides a good risk allocation. Thereby one can use the principles to motivate why he is able to bear a risk or why he isn't able to bear the risk.

To implement the four lessons learned indicated at subquestion 3, the following actions can be performed. To implement the lesson learned regarding the collaboration, there is no direct way to implement it. However, literature indicated that the main influencing factor of the collaboration is trust and it is indicated that there are 5 enabling factors for trust, namely:

- **Joined experience**, whereby the focus is on working together on a day-to-day basis and thereby the consistent proof to each other that they can be trusted.
- **Problem-solving**, problems are inherent in construction projects, whereby the question is how to deal with them. Trust can be enabled by having a procedure in place what to do if the problem can't be solved by the involved team members.
- **Shared goals**, this creates mutual understanding between the client and the contractor and the use of workshops to create the shared goals are also helpful for team building. The shared goals connect the team of the client and the contractor.
- **Reciprocity**, this is focussed on the principle "one good turn deserves another". Thus, if a person helps the other party to make it easier for that person and the favour is returned, this creates a mutual level of trust.

- **Reasonable behaviour**, which is about understanding what the other people involved in the relationship understand as reasonable. Therefore, this focusses on the different personalities involved in the relationship and understanding that people may differ.

These five factors should be seen as a tool to enable trust, thereby improving the collaboration and implicitly enhancing the risk allocation in DBFM projects.

To implement the insights of other projects, the client can create a programme for every more or less similar type of project in the same way as the Sluizenprogramma is set up. For example, the client can create a Tunnel programme and a Road programme. The set-up of the Sluizenprogramma includes explicit learning from each other and the exchange of people between projects. Thereby these programmes can also be combined into one large DBFM programme, whereby there is even more transfer of knowledge and insights.

To implement the open conversation on the risk allocation, an updated version of the list risks can be introduced. In the new format, the risks list is set up by the client with an initial risk allocation. Subsequently, this can be discussed and the client and the contractor can motivate why they are or aren't able to bear a risk. Based on this motivation the client can decide if a risk is taken back. This enables an open discussion on the risks in the procurement of DBFM contracts.

To implement an appropriate risk allocation regarding the data inadequacies, the following steps can be used:

1. Analyse the data regarding the project and determine what is actual, trustworthy and complete, (in Dutch ABC: actueel, betrouwbaar, compleet), and what not.
2. Determine in the dialogue what can be made actual, trustworthy and complete.
3. Determine a proper risk allocation between the client and the contractor.
4. Update the risk allocation if in practice it is different than thought on forehand.

All of these aspects can be used in the practical guidance to improve the “soft” risk allocation, whereby the focus is on how to deal with the risk allocation in practice.

10.2 Main research question

The answers to the sub research questions combined make the answer to the main research question, which was:

*How can the process of **risk allocation** in **DBFM projects** be improved through **design principles** from literature and **lessons learned** from practice?*

This research has provided practical guidance to improve the risk allocation in DBFM projects. In the practical guidance, the design principles from literature and the lessons learned from the three projects subject of this research are indicated. These aspects are categorized on the phase where they should be a focal point in. The design principles can be used throughout the whole project, where the risk allocation can be based on. These principles should be in mind of the people involved in the risk allocation of DBFM projects. The lessons learned should be a focus point in a different stage of the project. During the preparation phase of a project, the focus regarding the risk allocation is on the design principles, the usage of insights of other projects and to have a suitable allocation concerning data inadequacies. During the competitive dialogue in the procurement of the DBFM projects, the focus should again be on the design principles and there should be an open discussion on the risk allocation, in which the contractor can indicate which risks he is able to bear and which not. He can make use of the design principles to indicate why is able to bear a certain risk. During the execution, the design principles should be thought of when an unexpected risk pops up and the question is where to allocate the risk. Thereby a good collaboration between the client and the contractor improves the risk allocation. This can be

achieved by the five trust enabling factors named in this research, namely joined experience, problem-solving, shared goals, reciprocity and reasonable behaviour. The practical guidance can be seen in Figure 20.

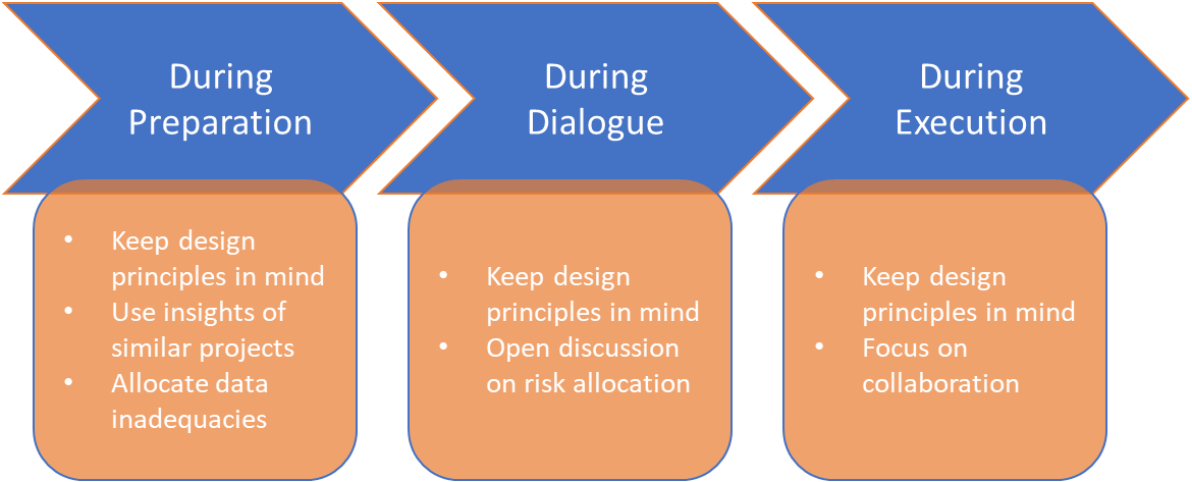


Figure 20: Practical guidance (own image)

10.3 Additional conclusions

In addition to the research questions, the respondents were also asked about their general opinion regarding DBFM and risks. These views do not relate directly to the research questions; however, it is valuable information that is relevant for this research.

10.3.1 DBFM

The view of the respondents regarding DBFM contracts was regarding two aspects, namely about the integration of the design, the build and the maintenance phase and separately about the financing. The answers regarding the integration of the design, the execution and the maintenance were merely positive. The respondents indicated that this created a self-cleaning ability since if the contractor produces a low quality of works, he has to deal with it in the following 25 to 30 years. Thereby there is an incentive for the contractor to optimize the design to increase the maintainability of the project. So, the integration of the design, the execution and the maintenance induce a backward thinking process, in which the maintainability is the starting point, followed by the construction followed by the design. This creates added value over other contract types.

On the financing component, the views were mixed. Due to the availability payments, the influence of the banks and the milestones that need to be achieved, there is a proactive attitude of the contractor. The pressure on the contractor ensures that the contractor will always continue to work even if the project is getting out of hand. Respondents also indicated that it ensured reoccurring payments for the contractor, instead of the usual single payments per project. Thereby the contractor is thus less reliable on single payments of other projects but has a stream of revenue for 25 to 30 years. However, respondents also indicated downsides of the financing. They indicated that this is an expensive way of construction work, whereby a lot of advisors are required that may not be directly link to the construction of the project. Thereby the respondents indicated that according to the theory the banks have a great influence and that they might intervene in the work of the contractor, however, the respondents indicated that this was less than could be expected from the theory. Lastly, they indicated that due to the involvement of the banks the milestones, like the availability certificate, were set in stone and could not be replaced, even if the project could be finished before the milestone.

