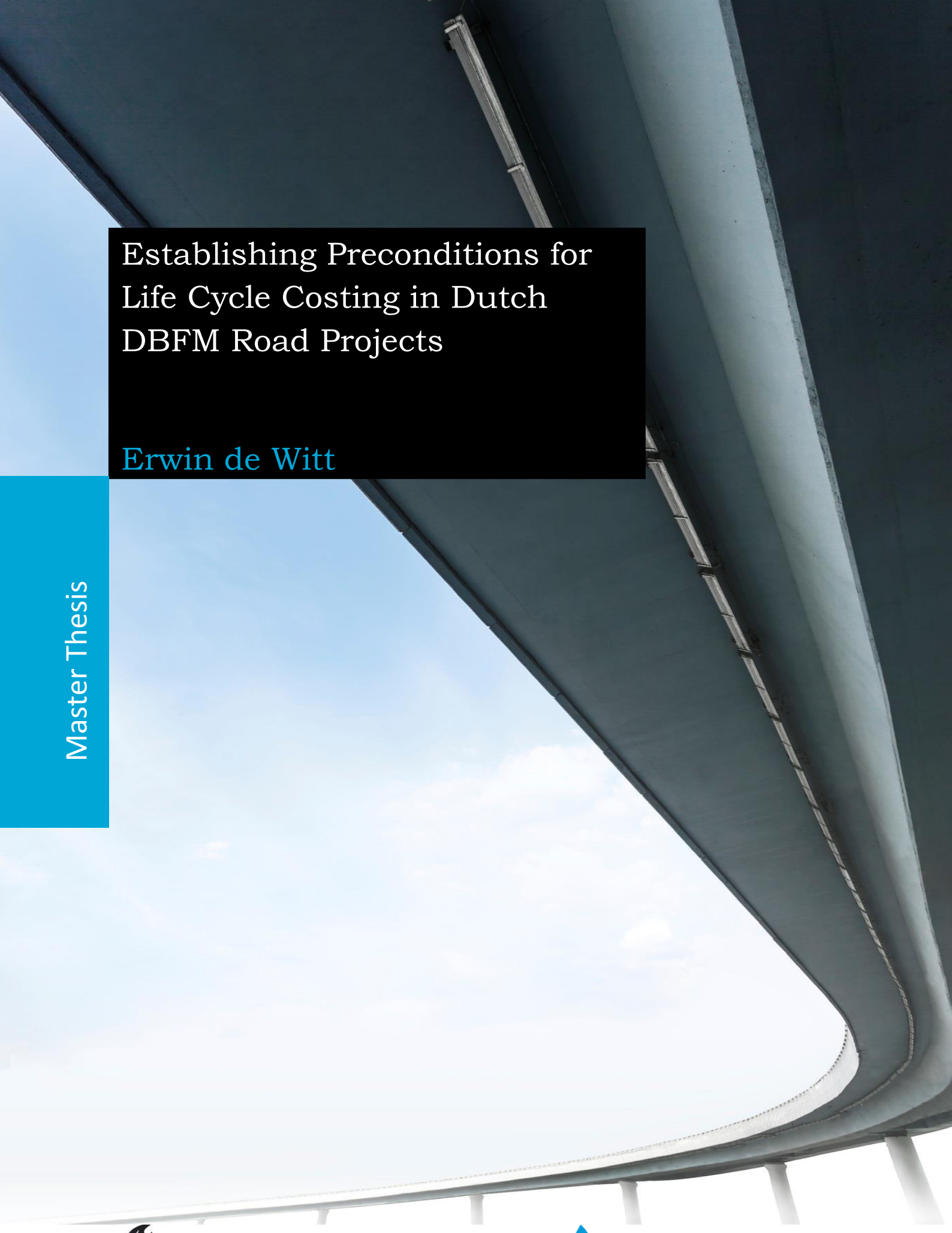

Establishing Preconditions for Life Cycle Costing in Dutch DBFM Road Projects

Erwin de Witt

Master Thesis

TU Delft Delft University of Technology

ITERFIDELIS Asset, Ageing & Risk Management

Challenge the future

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PERSONAL DETAILS

Author:	Erwin de Witt
Student number:	1304380
Telephone number:	+31 645004171
Email:	e.dewitt@student.tudelft.nl

STUDY PROGRAM

Study Program:	Construction, Management and Engineering
Graduation department:	Policy, Organization, Law & Gaming
Faculty:	Technology, Policy and Management
University:	Delft University of Technology

GRADUATION COMMITTEE

Chairman:	Prof.mr.dr. E.F. ten Heuvelhof
First Supervisor:	Dr. W.M. de Jong
Second Supervisor:	Mr. F.A.M. Hobma
Supervisor Iter Fidelis:	Ir. M. Eggink

GRADUATION COMPANY

ITER FIDELIS B.V.
Computerweg 2
3542 DR Utrecht
Tel: +31 346 544 497

Preface

This report is the result of my graduation project at the TU Delft of the master Construction Management & Engineering (CME). Even though I sometimes struggled with constant focus on one topic, I am pleased with the final result. The thesis combines management and construction, in my opinion the essence of the master CME and a valuable set of skills for the engineer of today.

The most challenging part of this research was to translate the identified problems into valuable solutions, without getting lost in the complexity of large projects and the construction industry. Despite this difficulty, I managed to write a concise and complete report.

I would like to conclude by thanking the people who supported me with my research. First of all I would like to thank may direct supervisors, Martin, Martin, Fred and Ernst. Secondly I would like to thank the people at my host company Iter Fidelis, who gave me the opportunity to conduct this research and facilitated me with a comfortable and stimulating environment for my research. At last I would like to thank the interviewees for their time and their openness. The interviews provided me with a lot of insights into the current industry and provided thereby an essential part of my thesis.

Summary

Historically, the Dutch public road authority (Rijkswaterstaat) had the responsibility for initiation, design, built, finance, operation and maintenance of road infrastructure projects. Fairly recently, integral DBFM) contracts have been introduced to road infrastructure. In a DBFM contract, a private party is responsible for Designing, Building, Financing and Maintaining a certain infrastructure section, usually for a period of 25 years. The road authority stays the owner and operator of the infrastructure and pays the private party for the availability of the road.

Before the introduction of DBFM, private parties were only responsible for one of the components (design/construct/maintain). Rijkswaterstaat had the overall responsibility and was responsible for integrating the components. The aim of Rijkswaterstaat was to create the lowest possible cost over the life cycle of a section of road infrastructure; this is referred to as Life Cycle Costing (LCC). With the introduction of DBFM this role switched to the private parties (or consortia). Life Cycle Costing is one of the 'core values' of DBFM and is the process of maximizing return on investment by combining capital investment decision making and operation & maintenance decision making for the total life cycle of a project. Pursuing LCC benefits the private party as wells as the public party. However there is doubt if the current approach of consortia in DFBM road projects optimal facilitates Life Cycle Costing in DBFM projects. Earlier research shows that there is considerable room for improvement, when it comes to applying Life Cycle Costing within DBFM consortia.

This research examines how consortia can improve the application of Life Cycle Costing during the realization phase (Design and Build) of DBFM projects. The goal of this research is to develop a framework to support consortia in DBFM road projects in the Netherlands. The framework should improve Life Cycle Costing in Dutch DBFM road projects by establishing the right preconditions.

From two cases and expert interviews elements are identified which positively influence (enablers) or negatively influence (disablers) the application of LCC during realization. Based on the interviews and cases the identified elements are ranked. The ranking establishes the undisputed elements. The line of reasoning is that if a disabler or enabler is undisputed, it should be included in the framework. The optimal framework should solve all the undisputed disablers and include all the undisputed enablers. Using the ranking, 16 of the 29 identified disablers should be included in the framework. However, none of the enablers are considered undisputed, this could be explained by the fact that multiple solutions (enablers) are available for one problem (disablers).The enablers are therefore considered as suggestions for possible solutions.

From an actor analysis appears that the considered most important actors (lenders, shareholders, Rijkswaterstaat and subcontractors) have an interest in, and have the power to influence the private consortia; a Dutch DBFM road project is a multi-actor environment. The consortia should consider this multi-actor environment, the multi-actor environment should thus be included in the framework.

Using the disablers, 10 problem statements are derived. For each problem statement one or multiple preconditions are formulated to deal with this problem. With the established preconditions a framework is composed. This framework is called the single-actor framework, since the framework does not include the multi-actor environment. The single-actor framework is presented in Table 1.

TABLE 1 SINGLE-ACTOR FRAMEWORK

No.	Precondition	Supporting conditions
1	**Avoid the traditional construction culture on LCC determining positions.**	1. LCC determining positions are identified. 2.Traditional persons are avoided on determining positions. 3. Strengths of the traditional construction culture are used.
2	**Involve companies experienced in Life Cycle Costing.**	1. Experience from other sectors is considered (Oil&Gas, Process industry, etc.) 2. Experience from the construction sector is considered.
3	**The main criterion for the selection of consortium partners is the contribution to the overall project interest.**	1. Shareholders are not selected primarily for their specific knowledge. 2. There are no assigned important subcontractors. 3. Subsidiaries are treated as external companies. 4. There are no long-term subcontractors.
4	**The Project Company is financially involved with the risk and the opportunity of Life Cycle Costing.**	1. The Project Company shares in losses and benefits with the EPCM. 2. Management of the Project Company is assessed on NPV. 3. The Project Company has the capacity to steer the EPCM.
5	**The financial consequences of technical solutions are easy available at operational level.**	1. Availability payments, time-value of money, cost of finance, etc. are available to include in LCC considerations.
6	**Shareholding companies have sufficient financial and technical knowledge available.**	1. Shareholding companies understand the technical risks and challenges of the project. 2. Shareholding companies have sufficient financial knowledge to obtain a strong negotiating position.
7	**The responsibility for both realization and exploitation is with the EPCM.**	1. Design, realization and exploitation are the responsibility of the same management. 2. The EPCM management is assessed on NPV of the project.
8	**Persons for key project positions are first selected on capabilities instead of shareholder representation.**	1. On strategic, tactical and operational level an important selection criterion is understanding and propagating the project interest. 2. (excluding the board) Shareholder representation is not a selection criterion.
9	**Gradually build-up the realization organization.**	1. The vision of the tender is adopted and expanded during realization. 2. Realization starts with the identified key positions. 3. Staff involved during tender is involved in the realization.
10	**For the initiators of Life Cycle Costing it is clear what the benefits should be and who the decision maker is.**	1. LCC responsibilities (initiating, decision making, implementing) are defined. 2. Benefits of LCC optimisations are noticeable/visible.
11	**Transfer of knowledge is embedded in the project organization.**	1. Experiences from previous DBFM projects are embedded in the project organization.

When the single-actor framework is combined with the multi-actor perspective, it appears that the interests and influences of the different actors limit the solutions in the single-actor framework. Therefore the preconditions of the single actor framework are adapted to the multi-actor environment. This is how the multi-actor framework is composed (Table 2).

TABLE 2 MULTI-ACTOR FRAMEWORK

Ranking*	No.	Precondition	Supporting conditions
1	10	**For the initiators of Life Cycle Costing it is clear what the benefits are and who the decision maker is.**	1. LCC responsibilities (initiating, decision making, implementing) are defined. 2. Benefits of LCC optimisations are noticeable/visible.
3	7	**The responsibility for both realization and exploitation is with the EPCM.**	1. Design, realization and exploitation are the responsibility of the same management. 2. The EPCM management is assessed on NPV of the project.
3	9	**The build-up of the realization organization is gradually.**	1. The vision of the tender is adopted and expanded during realization. 2. Realization starts with the identified key positions. 3. Staff involved during tender is involved in the realization.
3	11	**Transfer of knowledge is embedded in the project organization.**	1. Experiences from previous DBFM projects are embedded in the project organization.
5	6	**Shareholding companies have sufficient financial and technical knowledge available.**	1. Shareholding companies understand the technical risks and challenges of the project. 2. Shareholding companies have sufficient financial knowledge to obtain a strong negotiating position.
7	1	**Acknowledge, reduce the influence of, and make use of the traditional construction culture.**	1. LCC Determining positions are identified. 2. Traditional cultural strengths are used.
7	5	**At operational level different technical solutions can be compared on Life Cycle Costing.**	1. The tools to assess potential optimizations are available at operational level.
8	4	**The DBM components are contracted 'back-to-back' to the EPCM, the Project Company is expanded with staff that is responsible for adopting LCC within the EPCM.**	1. The additional staff has authority and power to influence the EPCM. 2. The additional staff has authority and power to influence the Project Company. 3. The additional staff is assessed on NPV
9	8	**Persons for key project positions are first selected on capabilities, shareholder representation is considered over the total project organization.**	1. On strategic, tactical and operational level an important selection criterion is understanding and propagating the project interest. 2. Key positions are not restricted to a certain shareholder.
10	2	**Involve companies experienced in Life Cycle Costing.**	1. Experience from other sectors is considered (Oil&Gas, Process industry, etc.) 2. Experience from the construction sector is considered.
11	3	**The main criteria for the selection of consortium partners are the contribution to the overall project interest, and the clients elegibility requirements.**	1. Shareholders can be selected for specific knowledge. 2. There are no assigned important subcontractors. 3. Subsidiaries are treated as external companies. 4. There are no long-term subcontractors.
* preconditions are ranked from easy to implement (1) to difficult to implement (11) compared with each other			

This research shows that there is still considerable room for improvement, in terms of Life Cycle Costing (LCC), in the realization phase of Dutch DBFM road projects. The fundamental goal for shareholders of DBFM consortia, maximization of shareholder value, equals optimization in terms of LCC. However, current organizational forms, contracts, and methods used prevent these from reaching this overall goal.

If the frameworks are compared: preconditions in the single-actor framework will eventually lead to more improvement regarding LCC, and therefore describes a more perfect situation. However, considering the multi-

actor environment, the single-actor framework is unrealistic and thus not implementable. The multi-actor framework is realistic and implementable, but therefore also time-bound. The single-actor framework is less time-bound and can be combined with a changed multi-actor environment to create again a realistic and implementable framework. Because of the focus of this research (strategic and tactical level) the framework covers a broad spectrum of solutions. The framework is thereby complete but does not deliver turnkey solutions. Therefore it is recommended that additional research is done to create more specific solutions..

The frameworks established in this research should be used for the further improvement of the application of LCC in the realization of Dutch DBFM road projects. Current and future DBFM consortia are recommended to use the frameworks. This research improves Life Cycle Costing in DBFM projects. Both private and public party will, in de long run, benefit from an improved application of Life Cycle Costing.