10.3.2 Shared risks

The view of the respondents about sharing risks was binary, either they were positive about sharing risks and they thought it would enhance the risk allocation in DBFM projects, or they were negative about it and they thought it would only provide more discussion. The proponents indicated that with sharing risks comes sharing responsibilities and therefore an open attitude is required. These respondents also indicate that with sharing risks you limit the budget required by the market parties, however, there is still an incentive for the contractor to ensure that the risk doesn't fire.

The opponents state that a risk either belongs to the client or to the contractor and thus a shared risk is impossible. Thereby they state that it will only increase the discussion, since who is going to pay if the risk fires, according to which rates and what are the preconditions. These respondents indicated that the current black-and-white division of risks is helpful in preventing discussions since it is always clear whose risk it is and thus whose responsibility to take control measures.

11 Recommendations

In this chapter, the recommendations that came forward in this research are presented. It starts with the recommendations for practice, whereby the recommendations are derived from the answer to the fourth research question of the conclusion. Subsequently, the recommendations for further research are indicated, partly based on the limitations of this research as they are stated in Chapter 9.3.

11.1 Recommendations for practice

These sections provide an overview of the recommendations that could enhance the risk allocation in DBFM projects. These recommendations follow from the fourth sub question answered in the conclusion. The recommendations combined provide the practical guidance as can be seen in Figure 21.

11.1.1 Design principles

To implement the design principles, everyone that deals with the risk allocation of DBFM projects should know about these principles, should understand these principles and should be able to assess a risk based on these criteria. These design principles provide guidance in who is able to bear a risk on six different aspects, whereby the combination of the aspects provides a good risk allocation. Thereby one can use the principles to motivate why he is able to bear a risk or why he isn't able to bear the risk. The six design principles are, based on their order of importance according to the respondents:

1. The party has identified, understood and evaluated the risk.
2. The party has the capacity and expertise to control, monitor and minimize these risks.
3. The party has the resources to deal with the risk if it fires.
4. The party has the right risk attitude and wants to accept the risk.
5. The party accepting the risks can charge the right premium for this risk
6. The party has the best capability to control the events that might trigger the risk.

11.1.2 Collaboration

One of the main factors influencing the collaboration between the client and the contractor is trust. This research has indicated five enabling factors to enhance the trust forming between the two parties. To implement these factors some measures can be taken. Below are the factors listed and what can be done to implement them.

- **Joined experience:** The joined experience can be implemented by having a shared office and different workshops together. By working side by side on a regular basis the trust can be enhanced.
- **Problem-solving:** At the start of the project the parties should formulate a joined procedure what to do when a problem arises. These procedures should also take into account what to do when the problem is not solved in the first instance to ensure that the trust between the parties is not hampered.
- **Shared goals:** The parties should join together and formulate a shared goal, in which every team member of the client and the contractor should have their input and should recognize this goal as their joined goal, both from the contractor and the client.
- **Reciprocity:** To implement the reciprocity the involved team members should reward the trusting behaviour of each other.
- **Reasonable behaviour:** The team members should be made aware of their own behaviours and what the other party is expecting in terms of behaviour. By having a mutual understanding of the behaviour and how you should behave, the trust improves.

This could be done by organising workshops together with a team coach to implement reasonable behaviour.

11.1.3 Insights of similar projects

To implement the programme structure as is done by the Sluizenprogramma, more projects can be combined into a programme. For every similar type of project, a programme can be set up just like the Sluizenprogramma. This means that the focus should be on learning from other projects and sharing experiences. To do so the different managers, like the technical managers or the contract managers, should meet regularly to share experiences and lessons that could be learned from their project. These managers should also shift between the projects to have their experience of one project directly implemented in the other project.

11.1.4 Data inadequacies

In the three cases analysed in this research, it came forward that the acreage data provided by Rijkswaterstaat wasn't up to date. However, the risk that the data isn't up to date is allocated to the contractor. This can be more generalized to that all the data provided by the client should be up to date and the risk that it contains inadequacies should be allocated at the client.

To come to a well-balanced risk allocation on this specific risk, the following steps need to be taken in the procurement of DBFM projects:

1. Analyse the data regarding the project and determine what is actual, trustworthy and complete (in Dutch ABC: actueel, betrouwbaar, compleet) and what not.
2. Determine in the dialogue what can be made actual, trustworthy and complete.
3. Determine a proper risk allocation between the client and the contractor.
4. Update the risk allocation if the practice is different than analysed on forehand.

11.1.5 Open discussion on risk allocation

To have a more open discussion about the risks and the risk allocation during the dialogue, the list risks can be reintroduced. However, not in the same way as it used to be. It used to be that a discount was applied if the contractor was willing to take a risk. This induced an incentive for the contractors to just take all the risks, since the competitors may do the same. In the new set up of the list, there should not be an award for the contractor to take a risk, but there should be an open discussion, in which the contractor can discuss with the client which risk he can handle and which risk he can't. The basis of the list should be the same as currently with DBFM contracts, that most of them are allocated to the contractor. Subsequently, the contractor can motivate why he isn't able to carry a certain risk. The client should be open for the motivation and the arguments of the contractor and should be willing to take back a risk when the contractor can motivate why he can't take a risk.

11.1.6 Conclusion

The different improvements and in which step they should be implemented can be seen in Figure 21.

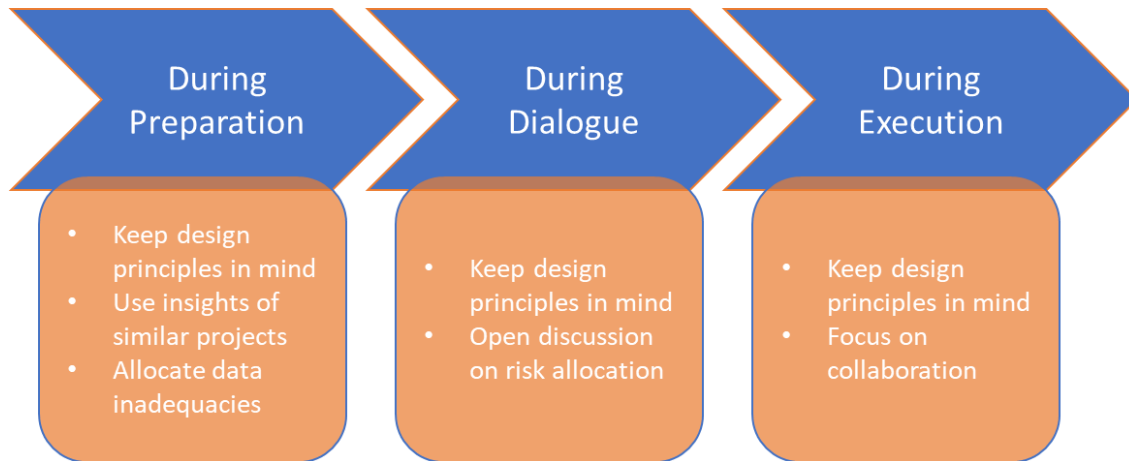


Figure 21: Practical guidance (own image)

11.2 Recommendations for further research

The recommendations for further research are based on the limitations of this research and on the selected cases. The three cases are selected on their similarities, whereby there are more similarities than thought of in advance. This regards the collaboration between the parties, that was stated to be good in the selected cases. It would be interesting to compare the results of this study with cases that are different than in this research. Hence, one can think of dry infrastructure projects, projects without a good collaboration between the client and the contractor, projects with line infrastructure instead of the point infrastructure of these cases and even projects where the expansion is within the current lock system and not outside as was the case in two of the three projects of this research.

Another interesting possibility is to research how good collaboration could be ensured between the client and the contractor. This research has only indicated enabling factors for trust, but it is not the case that if these factors are in place one will always have a good collaboration. Therefore, future research can focus on how to ensure good collaboration between the client and the contractor.

As is explained in the discussion of this research, it is possible that the last two DBFM projects are currently being procured and that there will not be a DBFM project after. It is the view of the author that the conclusions and recommendations for practice are also applicable for DBM projects, however further research is required to confirm that statement.

12 Advice

Based on the previous chapters and on the position in this report, this chapter may seem somewhat out of bounds. Since the previous chapters are of scientific nature, this chapter is more of an advisory nature. This chapter reflects the combination of the data that is gathered in this research and the view of the author. I believe that even though this chapter is not as scientific as the previous chapters, it does have added value for this research and the reader of this report.

12.1 Applicability of DBFM

There is currently some criticism on DBFM projects and it is unknown if the DBFM contract will be applied more often. However, the three projects in this research are relatively successful and they show that it is possible to have a successful project with a DBFM contract. Therefore, it might be that the problem is not the DBFM contract, but that the problem lies in factors related to the specifics of the project. Therefore, the question arises, what characteristics are required to have a successful DBFM project? These characteristics can be found in the overlap between the selected cases for this research since apparently, you can have a successful project with these characteristics. There are three aspects that overlap in the cases of this research, namely the disciplines involved, the size of the budget and the stability of the scope.

Mono-disciplinary

Regarding the disciplines involved, there is only one discipline in the cases, namely the construction of a lock. If one compares some of the unsuccessful projects of the last time in the Netherlands, like the A15 Maasvlakte Vaanplein and the Zuidasdok, there were always more disciplines involved. At the A15, it was the widening of a road, the construction of a bridge and the management and maintenance of two tunnels. Regarding the Zuidasdok, it is the construction of a tunnel, the expansion of a railway station and the enhancement of two junctions. Another example is the ViA15, which is currently still being procured. Several contractors have withdrawn from the procurement due to the high risks involved. This project entails the construction of a toll bridge and the construction of a sunken road. This is in contrast with the cases of this research since the cases were focussed on the construction of a lock chamber or a flood gate. This mono-disciplinary approach is apparently appropriate for the DBFM contract.

Appropriate budget

The mono-disciplinary approach is intertwined with the budget for the project. Since the more disciplines are involved, the higher the budget will be. Therefore, the preferred budget of a new project should be between €60 million and €500 million. The lower limit of €60 million is chosen since that is the limit Rijkswaterstaat indicates that it is worthwhile to start with a DBFM contract since otherwise, the extra costs involved do not match the possible gained efficiency. The upper limit is indicated by two respondents (#1 and 19) and from a report of Rijkswaterstaat, in which is indicated by market parties that an upper limit of €500 million euro is a proper limit (Rijkswaterstaat, 2019a).

Stability of scope

If one looks at the differences between the point infrastructure of this research and line infrastructure, one of the most prominent differences is the stability of the scope over time. Regarding a point infrastructure project, such as a lock, the scope is relatively stable. If you look at line infrastructure, like a road project, it is not as predictable as a lock. You can imagine that the smaller a scope is in the surface, the smaller the chance is that changes are needed. Scope changes in DBFM projects are relatively expensive and therefore a stable scope is favoured.

12.1.1 Assessment framework

These three characteristics are the input for the assessment framework, which can be found in Figure 22. In the assessment framework, the relative importance of the characteristics is shown. If the new project contains more than one discipline, this has negative consequences to the practicability of the new project, since the more disciplines involved the larger the amount of interfaces, which makes the project harder to handle.

Regarding the budget, within the 60 and 500 million euros, it is both favourable if it is within the limits and also unfavourable if it is outside these limits. Since if it is below the 60 million euros the extra costs that are involved do not outweigh the gained efficiency. If it is above the 500 million euros, it is stated by market parties that the projects are too large to handle.

Related to the scope, it may be clear that one can't look into the future and thereby a stable scope can't be guaranteed. However, the more stable the scope is the more favourable it is to use a DBFM contract, since changes in DBFM contracts are expensive.

If a new project is assessed according to the assessment framework and it is shown that the project is unfavourable, my advice is to split the single project into smaller subprojects until the subprojects are favourable according to the assessment framework. Thereby, the first separation should be based on the different disciplines involved, followed by the budget and lastly the stability of the scope.

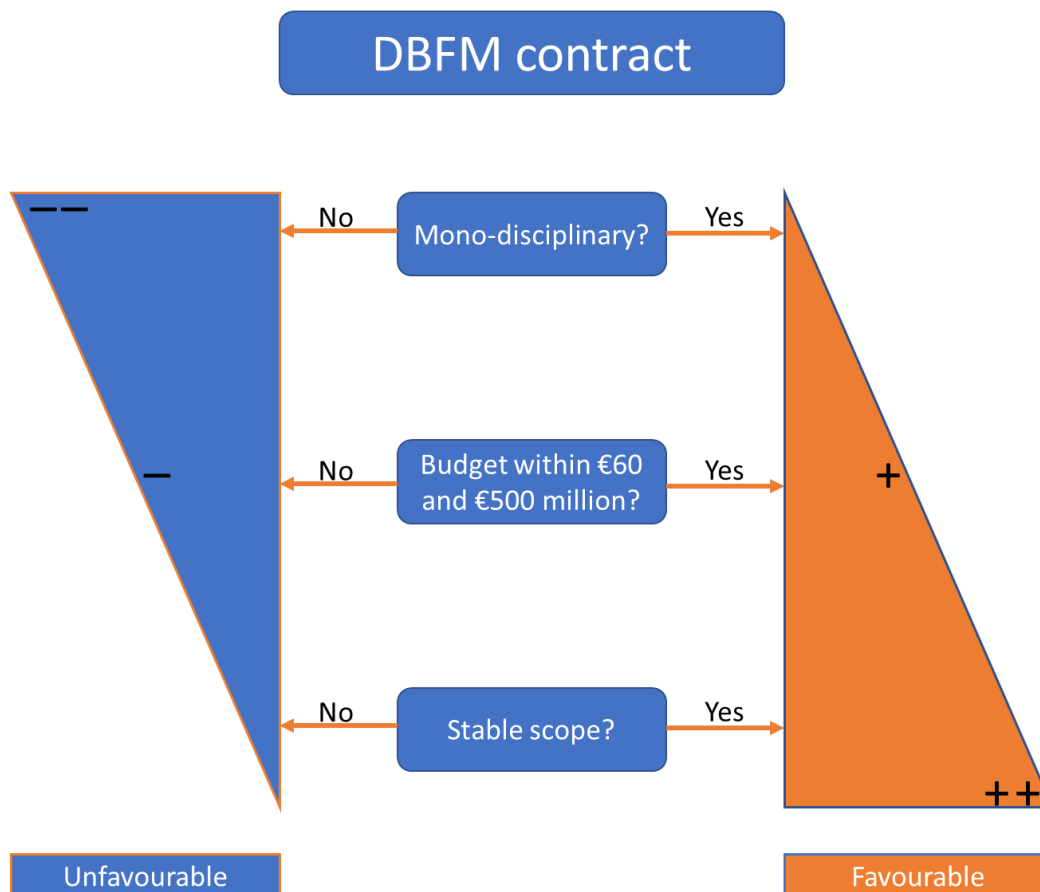


Figure 22: Assessment framework for new projects (own image)

The assessment framework and the practical guidance combined provide a basis of success for future DBFM projects.