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1 INTRODUCTION

1.1 OCCASION

Transport is essential in both developing and developed nations, many governments have assigned transport an important role as key to economic development (United Nations, 2006). This also applies to the Dutch government, which acknowledges the importance of transport for the development of the Netherlands (Ministerie van Infrastructuur en Milieu, 2012). Because of the great importance, the government bears the responsibility for providing adequate transport facilities in the Netherlands.

Adequate transport facilities in the Netherlands are largely achieved by proper road infrastructure. Historically, the Dutch public road authority (Rijkswaterstaat) had the responsibility for initiation, design, built, finance, operation and maintenance of road infrastructure projects. Fairly recently, integral DBFM contracts have been introduced to road infrastructure. In a DBFM contract, a private party is responsible for Designing, Building, Financing and Maintaining a certain infrastructure section, usually for a period of 25 years. The road authority stays the owner and operator of the infrastructure and pays the private party for the availability of the road (Lenferink, 2012).

The transfer of the responsibility for financing enables the government to initiate projects without major investments stretching the government budget (van Ham & Koppenjan, 2002). Additional to financial reasons, there are other reasons for governments to use DBFM. DBFM has the potential to accelerate project delivery, and perform operation and maintenance in more cost-effective manner enabling the public sector to effectively do more with less (Altamirano, 2010).

Before the introduction of DBFM, private parties were only responsible for one of the components (design/construct/maintain). Rijkswaterstaat had the overall responsibility and was responsible for integrating the components. The aim of Rijkswaterstaat is to create the lowest possible cost over the life cycle of a section of road infrastructure; this is referred to as Life Cycle Costing (LCC). With the introduction of DBFM this role switched to the private parties. This new role poses new challenges for the private parties in DBFM projects. One of these challenges is thus the application of Life Cycle Costing (LCC) in DBFM Road projects. The preconditions private parties should set for a proper application of LCC in DBFM projects is the subject of this research.

1.2 BACKGROUND

The background of this research is twofold. It is a graduation project of the master Construction, Management and Engineering at the Delft University of Technology. The research is conducted in collaboration with Iter Fidelis B.V., and contributes to their knowledge development in the field of DBFM projects.

DELFT UNIVERSITY OF TECHNOLOGY

This thesis is a graduation project for the Delft University of Technology (DUT). The project is the final piece of the master Construction Management & Engineering (CME). CME is an interfaculty master provided by the three faculties (Architecture; Civil Engineering and Geoscience; Technology, Policy and Management). This research is carried out at the faculty Technology, Policy and Management for the department of Policy, Organization, Law & Gaming.

ITER FIDELIS

This research is executed in collaboration with Iter Fidelis. Iter Fidelis is a small consultancy company established in 2008 and is part of the larger Oxand Group. A French international engineering and consulting firm specializing in risk-based management of infrastructure.

More than 50 % of the turnover of 2011 and 2012 of Iter Fidelis is directly related to DBFM projects (Iter Fidelis, 2013). It is therefore safe to say that DBFM projects are the core business of Iter Fidelis. In these DBFM projects Iter Fidelis consultants fulfil different parts, both in the tender, realization and operation phase at different levels in the private project organization. Iter Fidelis focuses in these projects on linking process and technology.

This research is used for the development of knowledge within the company. Using this study Iter Fidelis is better able to support and advise their clients in current and future DBFM projects.

In DBFM projects Iter Fidelis always works for the private party. Because of the large scope and the long duration of DBFM projects, the private party is generally a consortium of construction companies (Bruggeman, et al., 2010). These consortia are the clients of Iter Fidelis in DBFM projects, the following section discusses these consortia.

CONSORTIA

In the current Dutch DBFM projects only the nine largest Dutch construction companies are involved. These companies are the only Dutch contractors with an annual turnover exceeding one billion euro (Table 3). Nevertheless, all DBFM project in the Netherlands are adopted by a consortia. Besides Dutch construction companies also construction companies from other countries are active in the Dutch DBFM market; in comparison Koninklijke Bam Groep occupies the twelfth place on the top-100 largest construction companies of Europe, the largest is Vinici with an annual turnover exceeding the 37 billion (Sleight, 2012). Also investors and other financial institutions may own shares of the consortia (Appendix 0).

Company	Turnover 2011 (x €1000)
Koninklijke BAM Groep	7.920.108
Koninklijke Volker Wessels Stevin	4.712.510
Koninklijke Boskalis Westminister	2.801.037
Heijmans	2.361.337
TBI Holdings	2.171.952
Van Oord	1.714.960
Ballast Nedam	1.382.000
Strukton	1.317.976
Dura Vermeer	1.164.351
Van Wijnen Holding	635.232

TABLE 3 TOP-10 DUTCH CONSTRUCTION COMPANIES AND YEARLY TURNOVER (COBOUW, 2012)

A consortium of companies, usually called Project Company, lies in the centre of all the contractual and financial relationships. The Project Company signs the contract with the client (usually Rijkswaterstaat issuing the contract) and is therefore responsible for a proper execution of the total DBFM project.

As a result, the DBFM consortia can be appointed as the problem owners of this research. The consortia sign the contract with the public authority and get paid for the services; they are responsible for a proper execution of the DBFM project.

Life Cycle Costing is one of the core values of DBFM projects and therefore one of the main arguments for the government in favour of DBFM (Yescombe, 2007). Further exploration of the application of LCC in DBFM projects has led to a number of observations. On the basis of these observations one can question whether LCC is optimally facilitated using the current approach. This doubt is the start for the research structure following this introduction (Chapter 2).

2 RESEARCH STRUCTURE

The research structure starts with a problem description. The objective, questions, scope and methodology of the research follow the problem description. The chapter ends with a discussion of the relevance of the research. Parts of this research are confidential and are not included in the public report. This research uses sensitive project information and sensitive personal opinions. To protect the projects and the persons interviewed, this information is not displayed in the public report.

2.1 PROBLEM DESCRIPTION

Life Cycle Costing (LCC) is the process of maximizing return on investment by combining capital investment decision making and operation & maintenance decision making for the total life cycle of a project (The Institute of Asset Management, 2012). Capital investments are funds invested in a firm or enterprise for the purpose of achieving pre-defined business objectives. Operation and Maintenance decisions refer to the cost a firm incurs as a result of performing its normal business operations (Brealy, et al., 2008). Applied to a DBFM project this means that, a private party can choose to invest more during construction, if this is reflected in lower maintenance cost and thus a more profitable project at the end of the contracting period. The opposite may also be the case (see chapter 3).

By using DBFM contracts, the government transfers the responsibility for LCC to the private parties. Private parties are considered to be better at applying LCC through greater expertise in designing, building and maintaining. It is therefore one of the main arguments in favour of DBFM projects from a public perspective. The life cycle aspect contributes to a large extent to the argument that DBFM projects offer improved 'Value for Money' (see chapter 3) with respect to traditional procurement (Yescombe, 2007).

Besides the public interest in Life Cycle Costing, also private parties should benefit from LCC. Because total life cycle cost are an important part of the tender process, proper application of LCC will lead to an increased possibility of obtaining a DBFM contract (Ministerie van Financien & Rijkswaterstaat, 2012). In addition, a proper application of LCC during realization of a DBFM project will lead to a higher return on investment during projects as well (The Institute of Asset Management, 2012).

Pursuing LCC benefits the private party as wells as the public party. However there is doubt if the current approach of consortia in DFBM road projects optimal facilitates Life Cycle Costing in DBFM projects.

Traditionally construction companies had only the responsibility for one of the components (Design, Build or Maintain); contractors could acquire projects by offering the different components for the lowest possible cost. The government had the task of integrating the components. With the introduction of DBFM projects this changed; contractors are now responsible for all the components at the same time, this makes Life Cycle Costing possible. Research shows that the optimum project environment in DBFM for applying LCC therefore has not yet been reached:

Lenferink concludes that there is considerable room for improvement, when it comes to Life Cycle integration in DBFM projects (Lenferink, 2012). This conclusion is drawn as a result of multiple interviews, with experts from public and the private parties involved in DBFM projects. An example of this potential improvement is given by Van Heuckelum:

> *The biggest advantage of a DBFM consortium is co-specialization; different companies have other ways of solving problems and combine their strengths in consortia. Van Heuckelum states that through conflicting interest between consortium partners parts of the advantages of co-specialization are lost* (Heuckelum, et al., 2007)*. The degree of co-specialization will certainly influence the potential of LCC; conflicting interest will thus also influence this potential.*

The DBFM contract is currently the standard for complex national infrastructure projects in the Netherlands (Ministerie van Financiën, 2012), these projects are characterized by large numbers of stakeholders, large project scope, large project teams, etc. (Bosch-Rekveldta, et al., 2011). These characterizations are expected to have an influence on the application of LCC in DBFM projects.

From the above it can be concluded that optimal project environment for the application of Life Cycle Costing in DBFM projects has not yet been reached. This research addresses this problem.

2.2 Research Objective

This research contributes to improving the performance of DBFM projects. At the end of this study recommendations can be made for improving Life Cycle Costing in DBFM projects. These improvements will lead to cheaper and more sustainable infrastructure developments. For consorta, this research will lead to a higher return on investment.

The goal of this research is to develop a framework to support consortia in DBFM road projects in the Netherlands. The framework should improve Life Cycle Costing in Dutch DBFM road projects by establishing the right preconditions.

2.3 Research questions

To guide the research towards the goal, main and sub questions are defined. The sub questions help to answer the main research question.

Main question

The main question this research answers is:

What are the preconditions for improving the application of Life Cycle Costing during the realization phase of Dutch DBFM Road projects, and how can consortia combine the preconditions and actors' interests?

Sub questions

To answer the main research question the following sub questions are defined:

1. *Which elements can be identified that positively or negatively influence the application of Life Cycle Costing?*
2. *What are the stance and interests and power positions of the important actors?*
3. *Which preconditions can be established based on the elements identified?*
4. *What are the perspectives of the actors regarding the established preconditions?*
5. *Which preconditions can be established including the actor perspectives?*

2.4 Research Scope

Life Cycle Costing is a way of decision making, which focuses on the optimal solution over the life time of an asset (The Institute of Asset Management, 2012). Decision making is the thought process of selecting a logical choice from the available options (Business Dictionary, 2013). A precondition is defined as a condition or term that must be fulfilled before other thing can happen or be done (OED, 2013). This research focuses thus on the conditions in DBFM consortia that must be fulfilled, before the decision making based on life cycle cost can happen. Therefore, this research focuses on the elements that influence, positively or negatively, the application of LCC in the realization phase of DBFM road infrastructure projects. This research does not examine how the decision making process itself can be improved (Figure 1).

The research is scoped on Dutch DBFM Road projects. It discusses the project mainly from a private perspective. The public authority is included in the form of client and important actor. Not the entire design process of DBFM projects is considered, perhaps in contrast to the expectations, only the realization phase is part of this research. The next section explains this choice.

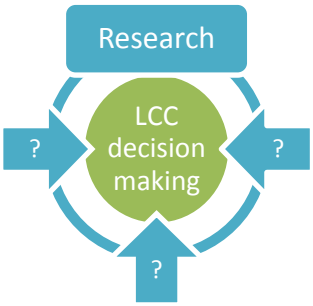

FIGURE 1 PART OF RESEARCH SCOPE: ELEMENTS INFLUENCING LCC DECISION MAKING

REALIZATION PHASE

Realization refers to the phase that begins when the client awards the contract to a consortium and ends when the maintenance (or exploitation) starts (see chapter 3). Other researchers argue that the opportunities for effective LCC are the largest during the earlier project phases (Clift, 2003) (Altamirano, 2010). In DBFM projects this is the tender phase. Nevertheless, this research focuses on the realization phase, as stated in the main question. Study has shown that the design process proceeds according to the Figure 2. After the tender phase a substantial redesign takes place. This indicates the need and the possibilities for LCC during the realization phase.

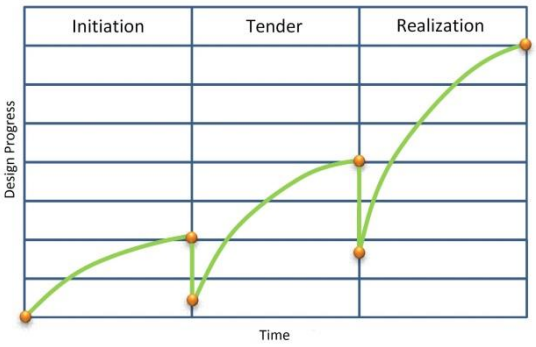

FIGURE 2 DESIGN PROGRESS VS PROJECT PHASE, ADEPTED FROM (FIKKERS, ET AL., 2012)

The fact that most of the project budget is spent during realization (The Institute of Asset Management, 2012) and the concomitant growth of the project organization makes the realization phase more complex (Bosch-Rekveldta, et al., 2011).

There is much opportunity for LCC optimizations during the realization phase of DBFM road projects. During realization the projects are more complex and thus more barriers exist which possibly thwart the application of LCC. For these reasons the research focuses on the realization phase.

MANAGEMENT LEVEL

This research focuses on the strategic and tactical level in DBFM projects (Figure 3). These are the levels where the outline of the project is determined, and thus the level where the preconditions can be implemented. How this strategic level and tactical level correspond with the project organization is discussed in chapter 3.

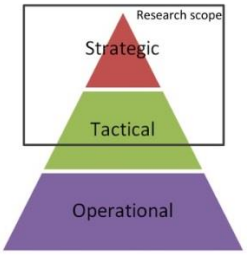

FIGURE 3 LEVELS OF DECISION MAKING

2.5 METHODOLOGY

This section discusses the methodology which will be used to answer the main and sub questions and to reach the goal of this research; a framework of preconditions to support decision making in future DBFM road projects. Figure 4 is a graphical representation of the method. The literature is input for the case study, the case study are input for the expert interviews and actor analyses.

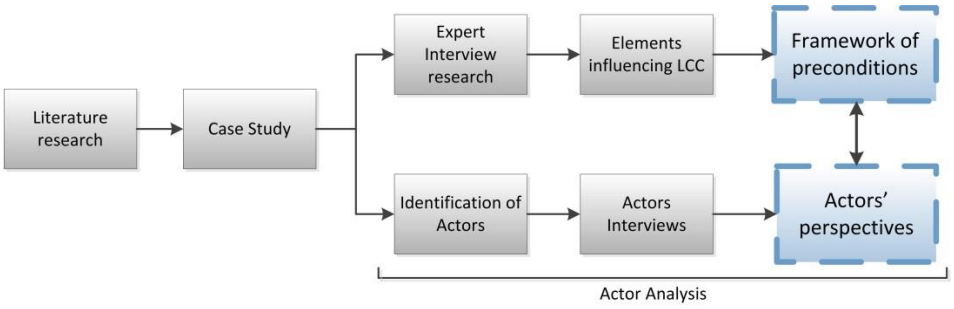

FIGURE 4 METHOD OF RESEARCH

LITERATURE RESEARCH

In the literature study further research is done on the subjects of:

- Public Private Partnerships
- DBFM projects
- Public perspective on DBFM
- Private perspective on DBFM
- DBFM project organization
- DBFM project stakeholders

Besides that the literature study is used to increase the knowledge level of the researcher, the literature study is also used to develop hypotheses about elements that can possibly thwart the application of Life Cycle Costing.

CASE STUDY

To get better insight in the current practices around DBFM projects, two current DBFM road projects are studied. The two projects are Dutch projects in the realization phase. The focus of the study is the organizational structure, and the contractual arrangements. The case study is used to extend the practical

knowledge of the researcher, identify elements that hinder the application of LCC, develop hypotheses about other elements that hinder the application of LCC.

Expert Interview research

The research focuses on the preconditions for LCC, preconditions are set in the higher organizational levels in Dutch DBFM road projects. The interviews for the identification of the elements will therefore be with persons involved at or subject to this organizational level. The interviewees all have worked for consortia in different Dutch DBFM projects. The interviews will be semi-structured. The preconditions are identified by focussing on elements that have a positive or negative influence on LCC in DBFM contracts. During the interviews is focused on three different types of elements: "What", "Who" and "How" elements. "What" of the project in terms of content, "who" of the project in terms of parties involved of perspectives, and "how" of the project in terms of staffing and organizing the project, see Figure 5 (Bosch-Rekveldta, et al., 2011).

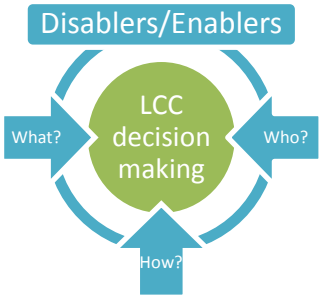

FIGURE 5 RESEARCH APPROACH: IDENTIFICATION OF ELEMENTS INFLUENCING LCC

The interviews are used to identify new elements and to test the hypotheses developed in the literature study and case study.

Actor Analysis (identification and interviews)

The analysis consists of the identification of actors and the identification of the actor's interests. The actors are crucial for the success of a DBFM project. Actors, such as banks, attach great importance to the successful completion of the DBFM project. The identification of the considered actors is done on basis of the literature study. Interviews will be conducted with the considered actors, or their representatives. The interest of different actors will become clear after the analysis of the results of the interviews. The interest of the actors and the power position will be analysed using the findings of the interviews. The interest of the actors is likely to limit the possible preconditions.

2.6 Relevance

This section discusses the practical and scientific relevance of the research. The first section is related to the practical relevance and discusses the value for the consortia of this research. The second section is about the scientific value of this research.

Practical Relevance

Before conducting the research the question must be answered, whether the construction sectors attaches importance to Life Cycle Costing in DBFM road projects. The earlier mentioned benefits for the private party emphasize mainly the potential of LCC; it is unclear whether this potential is large enough for the private sector to act up on.

Lenferink, et al. (2012) interviewed 25 decision makers involved in Dutch DBFM Road projects both from the public and from the private sector. They show that both sectors recognize the added value of systems that stimulate the life cycle perspective in DBFM projects. In addition, they acknowledge the opportunities for LCC,

and indicate that there is still considerable room for improvement for LCC in the field of road infrastructure development (Lenferink, 2012).

The focus on LCC should be important for both the public and the private sector. The public sector would receive improved 'Value for Money' and the private sector would receive higher returns (Yescombe, 2007). The fact that the Dutch government considers the Dutch DBFM contracts successful and leading in Europe (Ministerie van Financiën, 2012), offers many opportunities for Dutch construction companies, both internationally and in the Netherlands. A global survey shows that the Netherlands has one of the most desirable PPP- models in the world (Partnerships Bulletin, 2012)

It can be concluded that private parties value the application of LCC in DBFM road projects. This, in combination with the opportunity for construction companies both internationally and in the Netherlands, makes this research highly relevant from a practical perspective.

Scientific Relevance

In addition to the practical value this research also has scientific value. Most studies describe mainly the public side of DBFM contracts and the relationship between the public and private party (Demirag, et al., 2011). This research focusses almost entirely on the private project organization in DBFM contracts, and contributes to the development of knowledge in this area.

Several studies have been done to identify critical success factors for PPP or PFI projects (Xueqing, 2005), (Hardcastle, et al., 2005), (Jefferies, et al., 2002). The studies all identify a strong private party as critical success factor. However the studies do not go into detail how strong private parties emerge. This study attempts to fill this gap.

3 DESIGN, BUILD, FINANCE AND MAINTAIN

This chapter explains DBFM projects in more detail using literature study. The transition from traditional contracting to DBFM contracting will be explained, and with this the main reasons for a government to choose for DBFM. Thereafter is further focused on the private project approach in DBFM projects, the general approach and the reason for this approach will be discussed. Also the actors involved in the private project organization will be part of this chapter. This chapter does not directly answer one or multiple sub questions, but indirectly contributes to the answering sub question 1 (identification of elements influencing LCC). Through literature study more insights are gained about DBFM projects, this knowledge is used further in this research. Based on these insights hypotheses about elements influencing the application of LCC are developed, these hypotheses are tested during the interviews.

3.1 PUBLIC PRIVATE PARTNERSHIPS

Just before the millennium the Dutch government had to find solutions for a number of urgent matters. Traffic congestion was a problem and the ambition to develop Mainports to stimulate economic activities required large investments in transport infrastructure. During this time two mega-projects (HSL and Betuwe Route) stretched the government budget, this made it difficult to make large investments and led to postponement of other major projects. This resulted in an opportunity for private contribution to public projects and Public-Private-Partnerships (PPP) (van Ham & Koppenjan, 2002). This opportunity for PPP has led to a substantial share of PPP projects in the current transport infrastructure market.

Additional to financial reasons, there are other reasons for governments to adopt PPP. PPP has the potential to accelerate project delivery, and perform operation and maintenance in more cost-effective manner enabling the public sector to effectively do more with less (Altamirano, 2010).

Van Ham and Koppenjan (2002) give a broad definition of PPP in the transport infrastructure sector: *Public-Private-Partnerships are a form of structured collaboration with the construction and exploitation of infrastructural facilities*[1].

The term 'structured collaboration' refers here to the public and the private party who are both risk-bearing in a project. The phrase 'construction and exploitation' refers to the phases of project development where the collaboration takes place. (van Ham & Koppenjan, 2002).

The collaboration between the public and the private sector can take different forms. Figure 6 shows the development of PPP in the Dutch infrastructure. Traditionally the Dutch public road authority (Rijkswaterstaat) worked out their desired solution in detail in a 'RAW-bestek': a specification including technical design, specified materials and construction time. Based on this estimate, contractors could calculate their bid and the lowest contractor was awarded the construction contract. After construction the maintenance was performed by the public authority or contracted separately (See Figure 6, model 1). The next step in the development of PPP was that contractors were made responsible for working out the technical design in an E&C contract (See Figure 6, model 2). Positive experiences led to more extensive contracts (See Figure 6, model 3). The next step in the integration of project phases was the DBFM contract (See Figure 6, model 4) (Lenferink, 2012). The DBFM contract is currently the standard for complex national infrastructure projects in the Netherlands (Ministerie van Financiën, 2012). In other countries the DBFMO (model ?) is often used, which include private operation by tolling e.g. in Spain, Czech Republic and Germany (Yescombe, 2012). Tolling is generally not included in the Netherlands because of the historical availability of good national highway network without tolling (Lenferink, 2012).

[1] Translated from Dutch: "*Publiek-private samenwerking is een vorm van gestructureerde samenwerking bij de aanleg en exploitatie van infrastructuur voorzieningen*"

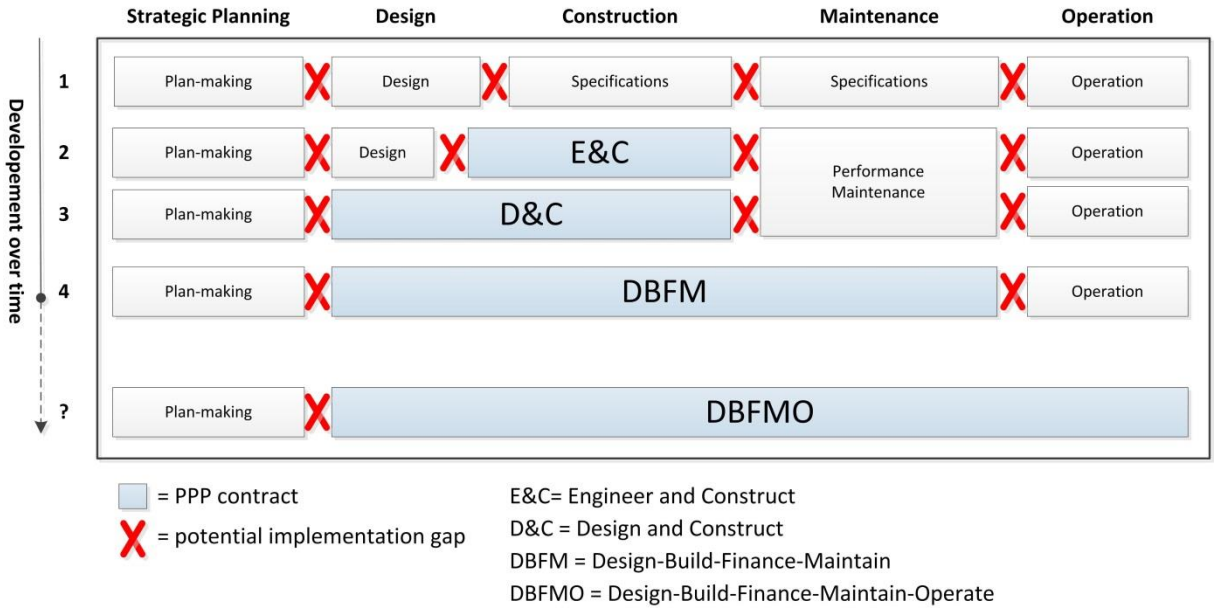

FIGURE 6 DEVELOPMENT OF PPP FORMS IN DUTCH INFRASTRUCTURE (LENFERINK, 2012)

3.2 DBFM

Traditionally all project phases were procured separately by the public road authority (Figure 7) with DBFM contracts this changed (Figure 8). In DBFM projects directing projects and the ownership of the infrastructure stays the responsibility of the government, but Designing, Building, Financing and Maintaining are assigned to a private party.

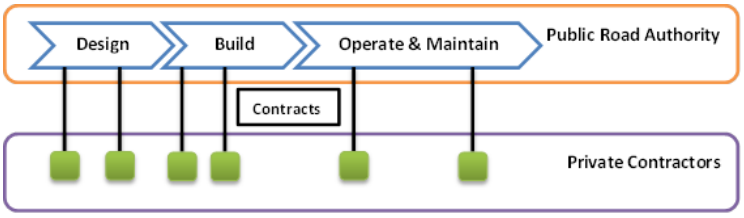

FIGURE 7 'TRADITIONAL'PROCUREMENT

Design, Build, Finance and Maintain (DBFM) contracts are the most extensive form of collaboration between the Dutch government and the private sector. In these projects the Dutch public road authority prescribes functional requirements of the assets but makes the contractor responsible for the technical solutions (Rijkswaterstaat, 2013).

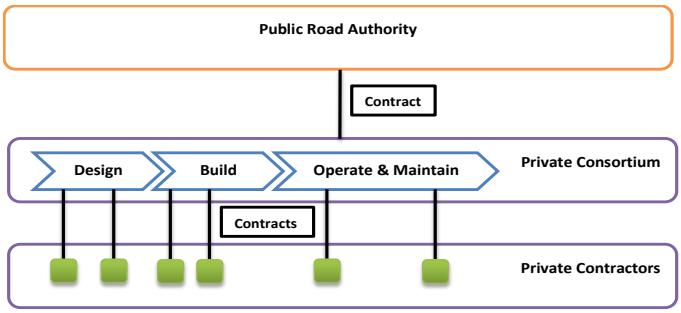

FIGURE 8 DBFM PROCUREMENT

With DBFM a consortium is paid for a service during the total life cycle of a project. This is done or by users of the infrastructure (toll) or by the public authority. In the Netherlands, the latter is usually the case. If the client pays the consortium, this is usually done with a combination of onetime payments and a regular fee during the contracting period (Koster, et al., 2008).

This means that the design and the construction of the project have to be pre-financed, most of the time this is partially through equity (±10%) and partially through debt (±90%). The equity is provided by the shareholders of the consortium, the debt is often provided by one or multiple banks. The loans are issued by the banks with the prospects of the future revenues of the project, in the form of a regular fee; this is called project finance (Yescombe, 2007). The term of the DBFM contract is usually long, 20 to 25 years and is linked with the economic lifetime of the infrastructure (Bruggeman, et al., 2010). Figure 9 gives a schematic representation of the working of a DBFM contract. The reason to choose for a DBFM project, from a public perspective, is the subject of the next section.