12.2 Future assignment Rijkswaterstaat

At the end of this research, a report was published by Rijkswaterstaat in cooperation with McKinsey. Since this research and the report of Rijkswaterstaat are focussed on large infrastructure projects, it is interesting to see where they overlap and what the differences are. However, both of these researches have a different focus and only the parts where the focus is similar are indicated.

12.2.1 Similarities

It is interesting to see that the report of Rijkswaterstaat in a subordinate clause in the management summary it is indicated that the risks can be reduced by decreasing large projects, however, this is not elaborated on. Later on, in a different part, it is stated in order to enhance the market dynamics, projects could be made smaller since this induces that contractors are less likely to form a consortium. This research, combined with the consultancy advice of the previous section, further elaborates on the decrease of large projects, by demarcating new projects based on the disciplines involved and by setting a maximum budget of €500 million. This demarcation lowers the risks involved in these projects and thereby enhances the risk allocation of the DBFM projects.

Another overlapping factor is to enhance the discussion on risks during the competitive dialogue. Both the report of Rijkswaterstaat and this research have indicated that in order to enhance the risk allocation (this research) or the risk/reward ratio (Rijkswaterstaat) an open discussion is required. The open discussion and thereby the willingness of Rijkswaterstaat to take back certain risks if the contractors provide a decent motivation why they can't bear a certain risk is required to have a proper risk allocation.

A third overlapping factor is that in the report of Rijkswaterstaat market parties have indicated that risks are not always allocated to the "natural owner". The report of Rijkswaterstaat indicates that the "natural owner" is the party that can carry the risk financially speaking and at the same time can control the risk. These factors are in overlap with two design principles indicated in this research, namely that the party should have the resources if a risk fires and the party has the capacity and expertise to control, monitor and minimize the risk. In addition, this research has indicated four more principles that lead to that a risk is allocated at his "natural owner". These additions make it more explicit who is the "natural owner" and thereby can enhance the risk allocation.

12.2.2 Differences

A remarkable difference between the report of Rijkswaterstaat and the view of the respondents of this research is that the report of Rijkswaterstaat proposes a so-called two-phase process, whereby after the design phase the pricing of the execution is performed. However, the respondents in this research indicated that it is possible to have an optimal risk allocation in the current set-up of the DBFM contract and thus such a two-phase process is not required.

One of the aspects that is named for the implementation of the two-phase projects is that during the procurement there is no full picture on the risks involved. Examples that are named in the report are regarding the condition of the acreage and the data related to the soil conditions. These aspects were also shown in this research, whereby this research indicated four steps to deal with this situation without changing the current setup of the DBFM contract. The four steps are:

1. Analyse the data regarding the project and determine what is actual, trustworthy and complete (in Dutch ABC: actueel, betrouwbaar, compleet) and what not.
2. Determine in the dialogue what can be made actual, trustworthy and complete.
3. Determine a proper risk allocation between the client and the contractor.
4. Update the risk allocation if the practice is different than analysed on forehand.

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Appendix A Interview guide

This document shows the guide that will be used for the interviews with the interviewees of the three cases. Since the interviewees' and the interviewer's mother language is Dutch, the questions and the interviews will be in Dutch. Before the interview takes place, the interviewees are asked to score 14 statements. These statements are the input for the interview. Subsequently, the questions to be asked in the interview are listed.

A.1 Statements

Project

Op een schaal van 1 tot 5, waarin een 1 staat voor helemaal oneens, een 3 voor neutraal en een 5 voor helemaal eens, in hoeverre bent u het eens met de volgende stellingen?

1. In dit project zijn de risico's juist gealloceerd.
2. In dit project draagt de opdrachtnemer te veel risico's.
3. In dit project draagt de opdrachtgever te veel risico's.
4. De risicoverdeling lag al vast voor de start van het project.

Algemeen

Op een schaal van 1 tot 5, waarin een 1 staat voor helemaal oneens, een 3 voor neutraal en een 5 voor helemaal eens, in hoeverre bent u het eens met de volgende stellingen?

5. Over het algemeen worden te veel risico's bij de opdrachtnemer neergelegd.
6. Binnen DBFM-contracten worden te veel risico's bij de opdrachtnemer gelegd.
7. Binnen de huidige opzet van DBFM is het mogelijk om tot een optimale risicoverdeling te komen.
8. Het introduceren van gedeelde risico's in DBFM-projecten kan leiden tot een betere risico allocatie.

Literatuur

Op een schaal van 1 tot 5, waarin een 1 staat voor helemaal niet belangrijk, een 3 voor neutraal en een 5 voor heel belangrijk, hoe belangrijk vindt u de volgende principes gericht op risico allocatie?

9. De partij heeft de capaciteit en expertise om het risico te controleren, te monitoren en te verkleinen.
10. De partij heeft het risico geïdentificeerd, begrepen en geëvalueerd.
11. De partij heeft de resources om met het risico om te gaan als het zich voordoet.
12. De partij heeft de juiste instelling en wil het risico accepteren.
13. De partij die het risico krijgt toebedeeld kan de juiste premie hiervoor vragen.
14. De partij is het meest geschikt om de gebeurtenissen te controleren die invloed hebben op het risico.

A.2 Interview questions

Introductie

- Toestemming om interview op te nemen
- Inleiding onderzoek
 - Anonimiteit
 - Stellingen beantwoord komen terug in dit interview
- Introductie van geïnterviewde
 - Rol
 - Ervaring

Introductie project

- Vanaf welk moment ben u betrokken bij het project?
- Wat maakt dit project specifiek?
- Wat zijn de belangrijkste risico's die u in dit project bent tegengekomen?
 - Waren deze risico's voor de start van het project geïdentificeerd?
 - Bij welke partij zijn deze risico's gealloceerd?
 - Waarom zijn deze risico's bij deze partij neergelegd?
 - Zijn deze risico's volgens u neergelegd bij de juiste partij?

Risico allocatie binnen project

- Kunt u het proces beschrijven hoe de risico allocatie tot stand is gekomen?
 - Wat waren hierin de belangrijkste overwegingen?
 - Wat waren de argumenten om een risico bij een partij te leggen?
 - Welke personen hebben hierbij een belangrijke rol gespeeld?
 - In hoeverre heeft de opdrachtnemer hier een rol in gespeeld?
- Ik zie dat u bij stelling 1 tot en met 3 heeft aangegeven dat ... Waarom heeft u deze scores gegeven?
 - Zijn er specifieke risico's die u liever anders gealloceerd zou zien? Zo ja waarom?
- Zijn er na het sluiten van het contract nog discussies geweest over welk risico waar zou moeten liggen? Al dan niet door het voordoen van een risico?
 - Wat was hiervan de oorzaak?
 - Wat was uiteindelijk hiervan de uitkomst?
- Hoe is er omgegaan met risico's die niet van tevoren zijn geïdentificeerd?
 - Bij welke partij zijn deze gealloceerd?