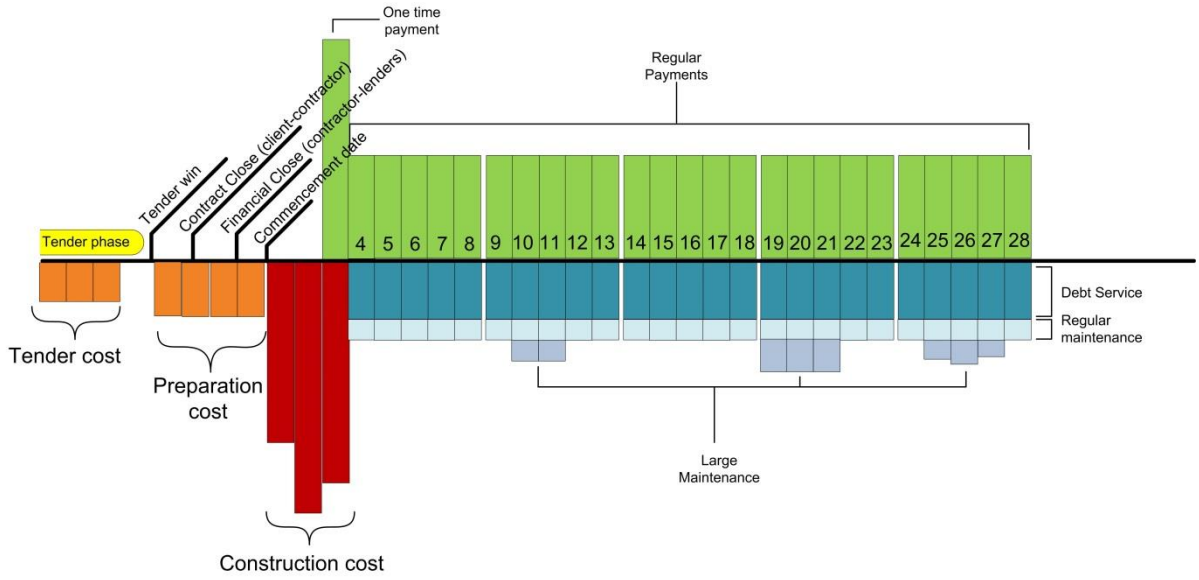

FIGURE 9 SCHEMATIC REPRESENTATION OF THE WORKING OF A DBFM CONTRACT (NOT TO SCALE)

3.3 PUBLIC PERSPECTIVE ON DBFM

A DBFM contracts is one of the ways a government can fulfil the responsibility for an adequate road system. DBFM projects are supposed to provide cost reductions and added value in respect of traditional procurement, the Dutch minister estimated almost € 1 billion realised added value (Ministerie van Financiën, 2012). This section discusses the advantages that should provide this added value: budgetary benefits, acceleration of projects, and increased 'Value for Money'. But also the disadvantages (e.g. cost of finance) and comments that can be placed with this added value.

BUDGETARY BENEFITS

A DBFM contract allows capital cost of a public-sector facility to be spread out over its life. The cost can be paid for by users by tolls, or charged to the public budget through regular payments over the lifetime of the project. The latter is usually the case in the Netherlands. The name of the British PPP-program, 'The Private Finance Initiative', and the name of the U.S. term for PPP's, 'Innovative Finance', suggests that the programs are primarily about finance. Therefore, opponents argue that the PPP programs are nothing more than "off-balance sheet borrowing" by the public sector to avoid budgetary constraints on infrastructure investments, such as the Maastricht Treaty. The service payments have much of the same impact on the future public

budget as borrowing (Yescombe, 2007). Proponents argue that there are additional benefits attached to DBFM contracts, these are further discussed.

ACCELERATE PROJECTS

DBFM projects enable the public sector to execute (or accelerate) infrastructure projects which would otherwise have not been executed (or delayed), because of the budgetary benefits. The choice is often to not execute a project or to do it in a DBFM (Yescombe, 2007).

COST OF FINANCE

A DBFM project is financed by the private sector. Private companies borrow money from financial institutions; these loans and the interest on these loans are repaid with the availability fees received from the public sector. The interest the private sector pays will always be higher compared to public sector borrowing. This, because the risk for financial institutions of losing money is higher with private sector borrowing. Therefore DBFM is in theory more expensive than public procurement, this is offset by a greater 'Value for Money' (VfM) (Yescombe, 2007), the ability of the private sector to do more with less (Altamirano, 2010).

VALUE FOR MONEY

The private sector should be able to deliver improved value, or services, for the same amount of money, as the public sector would spend to deliver a similar project (Grimsey & Lewis, 2005). This is meant by improved 'Value for Money'. There are six main drivers for success of improved VfM (Andersen, 2000), namely: risk transfer; the long-term nature of contracts (including Life Cycle-Costing); the use of an output specification; competition; performance measurements and incentives; private sector management skills. A couple of these drivers need further explanation.

RISK TRANSFER

In DBFM a significant risk transfer from the public sector to the private sector takes place. Construction risks, usage risks and availability risk can be transferred to the private sector. Transferring the risks means that the total construction price goes up. However, the private sector would be better able to manage these risks, and thus the cost of risk management will be lower than if the risks are managed by the public sector. In this way risk transfer contributes to improved 'Value for Money' (Yescombe, 2007).

LIFE CYCLE COSTING

Because the same investor is responsible for the design, construction and maintenance, they are incentivised to produce a design with the lowest cost over the 'total project life'. A private investor may be prepared to invest more during construction if this will result in greater savings during maintenance. This is perhaps the most important element of VfM (Yescombe, 2007). Life Cycle Costing is the primary focus of this research.

PERFORMANCE MEASUREMENTS AND INCENTIVES

The payment mechanism in a DBFM contract is based on the performance of the consortium. This is can be done in two different ways. The first is compensation by the public authority, related to the degree of availability of an object, regardless of the actual use of the object. This is the common mechanism used in the Netherlands. The second is compensation dependent on the use of an object. The assumption is that a better performance of a consortium will lead to an increase in users. The compensation can be paid directly by users (toll) or the consortium can be compensated by the public authority for every user (shadow-toll) (Koster, et al., 2008). Both mechanisms incentives the consortiums to perform well and therefore contribute to improved VfM. However, the Dutch Public Road Authority (RWS) combines the availability payment mechanism with other mechanisms. In current DBFM projects RWS issues guarantees about the availability payment, and pays the consortia single payments during realization based on (partial) completion of project (Algemene Rekenkamer, 2013). The purpose of these measures is to reduce the cost of finance for the consortia and in this

way reduce the total cost of the project for the government (Yescombe, 2012). The result of these measures is that it weakens the incentive of payment based on performance (Algemene Rekenkamer, 2013).

PRIVATE-SECTOR MANAGEMENT SKILLS

The involvement of the private sector in a DBFM contract brings particular skills which are not available to public-sector procured projects. The private sector is considered to be superior to the public sector in e.g. project management, efficiency and innovation (Yescombe, 2007).

Together these drivers should compensate the extra cost of private finance. The VfM arguments are important for gathering political support for DBFM projects (Yescombe, 2007).

SUPPOSED ADDED VALUE DBFM

The above mentioned benefits all contribute to the added value of DBFM projects. The Dutch Minister of Finance announced in 2012 a cost reduction of € 800 million and a realised added value of almost € 1 billion as a result of the DBFM(O) (Infrastructure and State Housing) projects (Ministerie van Financiën, 2012). The calculation of this added value is based on two instruments, the PPC and the PSC. The PPC (Publiek-Private Comparator) calculates the quantitative and qualitative added value of public –private partnerships (PPP) with respect to traditional procurement. If the result of the PPC is in favour of PPP procurement and there is chosen for a DBFM approach, then a more accurate calculation is required to assess the bids. The PSC (Publieke Sector Comparator) is used to make this calculation. The PSC is used to calculate the life cycle cost of a traditional procurement, the result of this calculation is used as maximum price level for the DBFM procurement. Comments can be placed to the calculation of the added value. The calculation is partly dependent of assumptions and estimates of a large number of uncertain parameters. Also uncertainty exists about the cost of traditional procurement. The long-term aspect of the DBFM projects also contributes to the uncertainty of the calculation. The announced cost reduction of € 800 million and the added value of almost € 1 billion are thus obtained from calculations with a reasonable degree of uncertainty. The actual added value of a DBFM contract can only be determined at the end of the contract period (Algemene Rekenkamer, 2013).

3.4 PRIVATE PERSPECTIVE ON DBFM

Besides the public side, there is a large role for private parties in DBFM projects. The fundamental goal of a private party is to maximize shareholder value and the worth of their business (Grant Thornton, 2008). The OECD emphasizes that corporations should be run, primarily, in the interest of shareholders (OECD, 2004). The management board of corporations define strategic goals in order to achieve the maximization of shareholder value. In the strategic objectives of companies also things like, reputation and corporate social responsibility play an important part (Money & Gardiner, 2005). When looking at the top three Dutch construction companies it can be seen that strategic objectives are set with reference to (BAM, 2013) (Boskalis, 2013) (VolkerWessels, 2013):

A. The development of the company in different markets (geographic regions and market segments).
B. The market position of the corporation.
C. Financial targets (debt services, cash flow, net revenue etc.).
D. Growth targets.
E. Strategic developments within the corporation.
F. Environmental and Sustainability responsibilities.
G. Social responsibilities.

To achieve the strategic objectives, an important focus of BAM and VolkerWessels is integrated projects and the provision of services in all project phases. BAM and VolkerWessels follow with this the market developments (BAM, 2013) (VolkerWessels, 2013). The interest of construction companies for DBFM projects is

thus in line with their strategic objectives and contribute to the achievement of the fundamental goals of the corporations. This is the reason why construction companies tender for DBFM projects.

During tenders of DBFM projects consortia make promises to the client, these promises relate to the award criteria and are the fundaments of the DBFM agreement. To further clarify the private perspective this promises are discussed.

Dutch DBFM projects are awarded on basis of three different criteria. The quality value (EMAS or in Dutch: EMVI), the listed risks and the financial model. The quality value and the listed risks are translated into a fictitious reduction on the tender price. The candidate with the lowest (fictitious) price is awarded the contract (Ministerie van Financien & Rijkswaterstaat, 2012).

Quality Plan (EMAS/EMVI)

The Economically Most Advantageous Subscription (or in Dutch: Economisch Meest voordelige Inschrijving, (EMVI)), is one of the award criteria in Dutch DBFM road projects. This award criterion stimulates the tenderers to anticipate the qualitative needs of the contracting authority and in this way create added value. The added value that a tenderer creates is translated into a reduction on the tender price. In this way bidders do not compete only on lowest tender price but also on added value. When applying EMAS the goal of the client is to obtain a good price-quality ratio for the requested products and services. During the tender, the client indicates the main criteria and sub criteria which are used to evaluate the added value (e.g. Project management) and the calculation method for calculating the added value. The value assignment of the various plans is done by an independent committee. A thorough EMAS plan is a way for a tenderer to differentiate them from the competition and in this way win a DBFM contract (Rijkswaterstaat, 2011).

Risks

In the tender documentation a number of risks are included, these risks are identified by the client. The consortium has the possibility to adopt responsibility over these risks from the client. If a consortium decides to adopt responsibility over these risks, this is translated in a fictitious reduction on their tender price. The reduction is dependent of the risks. With this reduction the possibility of wining the tender increases (Ministerie van Financien & Rijkswaterstaat, 2012).

The Financial Model

The tender price is still the most important award criterion (Ministerie van Financien & Rijkswaterstaat, 2012). The tender price is determined by a consortium using a financial model. The financial model is used to calculate the economic feasibility of a DBFM project. The financial model is a dynamic calculation model and is composed of formulas based on assumptions and estimates regarding macro- and micro – economic variables. The budgeted investments, income and expenses expected inflation, taxation, interest rates and other relevant macro-economic factors have to be included into the financial model. The financial model considers the total duration of the project, uncertainty exists about the future development of parameters used in the model. For this reason, assumptions have to be made. These are mostly financial assumptions (inflation, exchange rate, taxation, etc.) and technical assumptions (Output, maintenance cost, technical performance, etc.). The financial model uses Net Present Value as calculation method (Koster, et al., 2008). This method is based on the time value of money.

Net Present Value/Discounted Cash Flow

To account for different operations taking place at different moments in time, the time value of money is included in financial models. The basic principle of the time value of money is that a dollar today is more worth than a dollar tomorrow because the dollar today can be invested to start earning money immediately (Brealy, et al., 2008). Otherwise the present value of a future cash flow is less than the actual cash flow. The Net Present Value of a future cash flow can be calculated using the next formula.

$$NPV = \sum_{t=t_0}^{t_0} I_t * (1+r)^{(t_0-t)}$$

In which NPV = Present Value
I_t = Payment on t
t_0 = year of reference
r = Discount rate, time value of money

In the above formula *r,* the discount rate, should represent the opportunity cost of capital, the guaranteed rate of return on your investment if you decide not to invest (Brealy, et al., 2008). The value of the discount rate has significant influence on the NPV, see Figure 10. The discount rate which should be used during a tender is prescribed by the client (Ministerie van Financien & Rijkswaterstaat, 2012).

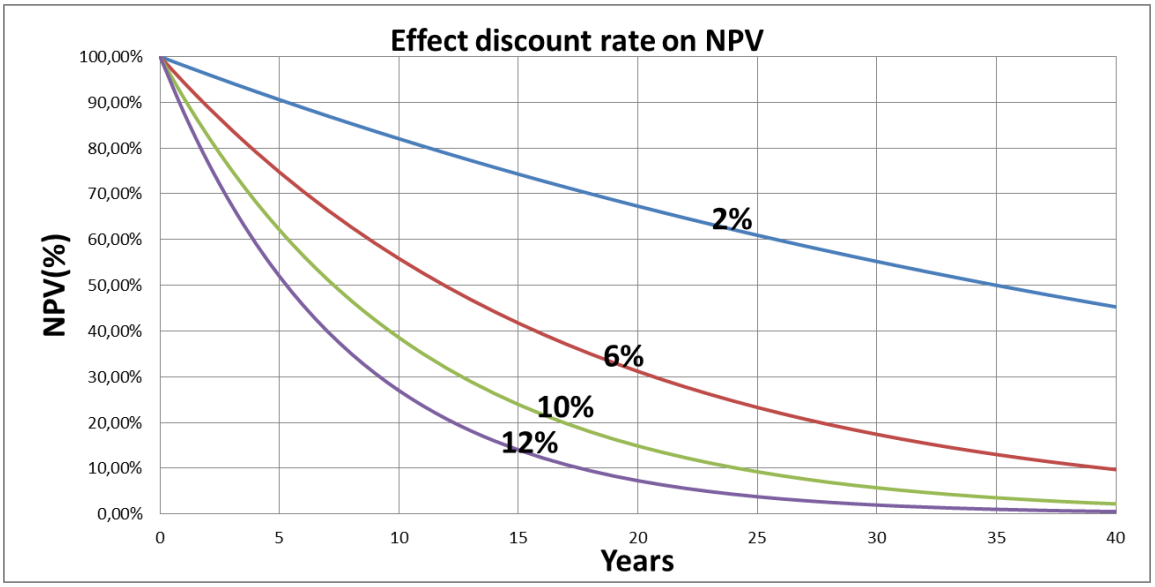

FIGURE 10 EFFECT DISCOUNT RATE ON NPV (CLIFT, 2003)

CAPITAL EXPENDITURE AND OPERATIONAL EXPENDITURE

In the financial model two different types of expenditure are considered; capital expenditure (CAPEX) and operational expenditure (OPEX). Capital expenditure is funds invested in a firm or enterprise for the purpose of achieving the business objectives. Operational expenditure refers to the cost a firm incurs as a result of performing its normal business operations (Brealy, et al., 2008). The debt payments, including interest payments are part of the operational expenditure.