DBFM/risico allocatie algemeen

- Hoe kijkt u in zijn algemeenheid aan tegen DBFM?
 - Wat zou er aan de huidige constructie verbeterd kunnen worden?
- Bent u bekend met de conclusies van het rapport dat McKinsey heeft opgesteld naar aanleiding van het terugtrekken van meerdere partijen bij grote tenders?
 - (Indien nee) In dit rapport heeft McKinsey onderzoek gedaan naar aanleiding van het aantal terugtrekkingen in grote tenders van Rijkswaterstaat. Een van de conclusies van dit rapport is dat er bij grote complexe projecten te veel risico's bij de markt liggen.
 - Nu zie ik dat u stellingen 5 en 6, dat te veel risico's bij de opdrachtnemer worden gelegd, heeft ingevuld dat Kun u hier een toelichting op geven?
- Terugkomend op de stelling over het delen van risico's binnen DBFM-projecten, u heeft hier ingevuld dat ... Kunt u hier een toelichting op geven?
 - Hoe ziet u dit worden toegepast binnen DBFM-contracten?

Risico allocatie literatuur

- Volgens welke principes zou volgens u een risico gealloceerd moeten worden?
 - Bijvoorbeeld dat het risico gealloceerd zou moeten worden bij de partij die het risico het beste kan managen?
- U heeft voorafgaand aan dit interview een aantal principes een score gegeven. Hierbij heeft u meerdere principes dezelfde score gegeven. Om hier een beter beeld bij te krijgen, kunt u deze zes principes op volgorde leggen, beginnend met degene die voor u het meest belangrijk is tot degene die voor u het minst belangrijk is?
 - De partij heeft de capaciteit en expertise om het risico te controleren, te monitoren en te verkleinen.
 - De partij heeft het risico geïdentificeerd, begrepen en geëvalueerd.
 - De partij heeft de resources om met het risico om te gaan als het zich voordoet
 - De partij heeft de juiste instelling en wil het risico accepteren

- De partij die het risico krijgt toebedeeld kan de juiste premie hiervoor vragen
 - De partij is het meest geschikt om de gebeurtenissen te controleren die invloed hebben op het risico.
- Op welke manier zouden deze principes kunnen worden geïmplementeerd binnen de opzet van DBFM in dit project?
- Zijn er nog andere principes die u hiertussen zou willen zien?

Afsluiting

- Hoe kijkt u naar de toekomst van DBFM?
- Heeft u nog inhoudelijke aanbevelingen voor mijn onderzoek?
- Wie zou volgens u de volgende persoon moeten zijn waar ik voor mijn onderzoek mee spreek?
- Heeft u er behoefte aan om de notulen van dit gesprek te ontvangen?
 - Wilt u een kopie van het eindrapport ontvangen?
- Is het mogelijk dat ik u op een later moment mogelijk nog een paar vragen kan stellen?

Appendix B Respondents

This appendix shows the overview of the respondents. In order to have the respondents talk more freely, they were given anonymity. Therefore, the numbers in this report are not shown in the overview and these numbers can't be derived from the table. The overview of the respondents can be found in Table 2.

Table 2: Overview of respondents

First name	Surname	Project	Function	Client / contractor
Jeroen	Ramakers	Beatrix	Contract manager EPC	Contractor
Koen	van Gelderen	Beatrix	Bid manager PPP	Contractor
Jeroen	in t Veld	Beatrix / Limmel	Manager SPC	Contractor
Sjoerd	Opdam	Eefde	Manager EPC	Contractor
Mark	de Koning	Eefde	Contract manager	Contractor
Gerold	Schaap	Eefde	Manager SPC	Contractor
Paul	Schaap	Eefde	DBM Manager	Contractor
Ken	Watzeels	Limmel	Technical manager	Contractor
Michel	Mulder	Limmel	Manager EPC	Contractor
Sjors	Wijnia	Beatrix	Manager project control	Client
Dick	Helmond	Beatrix	Manager project control	Client
Joyce	de Waard	Beatrix	Contract manager	Client
Leon	Wijnker	Beatrix	Technical manager	Client
Javiera	Maturana	Eefde	Manager project control	Client
Reinoud	Goudswaard	Eefde	Advisor project control	Client
Jan Dirk	Voorwinde	Eefde	Technical manager	Client
Robbert	Visser	Eefde	Project manager	Client
Jasper	Tils	Limmel / Eefde	Project manager	Client
Danny	Meys	Limmel	Technical manager	Client
Marcel	Menting	Limmel / Eefde	Contract manager	Client

Appendix C Sluizenprogramma

In the Netherlands, many of the locks were constructed in the 1920s and 1930s. With the expected life time of 80 to 100 years, it is shown that many of these locks need replacement in the coming years, which can be seen in Figure 23 (Willems & Busscher, 2014). The reason is that most of these locks have a durability design between the 80 and 100 years.

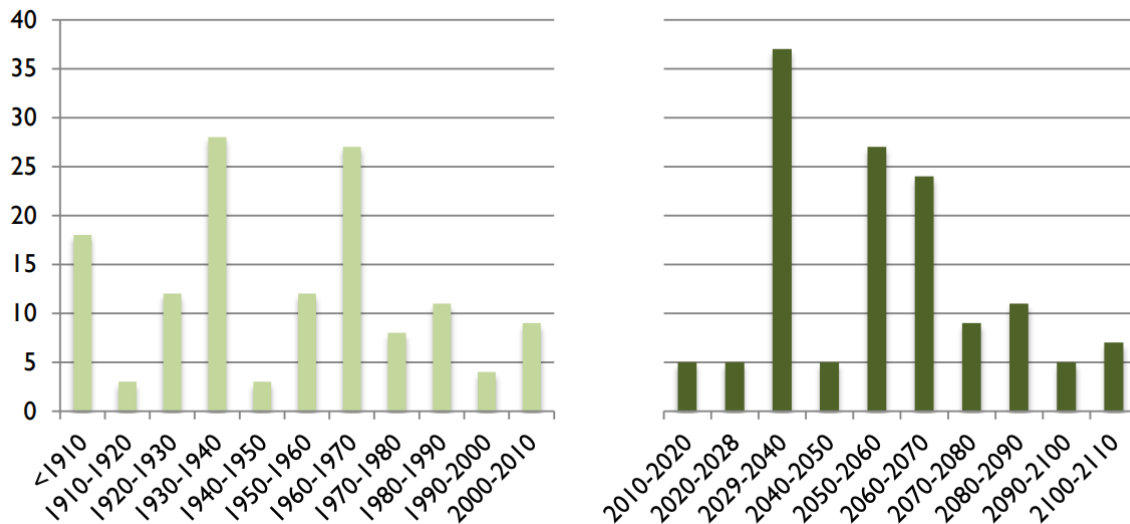


Figure 23: Constructed locks before 2010 and estimated per decade based on construction year (Willems & Busscher, 2014)

The increase in transport via inland vessels and the aging of the locks led to bottlenecks in the waterway network of the Netherlands. The six locks that were the main bottlenecks needed to be expanded, these six were the construction of a floodgate at Limmel, the construction of a second lock chamber at Eefde, the construction of a third lock chamber at the Beatrixsluis nearby Utrecht, the construction of a new sea lock in IJmuiden, the construction of a new sea lock in Terneuzen and the reinforcement and the construction of new floodgates at the Afsluitdijk (Stroeve & Peschier, 2018; Vonck, 2014). The main question at Rijkswaterstaat was how to sell and construct these projects in a relatively small amount of time, i.e. 10 years. One option was to treat these projects as separate projects, however, due to the limited capacity at Rijkswaterstaat and at the market, it is decided to merge these more or less similar projects into one programme. This led to an increased efficiency due to the collaboration between the teams of Rijkswaterstaat and due to the usage of the skills of one person for multiple projects (Stroeve & Peschier, 2018). Another reason for the programme is that five out of six projects, Terneuzen excluded, are procured with a DBFM contract, which was new for the “wet” sector of Rijkswaterstaat. There was experience within DBFM for “dry” projects like roads, however, it is hard to compare these projects. A lock has more functions than just the passage of vehicles, but should also encompass the passage of ships, the retaining of water and the water management.

The two main factors for the Sluizenprogramma are collaboration and knowledge exchange. To enable these factors a different way of working is implemented in Rijkswaterstaat. An example of that is the knowledge exchange between the managers of the five IPM disciplines, namely technical management, contract management, stakeholder management, project control management and project management. The managers of these five disciplines of the different projects meet regularly to exchange experiences and bottlenecks that might help other managers if they face the same problem. One of the main effects of these meetings is that the requirements in the contract were specified more clearly and therefore the market understood the contracts better (Stroeve & Peschier, 2018).

Each of the projects that is included in the Sluizenprogramma is discussed in the following paragraphs.

C.1 Flood gate Limmel

The old lock was constructed in the period between 1930 and 1935. The lock is the connection between the Julianakanaal and the Meuse. The lock chambers were 136 by 16 meters. The lock would only function if the discharge of water in the Meuse would rise above 1300 m³/s. This ensures that the water level in the Julianakanaal would not be too high (Rijkswaterstaat, 2009). However due to the increase of the size of inland vessels, the lock isn't large enough to encompass this grow and thus a new lock is needed (Rijkswaterstaat, 2015a; Wansink, 2015).

The new lock is constructed in a different way than the old lock. The old lock consisted of two lock chambers, where the new lock only consists of a single steel liftgate. Due to this new design, the lock can fit inland vessels with a length of maximal 190 meters a width of 11.4 meters and a depth of 3.5 meters. The liftgate will only close if the water discharge in the Meuse rises above 1300 m³/s, just like the old lock. The uniqueness of this new lock is that it is the first lock worldwide to be constructed via a DBFM contract (Rijkswaterstaat, 2015a; Wansink, 2015). The contractor of this new lock is a combination of the Belgium construction company Besix and Rebel, a Dutch investment and advisement company. The construction started in mid-2015 and was completed in May 2018 with a total budget of 60 million euros (Rijkswaterstaat, 2015a).

C.2 Lock Eefde

The lock at Eefde was constructed between 1930 and 1933 and it is located in the Twentekanaal, which forms the connection between the IJssel and cities like Almelo and Enschede. The lock consists of one chamber with a size of 133 by 12 meters. The lock is the only connection between the IJssel and the Twentekanaal and uses liftgates to lock the ships. The lock, including the pumping station, is a national heritage site of the Netherlands. However, due to the increase in traffic over the water and that there is only one lock chamber the waiting time for inland vessels rose over the last years to more than 30 minutes, which makes the travel times unreliable. Furthermore, due to the fact that there is only one lock chamber, the lock is vulnerable for malfunctions (Bierman Henket Architecten, 2012; Ministerie van Verkeer en Waterstaat, 2004; Rijkswaterstaat, 2017b).

To make the lock less vulnerable and to reduce the waiting time, a new lock chamber is being constructed. This chamber is suited for ships of 110 by 11.4 meters. The chamber has two types of doors, a mitre gate on the side of the IJssel and a radial lock gate on the Twentekanaal side. The radial lock door for this lock is the first radial lock door applied in the Netherlands. An important aspect of this lock is that this lock is energy-neutral due to the incorporation of solar panels in the design. The new lock chamber is constructed by a Dutch Contractor TBI and started in 2017 and has a planned completion date in the summer of 2020. The total costs for this chamber are scheduled to be 80 million euros (Koenen, 2017b; Ministerie van Verkeer en Waterstaat, 2004; Rijkswaterstaat, 2017b).

C.3 Beatrixsluis

The current lock of the Beatrixsluis is built around the year 1939 and is located in the Lekkanaal, which connects the Lek and the Amsterdam-Rhine channel. This route is the main connection between the ports of Rotterdam and Amsterdam. The old lock consists of two lock chambers, each with a length of 225 meters and a width of 18 meters (Rijkswaterstaat, 2019b). A unique aspect of this lock is that it is the largest monumental inland shipping lock in the Netherlands (Koenen, 2016a). However, this lock doesn't satisfy anymore, due to the low capacity and the relatively small lock chambers. The expectation is that the average waiting time will increase to more than 30 minutes, which is the limit on this kind of infrastructure (Rijkswaterstaat, 2014).

To increase the capacity there has been chosen to construct a 3th chamber. This chamber is at least 276 by 25 meters and has four rolling doors, two on each side. The advantage of the four rolling doors is that if one of the doors fails, there is always immediately a back-up door available. Furthermore, if only the outer doors are used the length of the chamber becomes 300 meters, which enables two ships of 135 meters long to be locked at the same time. Besides the construction of the third lock, the former dwellings of the lockkeepers are being transformed into the lock operation centre and the Lekkanaal is being widened. The new chamber, including the extra activities, are constructed by the combination Sas van Vreeswijk, which consists of Besix, Rebel, TDP, Heijmans and Jan de Nul. The construction started in 2016 and it is planned that the construction and the restoration of the other two chambers is finished in 2019. The total costs for this project are 133 million euros (de Leeuw, 2018; Koenen, 2016a; Rijkswaterstaat, 2014, 2015b)

C.4 Sea Lock IJmuiden

The lock complex of IJmuiden consists of four locks, namely the Kleine Sluis, de Zuidersluis, the Middensluis and the Noordersluis. The most important one for this research is the Noordersluis, which is the largest lock of the complex. The reason that this one is the most important is that the new lock that is being build is a replacement for this lock. The construction of the Noordersluis was finished in 1929 and at that time it was the largest lock in the world. The lock is located in the Noordzeekanaal, which connects the port of Amsterdam with the North Sea. The size of the lock chamber is 400 by 50 by 15 meters and it has two functions. On one hand the function is to lock ships and on the other hand, it is part of the primary flood defence system of the Netherlands (Provincie Noord-Holland, 2012; Wernsen & Lous, 2017). The reason for the construction of a new lock is twofold, namely due to the end of both the technical and the economical lifespan of the old Noordersluis and due to the increase of size of the vessels that want to go to the port of Amsterdam (Bureau B+B, 2015; Provincie Noord-Holland, 2012; Wernsen & Lous, 2017).

The new lock is constructed between the old Noordersluis and the Middensluis. The lock chamber has a length of 500 meters, a width of 70 meters and a depth of 18 meters. The lock is, just as all the locks of the complex, part of the primary flood defence system of the Netherlands and therefore the water retaining function is just as important as the locking function. This new lock is, just as the old lock when the construction was done, the largest lock in the world. Another interesting aspect is that the lock will be constructed with three equal doors, two functioning and one spare. The construction work is performed by the combination OpenIJ, which is a consortium of BAM and Volkerwessels, two large Dutch contractors (Lichtendahl & Rienstra, 2016; Wernsen & Lous, 2017). The construction works started in 2016 and it was planned to be completed in 2019. However, due to a design flaw part of the construction works needed to be changed and the completion date shifted to 2022 (ANP, 2017; Koenen, 2018d). This flaw not only changed the completion date, but also impacted the budget of the lock. It was awarded for 600 million euros, but there has been an increase of in total 199.5 million euros (Koenen, 2018d).