REVENUE

As discussed in the section about the public perspective the payments to a consortium are based on the performance of a consortium, thus the revenues depends on the performance. The performance is largely determined by the actual availability of the infrastructure. Road closures or traffic measures will have an impact on the availability of the infrastructure and thus an impact on the revenue (Koster, et al., 2008).

A project is awarded to the consortium with the lowest (fictitious) Net Present Value. In order to achieve the lowest NPV it is important to consider different design options and execution methods over the total project execution. The financial model fulfils an important role in evaluating these different options. This process is called Life Cycle Costing and is the subject of the next section.

LIFE CYCLE COSTING

Life Cycle Costing is briefly discussed in the problem definition; this section explains Life Cycle Costing in more detail. Life Cycle Costing is one of the main drivers of the Value for Money argument. The institute of asset management defines LCC as the process of maximizing return by combining capital investment decision making and operation & maintenance decision making for the total life cycle of an asset. Assets are defined as things that have value or potential value and Asset Management achieves the realization of this value. Life Cycle Costing is one of the main criteria for decision making in Asset Management (The Institute of Asset Management, 2012).

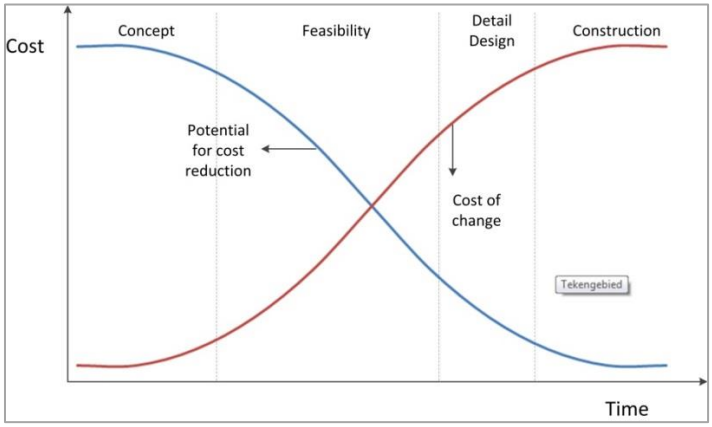

FIGURE 11 OPPORTUNITIES FOR EFFECTIVE LCC (CLIFT, 2003)

Individual capital investment decisions may neglect the trade-off between maintenance and capital investment. Individual operation & maintenance decisions may not consider the possibility to reduce maintenance cost through better design. For a typical asset, the distribution of the life cycle cost ratios over the phases plan, acquire, operate and dispose is 5%-30%-60%-15% (not specifically road infrastructure). Most of the cost are then incurred during the operate and maintain phase, but many of these operating cost are 'locked in' by the time the design is complete. It is therefore important to include all the different phases in the design (The Institute of Asset Management, 2012). The potential for LCC decreases and the cost of change increase as the design progresses (Figure 11) (Clift, 2003). Important for application of LCC is a supporting financial model which compares different LCC opportunities (The Institute of Asset Management, 2012).

3.5 ORGANIZATION OF THE PROJECT

This section discusses the general project organization and project approach during the realization phase, from a literature perspective. It describes the general approach and the reasons for this approach. This is not specifically the Dutch approach. The next chapter will look more closely to the Dutch DBFM practices. Figure 12 shows the project organization, surrounded by the internal stakeholders. This section is about the organization of the project team, the next section (section 3.6) is about the stakeholders surrounding the project team.

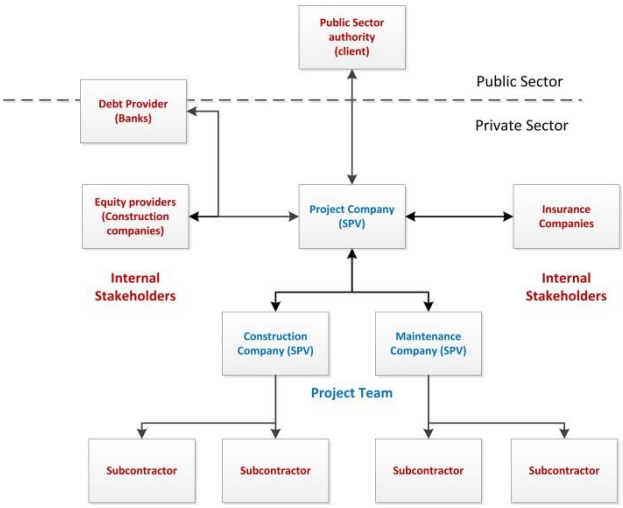

FIGURE 12 PROJECT ORGANIZATION (KOSTER, ET AL., 2008) (YESCOMBE, 2007)

PROJECT TEAM

A project is defined as a unique and temporary endeavour undertaken to create a unique product or service. Temporarily means that every project has a definite beginning and a definite end. The project team is defined as the team responsible for executing activities to complete the project. A project team has a perceived identity, so that they can work together using a common set of values or norms to deliver the project's objectives (Verbraeck, 2012). A project team is thus also temporary. Using this definition the general DBFM project team can be designated, see Figure 13.

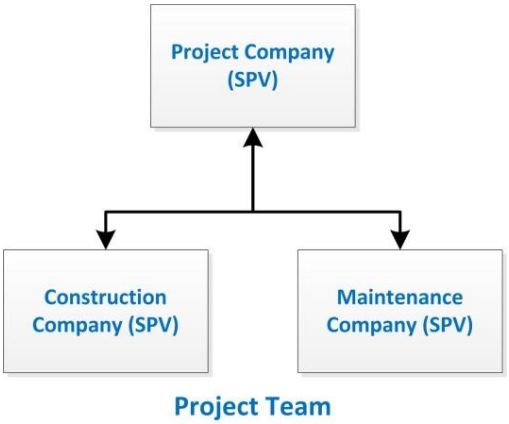

FIGURE 13 THE PROJECT TEAM

SPECIAL PURPOSE VEHICLE (SPV)

The project team consists of separate 'boxes' known as a SPV (Special Purpose Vehicles). A SPV (also SPC) is a separate legal entity only established for carrying out a specific project. The use of a SPV is required by the public authority and the lenders. The reasons for using a SPV include (Yescombe, 2007):

- A SPV ensures that there is no recourse to certain stakeholders, by isolating the project in a separate legal entity.
- A SPV ensures that the project is not affected by problems with any unrelated business.

The owners of a SPV are the consortium partners; sometimes the partners use a holding company, for security reasons and tax benefits. The legal structure of a SPV can differ, in the Dutch DBFM two legal structures are used for the formation of the project team.

- A B.V. (Dutch: Besloten Vennootschap) a private limited liability company. The shareholders of this company are- in general- not personally liable for legal acts of the B.V (Tax Consultants International, 2013).
- A VOF (Vennootschap onder Firma) a partnership, the partners are jointly and severally liable for all obligations of the partnership (Tax Consultants International, 2013).

The effect of these different legal structures is discussed in the next chapter.

Project Company

The Project Company has already been addressed in the previous chapter. The Project Company signs the main DBFM contract with the client. It lies in the centre of all financial and contractual relationships (Figure 12). The Project Company is often considered as an empty shell (Yescombe, 2007). The finance component in the DBFM is the responsibility of the Project Company, the other components are contracted to the other parts of the project team. This is done to minimize the risk for the Project Company and so minimize the risk for debt providers (Yescombe, 2012). A back-to-back contract is used for this.

Back-to-Back Contracting

To minimize the risk for the Project Company the DBM (design, build, maintain) components are transferred to other parties. This is done with a 'back-to-back' contract. A 'back-to-back' contract means that the Project Company transfers the DBM components of the main DBFM contract to the Construction Company and Maintenance Company, these companies guarantees the execution of its performance in the same way and under the same conditions to which the Project Company is obliged towards the public authority (Di Paola, 2009).

Direct agreements

The Construction Company, Maintenance Company, Contracting Authority and other key contracting counterparties are required to sign direct agreements with the Lenders. The direct agreements acknowledge the position of the lenders, and consent to their taking an assignment of the contracts as security. In the direct agreements (Yescombe, 2007):

- the client acknowledges the lenders' security interest in the DBFM contract;
- an specific project account is agreed for payments;
- the lenders have various rights to intervene if the Project Company is in default;
- is stipulated that no amendments will be made to the contracts of the Project Company without consent of the lenders.

Besides the direct agreements the lenders conclude multiple agreements with the Project Company to secure their investment. As mentioned above the lenders also interfere with the contracts the Project Company concludes. The lenders may obtain collateral warranties of the Construction Company, under which direct liability is accepted for the performance of their services (Yescombe, 2012).

Construction Company and Maintenance Company

The Construction Company and Maintenance Company are responsible for the DBM part of the project. These companies are contractors of the Project Company. The companies are also SPVs with as owners the consortium partners. These companies are together responsible for the technical solution and implementation of the project, the way in which these companies are organized varies considerably by project (Yescombe, 2007). This will become clear in the next chapter.

3.6 STAKEHOLDERS

Many different parties are involved in a DBFM project. These stakeholders all have a certain interest in the project.

Winch defines stakeholders as those actors which will incur a direct benefit or loss as a result of the project (Winch, 2002). For the management of the stakeholders it is useful to categorise the stakeholders in different categories. The first is the division into internal stakeholders, those who have a legal contract with the considered party, and external stakeholders which also have an interest in the project but no legal contract (Winch, 2002).

External stakeholders e.g. local residents, landowners, environmentalist or conservationists, do have a direct interest and should thus be considered in a DBFM project. External stakeholders which propose the project can delay the project and in this way disturb the project planning (Winch, 2002). The client also partly represents the interest of external stakeholders by means of the quality plan during the tender (Rijkswaterstaat, 2011). However, it is assumed that the interest and influence external stakeholders have on the private project organization are insignificant, that is why only internal stakeholders will be included in this research. For the remainder of this report the internal stakeholders are referred to as actors.

The actors in Dutch DBFM Road projects are for all DBFM Road projects the same type of parties, these parties and their general interests are further discussed in this section. A (simplified) overview of the involved actors is shown in Figure 12.

FINANCIAL PARTIES

In general two types of financing are used in DBFM projects; equity and debt. The distinction between the types of finance is the seniority. Debt has a higher seniority then equity, this means that a debt provider is repaid first, after this the equity provider is repaid. The provider of equity has thus higher risks of losing money then the provider of debt and expects usually a higher return on investment (Yescombe, 2012). Next section explains more about the interests and the roles of these parties.

INVESTORS (EQUITY PROVIDERS)

The equity providers are the shareholders of the Project Company. Agreements about percentage ownership, board representation, provisions to deal with conflicts, appointment of authority of management etc. are concluded in a shareholder agreement. As discussed in the context, all Dutch DBFM projects are executed by consortia. DBFM projects are usually complex and have a comprehensive project scope; the average contract value of the Dutch projects in or past realization is about 530 million. For one single investor this is usually too much risk, other companies may be brought in to share the risk. This both enables the risk to be spread and limits the amount of risk for each investor. Creating a consortium reduces also risk by combining different expertise of investors (Yescombe, 2012).

There are a couple of reasons why investors choose to use project finance (Yescombe, 2012):

- **High leverage:** leverage is the ratio between debt and equity, high leverage improves the return on investment for investors. This is because lenders are willing to accept a lower return on investment than equity providers; debt is thus cheaper than equity.
- **Off-balance-sheet financing**: If the investor has to raise the debt through a corporate loan, the debt would appear on the investors' balance sheet.
- **Borrowing capacity**: project finance increases the level of debt that can be borrowed. Corporate credit lines are not considered with non-recourse project finance (hence the off-balance sheet financing). Project finance increases a company's borrowing capacity and therefore enables the company to undertake several large projects simultaneously.

- **Enhanced credit**: If the client of the consortium has a better credit standing than the equity investors, debt can be raised on better terms than it would be if corporate finance is used. In the Netherlands this is often the case, since the government is often the client the probability of not getting paid is low.

LENDERS (DEBT PROVIDERS)

A significant part of the finance of DBFM projects is raised through debt. The private-sector debt markets consist of different types of financing; commercial banks, bond investors, mezzanine or subordinated debt, leasing and vendor finance (Yescombe, 2012). Although alternative sources of funding are considered in the Netherlands, the vast majority of the finance still comes from commercial banks (Ministerie van Financiën, 2012). This section focuses therefore on commercial banks.

The consortium has usually not the experience in and knowledge about project development to make sure that arrangements made in the early project stages are acceptable to the banking market. Therefore consortia use financial advisers or lead arrangers (or both). Financial advisory services can be provided by major banks, investment banks, major accounting or management consulting firms. They advise, among other things, about the optimum financial structure and the selection of commercial banks. The cost for these consultants is borne by the Project Company, and is between 0.5-1 % of the debt amount on an averaged sized project. The normal approach to arrange a project finance loan is to appoint one or more banks as lead arranger, this lead arranger will ultimately underwrite the debt and place it in the market. The lead arranger can also advise the Project Company during project development, instead of financial advisors. The advantage of using a financial advisor is that a competitive bidding process between banks is possible, the disadvantage is that the development costs will be higher and the process will be less efficient (Yescombe, 2012).

The lead arrangers (or Financial advisors) are likely to play an active role during the establishment of the project contracts, such as the DBM contract(s) and the sub-contracting, to ensure that the financing implications are taken into account and the risk of the Project Company is reduced to a minimum (Yescombe, 2012). Research shows that the risk transfer to subcontractors is considered to be an important factor for debt providers when assessing projects, also the availability of insurance is considered to be an important factor (Demirag, et al., 2011).

HEDGE PROVIDER/SWAP PROVIDER

Besides the role of lender banks also fulfil the role of hedge provider/swap provider. Lenders do not charge a fixed interest rate on their loans, with project finance the Project Company has the obligation to pay a floating interest rate on its loans. This floating interest rate is a risk, which can be hedged; this is done by means of an interest swap. With an interest swap the Project Company agrees a fixed interest rate on its loans with a bank, if the floating rate is above the fixed rate, the bank pays the difference, if the floating rate is beneath the fixed rate the bank receives the difference (Yescombe, 2012).

INSURANCE COMPANIES

To reduce risk for the Project Company to a minimum, lenders require insurances. As a result the cost for insurances is high. Therefore the consortium should involve an insurance broker at an early stage of the project. If required insurances are not in place the lenders can withhold a loan. Lenders require insurance for the construction stage as well as for the operating phase (Yescombe, 2012). Although insurance can be a significant proportion of the cost of a consortium, it is assumed that insurance companies do not interfere with the project organization, and thus have little influence on the application of LCC. Therefore, insurance companies will not be considered in the remainder of this research. The cost of insurance should be taken into account in LCC considerations.

CLIENT

The public perspective on DBFM projects is already discussed in a previous section. Although the tasks of the public sector are transferred to the private sector, the public authority stays involved during realization of a DBFM project. The involvement mainly relates to contract management (The Institute of Asset Management, 2012).

SUBCONTRACTORS

The Construction Company and Maintenance Company are together responsible for the complete design, construction and maintenance of the project. The Construction Company and Maintenance Company use subcontractors for the execution of the work. These subcontractors are often subsidiaries of the consortium partners (Heuckelum, et al., 2007). However this is not always the case. The Construction Company and Maintenance Company try to transfer as much risk as possible to the subcontractors (Yescombe, 2007).

3.7 CONCLUDING REMARKS

In this chapter the theoretical background of the DBFM contracts in the Netherlands is discussed. The public perspective and private perspective on the project is explained, and more closely is looked at the private project organization and the important actors from a literature viewpoint. Because of the finance component, additional actors are introduced to the project. Additional actors leads to additional interest and possible conflicting interest. Lenders, who provide 90% of the required funds, ensure that their investment is safe by minimizing the risk of the Project Company as far as possible (Yescombe, 2007). This provides lenders with significant influence in the project (e.g. direct agreements). It is expected that these additional interest and the influence of lenders can hinder the application of Life Cycle Costing. One could expect that the described absent experience and knowledge of the consortium regarding finance, has an negative influence on LCC. As described finance can have major impact on the result of a financial model (Figure 10), and is an important factor in LCC considerations. These hypotheses, the concepts, and structures explained in this chapter are used in the next chapters to identify elements that have a positive or negative influence on the application of Life Cycle Costing. In this way this chapter indirectly contributes to answering sub question 1.

4 DBFM IN PRACTICE; THE CASE STUDY - CONFIDENTIAL

Removed because of confidentiality.

5 DBFM IN PRACTICE; EXPERT INTERVIEWS

This chapter presents the findings from interviews conducted with several managers involved in different Dutch DBFM road projects. This chapter answers sub question 1: *Which elements can be identified that positively or negatively influence the application of Life Cycle Costing?* The interviews are used to identify enablers (positive influence) or disablers (negative influence). Input for the interviews are the hypotheses developed in chapter 3 and 0. This chapter discusses the interview setup and the results of the interviews. If further in this research is referred to EPC(M) (Engineer; Procure; Construct; Maintain), is meant the executive body of the project team that is responsible for the DB components with or without the maintenance component.

5.1 INTERVIEW SETUP

Following a protocol (Annex B), in total 8 semi structured interviews were held with managers or consultants involved in one or multiple Dutch DBFM road projects. All interviews were recorded and from every interview a transcript was created by the interviewer. From the transcripts the relevant points were summarized in a memo by the interviewer. The memos (Annex C-*Confidential*) were approved by the interviewee before further analysis. The candidates were asked in the interviews what elements contributed positively (enablers) or negatively (disablers) to the application of Life Cycle Costing in DBFM projects, in their point of view. The hypotheses developed in chapter 3 and 4 were tested, and if confirmed noted as a identified element. In successive interviews elements identified were presented and confirmed or denied. To start the interviews the candidates were asked about the importance and the current application of Life Cycle Costing. With the results of the interviews a matrix is created with the identified elements in rows and the 8 interviews in the columns (Annex D-*Confidential*). The number of new elements identified by the interviewees stopped after the seventh interview which indicates theoretical saturation, the moment in qualitative data analysis in which the researcher has continued until no new data appears (Glaser & Strauss, 1967), Figure 14.

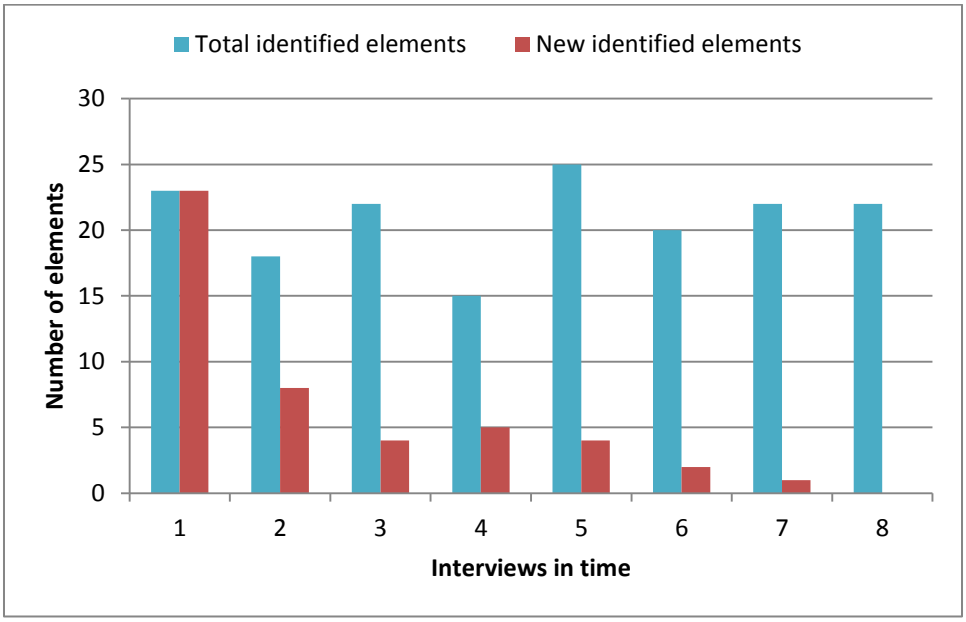

FIGURE 14 THEORETICAL DATA SATURATION OF NEW IDENTIFIED ELEMENTS

The same applies to the elements as with aspects influencing project complexity; the project elements identified can be classified into three different types: “What”, “Who” and “How” elements. “What” of the project in terms of content, “who” of the project in terms of parties involved of perspectives, and “how” of the

project in terms of staffing and organizing the project (Bosch-Rekveldta, et al., 2011). This classification is used in chapter 7, to group the elements and to establish preconditions.

5.2 Importance and Application of Life Cycle Costing

During the interviews the perception of the interviewees with respect to the importance and application of Life Cycle Costing is examined. The findings are discussed by means of quotes from the interviews and examples of projects, because of the confidentiality no sources are mentioned.

"Life Cycle Costing is of great Importance, as a tax payer it is distressing to see that suboptimal solutions are chosen"

As an example the bridge crossing the Hollands Diep for the Dutch High Speed Railway is mentioned. This bridge was built and not used for several years. When viewed from a life cycle perspective this is not an optimal solution. The years that the bridge is not used 'costs money', in terms of: the time value of money, maintenance cost, lost income, etc. With this in mind the importance of LCC is great. By properly applying LCC this loss can be prevented. The interviews confirm this importance and acknowledge that LCC is an important part of DBFM projects.

During tender phase Life Cycle Costing is an important subject, the application of Life Cycle Costing during realization phase is still not good"

As an example is referred to the choice for the type of coating on the support of the noise barriers along the highway. The contractor guarantees a durability of 25 years for the coating, from this perspective a proper LCC choice. However, the contract terms of the contractor have not been taken into account. The terms state that every single support has to be cleaned every year with high pressure, otherwise the warranty will invalidate. If these costs are included, the choice is far from optimal. This is an example which illustrates a not proper application of LCC. All interviewees agree that there is still much improvement possible. During tenders the application of LCC improved rapidly, the application of LCC during realization is lagging behind. The elements that cause this lag, are the discussed in the next section.

5.3 Disablers and Enablers of Life Cycle Costing

The memos of the interviews were studied to identify the elements that contribute negatively (disablers) or positively (enablers) to the application of LCC.

Table 4 displays all the disablers that are mentioned during the interviews. These elements have a negative influence on the application of LCC during realization. The elements are derived from annex D, they are translated from Dutch and ranked according to the times they are mentioned (column 3). The fourth column of the table refers to the index of annex D, the second column refers to the "What", "Who", "How" classification mentioned in section 0. The fifth column gives an explanation of the element.

Table 5 displays the enablers, or elements that have a positive influence on Life Cycle Costing during realization. The elements are identified by asking the interviewees about the changes they would implement in future DBFM projects regarding the application of LCC, but also current practices that have a positive influence on LCC. The columns have the same functions as in Table 4.

TABLE 4 DISABLERS OF LCC DURING REALIZATION

Description	Class.	Count	Index	Explanation
Traditional construction culture	What	8	D8	*Dominant culture which is focused on: short-term, cost minimization, and confrontation*
Separating disciplines and project phases with 'fixed price' contracting	How	7	D1	*Governance of the project through fixed budgets for separate project phases and disciplines*
Conflict of interest between shareholders	Who	7	D12	*Shareholders which do not have the overall project goal as main interest*
Organizational structure construction companies	Who	7	D13	*Dozens of subsidiaries which are focused on optimizing their own business case*
Competencies of key project team members	What	7	D7	*Individuals with limited knowledge (DBFM, LCC, Technology) have large influence*
Incentives for LCC optimizations	How	6	D10	*Unclear incentives or lack of incentives*
Project Company limitations	How	6	D4	*Limited staffing and technical knowhow*
Shareholders acting as (preferred) subcontractor	Who	5	D11	*Two conflicting methods of withdrawing revenue from the project*
Project Company risk	How	5	D14	*Placing the total project risk at the operational level (EPC(M))*
Uncertainty of information relating to lifetime	What	5	D17	*Large uncertainty (lack of data) of technical lifetime of project components*
Mutual understanding activities Project Company and EPC(M)	How	5	D15	*Focus Project Company: finance* *Focus EPC(M): design, build, maintain*
Importance of financial model	What	5	D16	*Securing income and expenditure of the Project Company*
Mutual understanding Technical and Financial sector	How	5	D18	*Technical sector: limited financial knowledge* *Financial sector: limited technical knowledge*
Transition from tender to realization	How	5	D25	*Relapse, as described in 0*
Experience with DBFM	What	5	D9	*Limited experience with DBFM projects*
Number of shareholders	Who	4	D20	*The number of shareholders in a consortium*
Type of shareholder	Who	4	D21	*Investors, construction companies, engineering companies, etc.*
Different shareholders in different parts of the project	Who	4	D5	*Separate organized parts of the project team have different shareholders*
Time pressure during realization	What	4	D6	*Time-pressure to complete the realization phase*
Cultural differences shareholders	Who	3	D3	*Foreign companies, company cultures, etc.*
Design capabilities of construction companies	What	3	D22	*Limited experience with designing and management of design.*
Process for Life Cycle Costing	How	3	D23	*Absence (or limitations) of process for decision making on LCC optimizations*
Overall management	How	2	D2	*Lack of governing body within the project*
Failure Cost	What	2	D28	*High cost for breach of DBFM contract (availability requirements)*
Discount factor	What	1	D24	*The influence of the discount factor on possible optimizations*
Pre-financing of optimizations by shareholders	What	1	D26	*Pre-financing of LCC optimizations during realization by shareholding companies*
Suggestibility of Rijkswaterstaat	Who	1	D27	*The idea that RWS will never let a shareholder go bankrupt and ultimately will help out the project*
Growth realization organization	How	1	D29	*Starting the realization with the complete organization (about 300+ people)*
Requirements Rijkswaterstaat (functional)	What	1	D30	*Not fully functional specifications which limits the possible design choices*

TABLE 5 ENABLERS OF LCC DURING REALIZATION

Description	Class.	Count	Index	Explanation
Selection of key project team members	How	4	E11	*Selecting based on DBFM experience and knowledge*
Process for Life Cycle Costing	How	4	E2	*Defining: individual responsibilities, incentives, and considerations for the LCC process*
Shared project interest	How	4	E5	*The main project interest should be shared by all shareholders*
Responsibility for DBM(total project) with one party	How	4	E7	*Design, Build, Maintenance realization and Maintenance exploitation are the responsibility of one part of the project team and have a combined budget*
Overall management on Project Company level	How	3	E1	*Actively manage the execution of the project and possible LCC optimizations*
Different shareholders	Who	3	E10	*Different types of shareholders bring different and more experiences (more/better solutions/optimizations)*
Transfer of knowledge construction companies	Who	3	E13	*Increasing the learning process of construction companies so experiences from previous projects are more used*
Growth project organization	How	3	E17	*Gradual growth at the start of the realization phase*
Number of shareholders	Who	2	E14	*More shareholders bring more experience (more/better solutions/optimizations)*
Treating subsidiaries as external companies	How	2	E16	*Same treatment for subsidiaries of shareholders as for external companies (quality/price)*
Importance of business case	What	2	E3	*Improvement of the project business case is the first consideration of optimizations*
Insight into financial model	What	2	E4	*Insight in all financial consequences of technical solutions.*
Project Company risk	What	2	E9	*The Project Company bears a part of the total project risk*
Separating DB and M responsibility (shifting budgets)	How	1	E12	*Design, Build, and Maintenance realization and Maintenance exploitation are separated they have their own budget and optimization is facilitated by shifting budgets between these parties*
Configuration change board	How	1	E15	*One party has the responsibility for approving and implementing LCC optimizations*
Involvement of subcontractors with LCC	Who	1	E6	*Subcontractors can be a source of knowledge for the application of LCC*
Real Options Valuation	What	1	E8	*Including the theory of real options valuation with LCC considerations can be of value*

Table 4 and Table 5 present the findings of the interviews. In chapter 7, these findings are interpreted and used to compose the framework. Striking about the findings is the difference in times the disablers and enablers are mentioned, this is also interpreted in chapter 7.

5.4 Concluding Remarks

As discussed LCC is of great importance, but the application of LCC, especially during realization, lags. This chapter answers the sub question: *Which elements can be identified that positively or negatively influence the application of Life Cycle Costing?* The elements that hinder the application during realization are presented in Table 4. Table 5 presents the identified enablers for the application of LCC. The findings of the interviews are considered more representative for the Dutch DBFM projects in general then the case study. In the case study two specific projects are considered, the experts interviewed have worked on a multitude of DBFM projects. The findings presented in this chapter are combined in chapter 7 with the elements and hypotheses from the cases (chapter 4) and the findings of the next chapter. How components are combined is explained in chapter 7.