C.5 Lock Terneuzen

The lock complex of Terneuzen consists of three locks, namely the Westsluis, the Oostsluis, both built in 1963, and the Middensluis, built in 1910. The locks are located in the Kanaal Gent-Terneuzen, which forms the connection between the Western Scheldt and the port of Gent. The Westsluis is the largest lock in the complex, with a length of 290 meters and a width of 40 meters. The Oostsluis is a bit smaller with a length of 280 meters by 23 meters. The Middensluis is the smallest lock with a length of 110 meters and a width of 18 meters (Nieuwe Sluis Terneuzen en Zandbeek, 2018). There are four reasons for the construction of the new lock. The first reason is that there is a limited capacity and therefore the goods are more and more transferred over the road or via the rails instead of over the water. The second reason is that due to the low capacity, there is an increase in waiting time and currently the waiting time exceeds the limits. Thirdly, the

availability and the reliability of the current locks are not optimal, due to the fact that these locks are the only connection between the port of Gent and the North Sea. Lastly, the dimensions of the locks are relatively small and the locks can't cope with the scaling of the maritime sector (Ministerie van Infrastructuur en Milieu, 2016).

The new lock will replace the current Middensluis and will have a length of 427 meters and a width of 55 meters. The lock will have four rolling doors to increase the availability and the reliability of the lock. Furthermore, the lock will be energy-neutral, and the construction of the lock will be as sustainable as possible. The construction works are executed by combination Sassevaart, which consists of BAM, DEME Group and Algemene Aanemingen Van Laere. The construction started in 2018 and is planned to be finished at the end of 2022. The budget for this project is 934 million euros. This project is the only project in the Sluizenprogramma, which not has a DBFM contract, instead, this project has a Design & Construct contract (Ministerie van Infrastructuur en Milieu, 2016; Nieuwe Sluis Terneuzen en Zandbeek, 2018).

C.6 Afsluitdijk

The Afsluitdijk is constructed between 1927 and 1932 and it is a dam of 32 kilometres, connecting Den Oever and Kornwerderzand. The main objectives of this dam were to shorten the coastline and to create new land. To make it possible for ships to pass the dam, two lock complexes were build, one on each side of the dam (Feddes/Olthof landschapsarchitecten & Architectenbureau Paul de Ruiter, 2015; Ministerie van Infrastructuur en Milieu, 2017). The lock at the Den Oever side, the Stevinluis, is 120 meters long, 13 meters wide and 3.5 meters deep. The other lock complex at Kornwerderzand, named the Lorentzsluizen, consists of two locks. The larger lock chamber is 120 by 13 by 3.5 meters and the smaller lock chamber is 67 by 8.2 by 3.5 meters (Rijkswaterstaat, 2019b). The Afsluitdijk is can be seen as an international statue of the Dutch hydraulic engineering (Ministerie van Infrastructuur en Milieu, 2017). However, it is determined in 2006 that the water retaining function of the dam doesn't satisfy the requirements anymore. Another aspect is that surplus water of the IJsselmeer is discharge on the Wadden Sea with the use of a scour outlet. However, due to the increase in sea level, there will be less occasions that this can happen without pumping (Rijkswaterstaat, 2016).

The main construction work consists of four parts, namely the dam, the Stevinluis, the Lorentzsluizen and the A7. To make sure that the dam satisfies the requirements for water safety a new revetment will be constructed. The new revetment is made up from special concrete blocks designed by BAM, one of the contracting parties. With the new revetments, the Afsluitdijk is more robust for overtopping. At the Stevinluis and at the Lorentzsluizen a floodgate will be installed to protect the locks from extreme high water and waves. The contractor is combination Levvel, which consists of BAM, Van Oord and Rebel. The construction started in 2018 and is planned to be finished in 2022. The total costs for this project is 550 million euros (Rijkswaterstaat & Levvel, 2018).

Appendix D Events in the DBFM model agreement

This chapter describes the events that according to the model agreement are part of one of the three main events, namely the events of compensation, the events of delay and the events of force majeure.

The events of compensation:

- Shortcoming client.
- Change by the client.
- Change in law.
- Implementation of measures for traffic safety on request of the client.
- The client granting access to third parties during the construction period.
- Damage to infrastructure that is the result of an incident or incident management.
- Damage to RWS infrastructure caused by third parties assigned by the client.
- In the events of a force majeure and the client needs to take certain measures.
- An administrator of third-party infrastructure isn't obeying to the implementation agreement.
- An administrator of cables and pipes isn't obeying to the contract agreement.
- The delivery and the placement of signage, including a signage plan, by the national signing service.

The events of delay:

- An event of compensation.
- An event of force majeure.
- The usage of the right by the financiers based on their direct agreement.
- The route decision didn't become irrevocable on a certain date.
- The client doesn't provide access to the project site before the agreed date.
- The delay caused by a delayed decision of a governmental body.
- A decision of a governmental body to withdraw a permit that the contractor needs and the request is conforming the regulations.

The events of force majeure:

- Disruption of financial markets before financial close.
- War, civil war, terrorist attacks, hostile actions, rebellion or armed revolt.
- Nuclear explosions or other explosions not caused by the contractor.
- Ionic radiation or radioactive, chemical or biological pollution in or close to the project site, to the extent that it appears after the contract close and not caused by the contractor.
- The crash of an air or spacecraft or damages by a supersonic aircraft.
- The impact of a meteorite, volcanic disruption or a hurricane.
- Earthquake larger than a 6 on the scale of Richter.
- Flooding due to local precipitation or leakage of infrastructure not caused by the contractor.

Appendix E Risk management

There are several ways to implement some sort of risk management. This research will describe two methods, namely the ISO method and the RISMAN method. The reason for these two methods is that the ISO method is the international standard, which describes the points that should be taken into account and is accepted worldwide, while the RISMAN method, which describes a way of working, is the most applied tool in The Netherlands for risk management.

E.1 ISO 31000

The international standard is described in the ISO 31000 Risk Management – Guidelines. These guidelines consist of three clusters, namely principles, a framework and a process. The principles that should be taken into account are:

- Risk management should be integrated in all activities.
- Risk management should be structured and have a comprehensive approach.
- The framework and process should be customized to the organization.
- The stakeholders should be involved timely.
- The risk management should be dynamic, since risks can change over time.
- The input of risk management should be based on the best available information.
- It should be noted that human behaviour impacts all the aspects of risk management.
- The risk management should be continually improved (International Organization for Standardization, 2009).

The goal of the framework is to assist an organization to implement risk management. The steps described in the framework focus on tasks to integrate risk management in the activities, to design the risk management process for the organization, to implement it, to evaluate it and to see what could be improved, to improve the process and integrate the risk management again. A central role is reserved for the leadership and commitment by the higher management. They should oversee the bodies and ensure that risk management is integrated into all activities of the company (International Organization for Standardization, 2009).

The actual process of risk management is an iterative process in which the main activity is the risk assessment, in which the risks are identified, analysed and subsequently evaluated. Based on the risk assessment a treatment for every risk is selected. The input for the risk assessment is the scope, context and criteria of the organisation, the communication and consultation of relevant stakeholders and the monitoring and review of the process. The last activity consists of the recording and the reporting of the risks and their treatment and thereafter the process starts again (International Organization for Standardization, 2009).

The overview of the three clusters and the different aspects can be found in Figure 24.