6 ACTORS STANCES, INTERESTS AND POWER POSITIONS

Important during decision making is that attention is paid to the actors whose interest may be harmed by the decision making (de Bruijn & ten Heuvelhof, 2008). Thus in order to make decisions based on a framework it is important that the interests of the important actors are included in that framework. This chapter discusses the actors who influence the application of LCC and thereby answers sub question 2: *What are the stance and interests and power positions of the important actors?* As discussed in chapter 3, only the actors with a contract with the Project Team are considered. However, in these contracts agreements are made about the interests of other actors. If these interests are present, they will be briefly discussed. Section 6.1 describes the setup of the actor analysis; the following sections describe the different actors. Section 6.5 describes the findings of the analysis. The next chapter discusses how these findings are combined with the established preconditions.

6.1 ACTOR ANALYSIS SETUP

Actors can be categorized into different types. These types of actors are based on five characteristics (de Bruijn & ten Heuvelhof, 2008).

- The stances of actors: What view do they take?
- The underlying interest of actors: Why do they take that particular view?
- The resources of actors: What means do they have to block or promote a decision?
- The relations of these actors: With what other actors do they maintain relations?
- The repetitive character of the relation with the actor: How often and in connection with what subjects will the initiator meet the other actors again?

Based on these characteristics actors can be categorized (Table 6). The first thing to know when categorizing an actor is what stances and interest they have. An actor can support the decision (proponent), oppose the decision (opponent) or the actor does not express any preferences (yet) (fence sitter).

The sum of resources, relations and repetitive character of relations leads to three types of power positions (Table 6). Actors with production power can make a positive contribution towards the realization of something. Blocking power means that an actor can only halt something. A diffuse power position means that it is unclear what the position of the actor is, that this position may change or that it is unclear if the actor wants to use its power position (de Bruijn & ten Heuvelhof, 2008).

TABLE 6 TYPES OF ACTORS (DE BRUIJN & TEN HEUVELHOF, 2008)

	Actors with production power	Actors with blocking power	Actors with diffuse power position
Proponents			
Opponents			
Fence sitters			

In this chapter the main stance and interest and the general power position of the various actors will be discussed. This line of reasoning will be continued with the composition of the framework (chapter 7), in which these characteristics are made more specific. The information shown is retrieved from interviews with actors, interviews with counterparts of actors, and project documentation; because of confidentiality no references are used. Memos of the interviews can be found in annex F (confidential). The interests of actors from a literary viewpoint are already discussed in chapter 3, and will not be extensively discussed in this chapter. Four main categories of actors are discussed: lenders, shareholders, subcontractors and the client (Rijkswaterstaat).

6.2 LENDERS

Lenders loan the vast majority (±90 %) of the funds required by the consortium. It is therefore expected that they take interest in the DBFM project and have significant power to influence the project. This section discusses these characteristics in general. In the current Dutch DBFM Road projects, with the exception of the N33, the loans are provided by banks. Possibilities for other debt providers are currently investigated (Ministerie van Financiën, 2013); new banking agreements (Basel III) make long-term loans (20-25 years) more expensive for commercial banks. Therefore it is expected that the type of lenders will change in the coming years e.g. to pension funds. These other types of lenders are inexperienced with project finance and controlling a consortium. Therefore they are reluctant to take responsibility over construction(realization phase). This is why it is expected that commercial banks will still be involved in the projects in the coming years. In addition, the controlling mechanism of banks will eventually be adopted by other type of debt providers. The perspective of the banks is therefore relevant for this research and for future projects.

The core competence of a bank is risk management, any act of a bank in a DBFM project can be explained from this viewpoint. The choice to finance a project is dependent of the risk profile, the involved shareholders and their knowledge and skills is an important part of this profile, and therefore agreements are made that limit the possibilities for the transfer of shares. For banks it is no necessity that construction companies are part of a DBFM consortium, consortia without construction companies are already financed.

A DBFM project is currently not financeable without total 'back-to-back' contracting. In 2008 also other ways to finance a project were possible, due to the current economy total 'back-to-back' contracting is now a necessity. In finance agreements a certain margin is defined for the consortium. The consortium has to ask permission for breaching this margin. Till financial close moment, agreements are made about the realization phase. These agreements are there to maintain a certain risk profile, lenders prefer not to breach these agreements. This does not mean that there is no flexibility from the lenders side, if it can be guaranteed that an optimization is an improvement of the business case and the risk profile does not increase, permission is granted by the lenders. In this case it is even possible to acquire additional funds for this optimization from the lenders.

The total project risk and external factors together determine the interest rate on the loan. The LTA plays an important part with the identification of the possible project risks

LENDERS TECHNICAL ADVISER (LTA)

The Lenders Technical Adviser or LTA advises the lenders on the technical aspects of the DBFM project (cost and feasibility of the construction, maintenance cost, technical aspects of the contracts etc.) (Yescombe, 2007).

The LTA is appointed and paid by the consortium, but represents the interest of the lenders during the project. The LTA is the link between the technical and the financial sector; they translate the technical content of the project into content understandable and relevant for the lenders.

During the tender the LTA is involved in attracting lenders to the project, the due diligence process, and advising and mediating between lenders and Project Company. Because the Project Company, unlike a corporate borrower, has no business record to serve as a basis for the lending decision, lenders have to be confident that they will be repaid. Therefore the due diligence takes place. The due diligence is for the lenders to have a high degree of confidence that the project can be: completed on time and budget, revenues and OPEX can be predicted with reasonable certainty (Yescombe, 2007). During the due diligence the LTA focuses on the extent to which the design of the consortium complies with the requirements of the public authority. The LTA reviews the cost estimate (CAPEX and OPEX), and the quantification of the risks. On the basis of the due diligence process the LTA gives a qualitative estimation of the risk involved in the project.

During realization the LTA is responsible for construction monitoring. In a monthly recurring audit on the progress of the project, the focus is on following the agreed financial model. Part of the construction

monitoring is certifying the claims from the consortium to the lenders; the LTA has in this matter the final say. Principle here is that the value of the asset is equal to the hitherto paid loan.

The LTA is in the first place an adviser for the lenders, and puts lenders interests first. They do share their experiences with the consortium but are not paid to advise the consortium.

LENDERS STANCES AND INTERESTS

The stances and interest of the lenders is the result of one main interest during realization. This main interest during realization is to secure their investment and reduce the possibility of losing money. This main interest leads to certain stances and interests during the different project phases.

Before financial close is reached and the realization can start, the consortium negotiates with the potential debt providers. Here the lenders influence the contracts used in the consortia, goal is to safeguard the financial model and hence their investment. The project risk is transferred to the executing part of the project team (EPC(M)) and the shareholding companies. Lenders require bank guarantees from shareholding companies to reduce their own risk. The remaining risk for the lenders is linked to the interest rate on the loans, the higher the risk the higher the interest rate.

The organization of the project team (Project Company-EPC(M)) is a consequence of the interest of the lenders. The capturing of the expenses (fixed price contracting) and ensuring the income (back-to-back contracting) results in a safe financial model during realization and exploitation. During realization the LTA ensures that the worth of the asset is in accordance with the paid out loan. Should the project come to a halt, the Project Company can be replaced without major losses of the lenders. Section 0 explains which power lenders use to safeguard their interests.

LENDERS POWER POSITION

Depending on the situation, lenders can take different power positions.

During negotiating till financial close lenders have to possibility to decide not to finance the project. Because the time to reach financial close is limited, consortia are eager to close. If not, the consortium can lose the status of preferred bidder. The public authority requests a letter of commitment from a lender as part of the bid. However, this letter is more an expression of intent then a solid commitment. The power mechanism of lenders exists, in this phase of the project, mainly of the threat to withdraw. In this phase lenders can block decisions of the project team.

During realization the lenders have different ways to exercise their power. As discussed in chapter 3, direct agreements are signed. With these agreements lenders can replace the Project Company if the project is in default. Also the lenders have to give permission to major changes in the project (budget changes, contract changes, etc.). Therefore, decisions can be blocked by the lenders during realization.

The conducted interviews show that the large influence of the lenders is partially caused by a lack of financial knowledge of consortia. Banks are often advisor for consortia and in the same time counterpart at the negotiation table.

6.3 SHAREHOLDERS AND SUBCONTRACTORS

This section discusses the shareholders and subcontractors. These two actors are discussed in the same section because these two roles often intermingle in Dutch DBFM projects, as is shown in the case study. If these actors would be considered separately this would not provide an accurate representation of the reality. Considering the current projects (Appendix A), generally construction companies, but also engineering companies and infrastructure investors are shareholders in DBFM projects. If construction companies act as

shareholder and subcontractor the intermingling takes place. This section discusses both the pure shareholder perspective as the pure subcontractor perspective as the combination of these two.

STANCE AND INTERESTS

Reasoned from a pure shareholder perspective, return on investment is the main interest of a shareholder. To secure the return on investment a shareholder is involved with a company on strategic level. If this is applied on a DBFM project, all the shareholders are represented in the board of the Project Company. The board is responsible for the appointment of the executive management and supervising of the executive management. A pure shareholder will thus have as main interest their return on investment and is, because of this main interest, involved at the strategic level of the company. Shareholders are interested in opportunities that increase the return on investment; LCC optimizations are such opportunities. If, with reasonable certainty, can be demonstrated that the business case of the overall DBFM project improves shareholders will support the optimizations.

Subcontractors in DBFM projects will predominantly optimize their own business model. This means that they will have the main interest of a private company as described in section 3.4. The fact that construction companies are organized in many subsidiaries, which are managed like independent companies, contributes to the drive for predominant optimization of the own business model of subcontractors. Rather than optimization of the total company business model.

The position of shareholder and the position of subcontractor intermingle, construction companies fulfil both positions in DBFM projects. As a consequence the interests intermingle and deviate from the above described main interest of a shareholder. Figure 15 displays the main revenue streams from a shareholding construction company in a Dutch DBFM Road project. A pure shareholder would only have A and B as revenue streams. Construction companies can also obtain revenue through C. Contractual agreements suggest that the main goal of some of the shareholding companies is to obtain revenue through C, interviews confirm this.

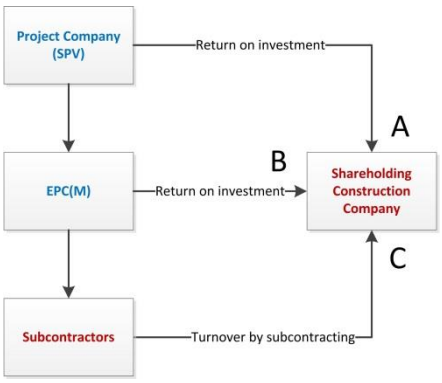

FIGURE 15 REVENUE STREAM SHAREHOLDING CONSTRUCTION COMPANY IN DUTCH DBFM

As consequence shareholding companies extent their interest to the tactical and operational level, to secure subcontracting and to oversee their consortium partners. Selection of management is therefore not based on skills but on representation of the shareholding company.

POWER POSITION

As a result of the intermingling between shareholder and subcontractor, also the power positions of shareholders and subcontractors intermingle. Where normally the influence of the subcontractor is limited; in a DBFM project their influence can be significant because of a relationships with one of the shareholders. This relationship has two sides, shareholders can use their power for the appointment of a subcontractor, but shareholders can also influence subcontractors to cooperate with the project team outside the contract.

Shareholders have the possibility to block or promote changes in the project board. However, a majority of the board is required, therefore a single shareholder rarely occupies a majority.

6.4 CLIENT (RIJKSWATERSTAAT)

Rijkswaterstaat is the executive agency of the Dutch Ministry of Infrastructure and Environment (Rijkswaterstaat, 2013). Therefore it is usually the principal of all the major Dutch DBFM Infrastructure projects, but subject to the political climate. In the previous sections of this report it seemed that Rijkswaterstaat is one party with the same stance and interest, however also Rijkswaterstaat is divided in a national body and regional bodies (Rijkswaterstaat, 2013). These two organizations have different stance and interests. In addition, the responsibility for stakeholder management is transferred to the consortium by means of the DBFM contract. This results in actors like municipalities and 'Waterschappen' who put down additional requirements. This section discusses the consequences of this situation but attempts, despite the differences, to present general stances, interests and the power position of RWS.

STANCES AND INTERESTS

Rijkswaterstaat determines the requirements of the DBFM contracts and pays for the availability of the infrastructure. The contractor must meet these requirements (desired availability and desired value) for the lowest possible cost. The tenderer which offers the lowest NPV wins the project. In which way the lowest bid is established does not matter to Rijkswaterstaat as long as the requirements are met. The availability of the infrastructure is the most important for Rijkswaterstaat. The client requires a certain level of availability, the actual availability can be higher, lower is not acceptable. In the case that the actual availability is lower than the required availability, deficiencies can be imposed which can lead to negative financial consequences for the contractor. If an agreed performance is not achieved this can lead to political questions for Rijkswaterstaat. It appears that this is particularly the stance of the national RWS organization, the regional RWS organizations tend to be more involved in the DBFM projects from their role as road administrator and are therefore more concerned with the proper and timely execution of the works.

Where RWS is mainly focussing on the national and regional importance of the projects, municipalities and other local authorities are more focused on the local interest. These interests can conflict and the inclusion of these interests is the responsibility of the consortium.

POWER POSITION

The power of RWS is mainly expressed during tender and in the DBFM contract. During tenders Rijkswaterstaat uses selection criteria or eligibility requirements. For example, requirements about the experience of the contractor; often is required that the contractor has sufficient experience with project management. In addition, requirements may be imposed about the technical experience of a contractor, for instance experience in tunnelling. If the contractor does not meet these requirements they are excluded from the tender (Rijkswaterstaat, 2013). From this perspective, Rijkswaterstaat exercises influence on the composition of a consortium, experience requirements force a consortium to include construction companies. RWS limits the possibilities and mainly exerts blocking power.

DBFM progress reports show that actions of Rijkswaterstaat do influence the potential of Life Cycle Costing. Output specifications have still a strong prescriptive nature, this reduce the possible number of solutions and thus the opportunities for LCC. Availability payments are guaranteed and one-time payments are made, this reduces the incentive for LCC. Penalties and availability reductions are not always imposed by RWS; this reinforces the idea that RWS is impressionable and will be if the consortium gets into trouble (Algemene Rekenkamer, 2013).

Local authorities are responsible for licensing of the project. In this way local authorities can block the progress of the project and exert influence on the consortium to meet their interests. The consortium has few resources

to influence the local authorities. Although it is not their responsibility, RWS does have the resources to influence the local authorities, often this is the way in which conflicts between the consortia and local authorities are resolved.