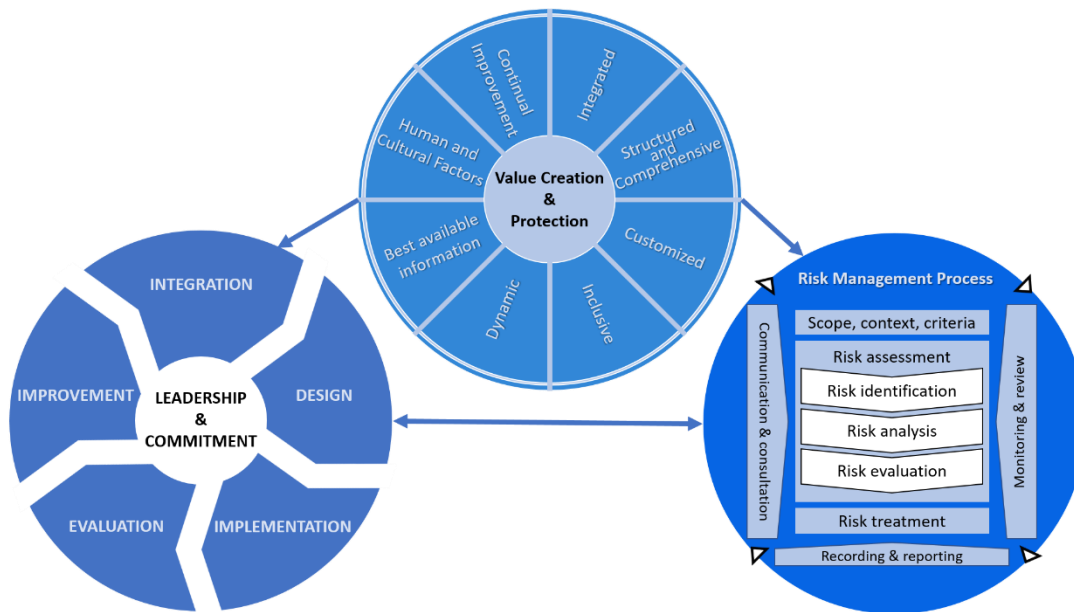


Figure 24: The three clusters of the ISO31000 (International Organization for Standardization, 2009)

E.2 The RISMAN method

The RISMAN method is developed by Rijkswaterstaat, Twynstra Gudde, the Delft University of Technology and Gemeentewerken Rotterdam. This method is developed in 1995 as a tool for risk analysis and was adopted by the market in 1999 for the whole process of risk management. The method can be applied to all sorts of projects, either large or small. The method describes both the risk analysis as well as the risk management (van Well-Stam et al., 2008).

The risk analysis is always the first step in the risk management process. This analysis can be subdivided into four steps, namely setting the goal, mapping the risks, determining the most important risks and planning the control measures. The goal of the risk analysis is an important first step, since it determines the completion of the next steps in the process. Within this first step it is necessary to answer the following questions:

- What do you want to achieve with the risk analysis?
- On which of the control aspects, i.e. time, money, quality, is the focus of the risk analysis?
- On which part and which phase of the project is the risk analysis focussed?
- Is it a qualitative or a quantitative risk analysis?
- Which information is available and useful? (van Well-Stam et al., 2008)

The second step in the process is to identify the different risks. This method defines a risk as 'chance' times 'consequence'. Within the RISMAN method, risks can be categorized into several perspectives: technical, organizational, urban planning, political, juridical, financial and social. The project is viewed from the different perspectives and that way the risks can be identified (van Well-Stam et al., 2008).

The third step in the risk analysis process is to determine which risks are the most important. As is stated in the previous paragraph, this method uses the quantitative definition of risk and therefore the determination of the most important risks is also quantitative. The method describes two ways of quantifying the risks. The first way is to have a chance/consequence matrix, in which the axes are formed by chance/consequence grades. The risks are scored according to the chance grade and multiplied by their consequence grade and this provides a risk ranking. The other way of determining the most important risks is to have a group of people score the risks

based on what they believe is the most important risk. Subsequently, the risks that have been awarded the most points is the most important risk and so forth (van Well-Stam et al., 2008).

The fourth step is the identification of the control measures. These control measures can be divided into two groups, namely to either take the risk yourself or to transfer the risk. If the risk is retained by the organization, there are three possible control measures, either to avoid the risk, to reduce the risk by either reducing the consequences or the chance of the risks firing or to accept the risk at it is. If the risks are being transferred, they could be transferred to an insurance company, a (sub)contractor or to a third party. The principle of deciding to either retain a risk or to transfer the risk is the process of risk allocation, which is elaborately described in the next paragraph (van Well-Stam et al., 2008).

After the risks are being analysed and the control measures are identified, the actual risk management process can start. The risk management process consists of four iterative steps, namely to determine the control measures, to execute the control measures, to evaluate the control measures and to update the risk analysis (van Well-Stam et al., 2008).

The overview of the different steps can be found in Figure 25.

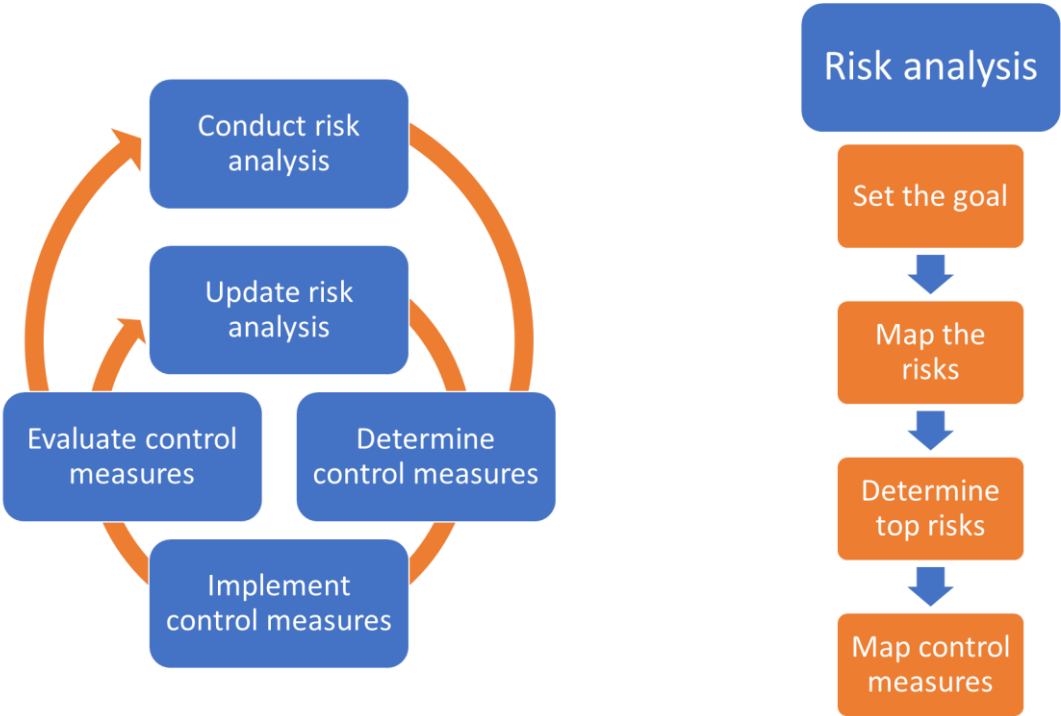


Figure 25: RISMAN method for risk management³

³ Adapted from: (van Well-Stam et al., 2008)