6.5 Findings Actor Analysis

This chapter describes the four actors that have the most influence on a DBFM consortium. The stances, interests and power positions of each of the actors are presented. An important finding is that the role of shareholder and the role of subcontractor intermingle in the Dutch DBFM projects, consequence is that the power position of shareholders is used to secure the interest of subcontractors. The influence of lenders is substantial and underlies the structure of the project team. Rijkswaterstaat is presented as one client but effectively is a national and regional body with own interest. The former stakeholders of RWS (e.g. municipalities) are now the responsibility of the consortium and lay down additional requirements. Overall can be concluded that a Dutch DBFM project is a multi-actor environment. This multi-actor environment has disadvantages but also advantages. Multiple actors lead to multiple interest and sometimes conflicting interest, but multiple actors also lead to different perspectives and therefore multiple ways to solve problems. This characteristic of DBFM projects must be included in the framework. The multi-actor environment as described is this chapter is topical. However, the multi-actor environment is also time-bound and constantly changing. An example of this is the possibility to deviate from back-to-back contracting as described in the lenders section (section 6.2).

6.6 Concluding Remarks

Chapter 6 answers the sub question: *What are the stance and interests and power positions of the important actors?* Most important finding is that these stance and interest of the important actors are relevant for the application of LCC and the power to influence is significant. To develop a framework that is applicable in DBFM projects this multi-actor environment should be included in the framework. How the multi-actor environment can be included in the framework is the discussed in the next chapter .

7 COMPOSING THE FRAMEWORK

Chapter 7 combines the findings of the case study (chapter 4), expert interview research (chapter 0) and actor analysis (chapter 6). This chapter answers thereby three of the sub questions:

1. *Which preconditions can be established based on the elements identified?*
2. *What are the perspectives of the actors regarding the established preconditions?*
3. *Which preconditions can be established including the actor perspectives?*

Section 7.1 explains how the different findings are combined in a framework. Sections 7.2-7.6 are devoted to establishing the framework. Section 7.7 discusses the internal and external validation of the framework.

7.1 USE OF FINDINGS

The case study, interviews and actor analysis provide input for the establishment of the preconditions. How these findings are exactly used is explained in this section.

The bases of the framework are the findings from the interviews. As explained the findings from the interviews are assumed to be more representative for the Dutch DBFM in general. The findings are presented in Table 4 and Table 5 (chapter 0). The findings of the interviews are combined with the findings of the cases (Table 7). The findings of the cases are derived from contracts and other project documentation. An element identified in the interviews can be confirmed or not confirmed by the cases (Table 7; column 5). Because of the type of elements identified in the interviews and the type of input for the cases it is not possible to confirm all elements by the cases. Interview elements can be based on a prevailing view of the interviewees, on the other hand the case study are purely based on factual information.

The findings of the interviews are separated in disablers and enablers. Enablers provide possible solutions for the disablers. The enablers often relate to future projects and can therefore not be confirmed by cases relating to previous projects. This is why only the disablers can be combined with the case study. Table 7 presents the combination of the elements with the case study.

TABLE 7 COMBINATION OF ELEMENTS IDENTIFIED IN THE INTERVIEWS AND THE CASE STUDY FINDINGS

Disablers				
Index	Description	Class.	Count	Case
D1	**Traditional construction culture**	What	8	No
D2	**Separating disciplines and project phases with 'fixed price' contracting**	How	7	Yes
D3	**Conflict of interest between shareholders**	Who	7	Yes
D4	**Organizational structure construction companies**	Who	7	Yes
D5	**Competencies of key project team members**	What	7	No
D6	**Incentive for life cycle optimizations**	How	6	Yes
D7	**Project Company limitations**	How	6	Yes
D8	**Shareholders acting as (preferred) subcontractor**	Who	5	Yes
D9	**Project Company risk**	How	5	Yes
D10	**Importance of financial model**	How	5	Yes
D11	**Uncertainty of information relating to lifetime**	What	5	No
D12	**Mutual understanding activities Project Company and EPC(M)**	How	5	No
D13	**Mutual understanding Technical and Financial sector**	How	5	No
D14	**Transition from tender to realization**	How	5	No
D15	**Experience with DBFM**	What	5	No

D16	**Different shareholders in different parts of the project**	Who	4	Yes
D17	**Number of shareholders**	Who	4	No
D18	**Type of shareholders**	Who	4	No
D19	**Time pressure during realization**	What	4	No
D20	**Process for Life Cycle Costing**	How	3	No
D21	**Cultural differences shareholders**	Who	3	No
D22	**Design capabilities of construction companies**	What	3	No
D23	**Overall management**	How	2	No
D24	**Failure Cost**	What	2	No
D25	**Discount factor**	What	1	No
D26	**Pre-financing of optimizations by shareholders**	What	1	No
D27	**Suggestibility of Rijkswaterstaat**	Who	1	No
D28	**Growth realization organization**	How	1	No
D29	**Requirements Rijkswaterstaat (functional)**	What	1	No
Enablers				
Index	**Description**	**Class.**	**Count**	**Case**
E1	**Selection of key project team members**	How	4	N.A.
E2	**Process for Life Cycle Costing**	How	4	N.A.
E3	**Shared project interest**	How	4	N.A.
E4	**Responsibility for DBM(total project) with one party**	How	4	N.A.
E5	**Overall management on Project Company level**	How	3	N.A.
E6	**Different shareholders**	Who	3	N.A.
E7	**Transfer of knowledge construction companies**	Who	3	N.A.
E8	**Growth project organization**	How	3	N.A.
E9	**Number of shareholders**	Who	2	N.A.
E10	**Treating subsidiaries as external companies**	How	2	N.A.
E11	**Importance of business case**	What	2	N.A.
E12	**Insight into financial model**	What	2	N.A.
E13	**Project Company risk**	What	2	N.A.
E14	**Separating DB and M responsibility (shifting budgets)**	How	1	N.A.
E15	**Configuration change board**	How	1	N.A.
E16	**Involvement of subcontractors with LCC**	Who	1	N.A.
E17	**Real Options Valuation**	What	1	N.A.

A precondition is defined as a conditions or term that must be fulfilled before other things can happen or be done (OED, 2013). Applied to this research this means that a precondition for Life Cycle Costing is: a DBFM project condition that should be present to guarantee a proper application of Life Cycle Costing. Until now, only the elements are identified which disable or enable Life Cycle Costing. The line of reasoning is that if a disabler or enabler is undisputed, it should be included in the framework. The optimal framework should solve all the undisputed disablers and include all the undisputed enablers. To establish the undisputed elements, criteria must be defined for including an element in the framework:

A Elements that are mentioned by more than half of the interviewees.
B Elements that are mentioned by at least a quarter of the interviewees and are confirmed by the case study.

If these criteria are applied to the disablers and enablers, it appears that the first sixteen disablers should be included in the framework. However, none of the enablers meet the requirements. Possible reasons to explain these differences are:

- Multiple solutions (enablers) are available for one problem (disablers)(e.g. E4 and E14)
- With the identification of disablers interviewees can draw on past project experiences, with enablers interviewees can draw less from this experience.

From this observation can be concluded that the interviewees agree more about the current problems in DBFM projects than about the solutions for these problems. Therefore it is chosen to use the enablers as suggestions for possible solutions, and therefore not necessarily include one of the enablers in the framework.

From chapter 6 appears that a DBFM project is a multi-actor environment and that this characteristic should be included in the framework. However, the chapter also concludes that the multi-actor environment is time-bound and constantly changing. The research is performed from the perspective of DBFM consortia (chapter 2), and should thus address their problems. It is assumed that the internal consortia environment is less volatile then the external multi-actor environment. Therefore, to increase the durability of the framework, two frameworks will be developed: A single-actor framework with the focus on the consortium, and a multi-actor framework where the multi-actor environment is included. The single-actor framework increases the durability of the findings of this research while the multi-actor framework increases the current applicability. The single-actor framework is established using the findings from the cases and interviews. The multi-actor framework is established by combing the single-actor framework with the multi-actor environment (Figure 16).

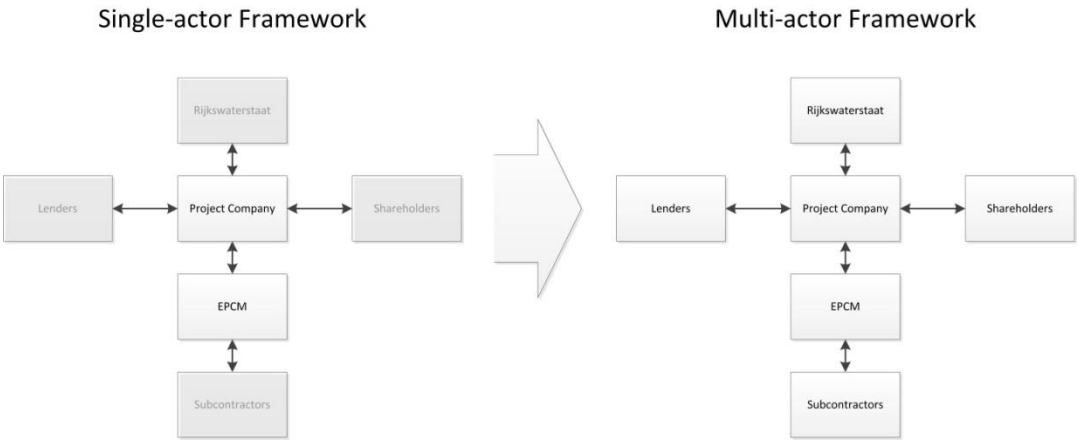

FIGURE 16 VISUALIZATION OF SINGLE-ACTOR FRAMEWORK AND MULTI-ACTOR FRAMEWORK

7.2 GROUPING OF ELEMENTS

The disablers which will be included in the framework (D1-D16) are not all independent elements. Some of the elements are directly linked with each other and can therefore be solved by one precondition. In this way preconditions can be created for a group and not for every single element. The linkage of the elements can be made visible in a matrix (Appendix E). The line of reasoning is that elements which share the same direct relations can be grouped together, the extent to which elements share the same relationships is represented by the Pearson product-moment correlation coefficient. Correlation coefficients are always between -1 and 1, but can take any value in between. The correlation becomes more positive if both elements share the same relation e.g. D12 and D13 both have a direct relation with D9 (Appendix E). The correlation becomes more negative if they have opposite relations. If the correlation is 1 both elements share all relations (Freedman, et al., 2007). Based on this correlations Table 8 can be established.

TABLE 8 CORRELATION MATRIX DISABLERS

Index	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16
D1	1,00															
D2	-0,42	1,00														
D3	0,52	-0,24	1,00													
D4	0,52	-0,24	0,73	1,00												
D5	0,67	-0,40	0,26	0,26	1,00											
D6	-0,02	0,37	-0,37	-0,04	-0,16	1,00										
D7	-0,42	0,13	-0,52	-0,52	-0,13	-0,32	1,00									
D8	0,52	-0,24	0,73	0,73	0,52	-0,04	-0,52	1,00								
D9	-0,31	0,31	-0,60	-0,60	-0,26	-0,04	0,87	-0,60	1,00							
D10	-0,31	0,31	-0,60	-0,60	-0,26	-0,04	0,87	-0,60	1,00	1,00						
D11	-0,15	-0,25	-0,29	0,10	0,00	0,30	-0,25	0,10	-0,29	-0,29	1,00					
D12	-0,13	0,13	-0,26	-0,26	0,25	-0,16	0,67	0,00	0,52	0,52	0,00	1,00				
D13	-0,13	0,13	-0,26	-0,26	0,25	-0,16	0,67	0,00	0,52	0,52	0,00	1,00	1,00			
D14	0,39	-0,08	0,15	0,15	0,58	0,09	-0,39	0,45	-0,45	-0,45	0,22	0,29	0,29	1,00		
D15	0,42	-0,42	0,24	0,24	0,40	-0,02	-0,42	0,24	-0,59	-0,59	0,25	-0,13	-0,13	0,39	1,00	
D16	0,45	-0,16	0,59	0,87	0,13	0,02	-0,45	0,59	-0,52	-0,52	0,15	-0,13	-0,13	0,23	0,16	1,00
Total	11	5	6	6	8	3	5	6	6	6	2	8	8	4	11	5

The elements with a correlation coefficient higher than 0,7 (Table 8) are grouped together in Table 9. Three clear groups can be identified, the groups are marked in red. The grouping of the elements is confirmed by the classification of the elements (column 3), the groups consist of disablers of the same classification. It could well be that the classification of a disabler is linked to the type of solutions which is applicable. However, this is not further researched. The bottom row of Table 8 presents the total number of relations of the elements, the total number of relations of an element tells something about the influence of the selected element on the other disablers. Based on the total number of relations two elements, marked in green (Table 9), are identified as the elements with the most influence on the other elements.

TABLE 9 GROUPING OF SELECTED DISABLERS

Index	Description	Class.
D3	**Conflict of interest between shareholders**	Who
D4	**Organizational structure construction companies**	Who
D16	**Different shareholders in different parts of the project**	Who
D8	**Shareholders acting as (preferred) subcontractor**	Who
D7	**Project Company limitations**	How
D9	**Project Company risk**	How
D10	**Importance of financial model**	How
D12	**Mutual understanding activities Project Company and EPC(M)**	How
D13	**Mutual understanding Technical and Financial sector**	How
D5	**Competencies of key project team members**	What
D1	**Traditional construction culture**	What
D14	**Transition from tender to realization**	How
D2	**Separating disciplines and project phases with 'fixed price' contracting**	How
D6	**Incentive for Life Cycle Costing**	How
D11	**Uncertainty of information relating to lifetime**	What
D15	**Experience with DBFM**	What

7.3 COMPOSING THE SINGLE-ACTOR FRAMEWORK

In this section the single-actor framework is established using the disablers and the groups from Table 9. Using the disablers a problem statement is derived. For each problem statement one or multiple preconditions are established to deal with this problem. The statements are explained using quotes from the interviews. Because of confidentiality, the sources of the quotes are not mentioned. This section provides the answer on sub question 3: *Which preconditions can be established based on the elements identified?* For the clarity is problem is discussed on a separate page:

Problem 1: The traditional construction culture predominates in DBFM road projects (D1)

Quote: "The current behaviour can be explained from the old mind-set"

DBFM projects are relatively new. Traditionally all elements where procured separately, as explained in section 3.2, money could be earned by changes of scope and ad hoc response on client requests. The traditional culture is focused on the short-term, separating disciplines, confrontation and cost minimization. This opposes the DBFM culture (and thus LCC) which is focused on the long-term, integrating disciplines, collaboration and possible additional investments. The traditional culture predominates in DBFM Road projects, and therefore hinders the application of LCC. As presented in Table 8 the traditional culture has influence on as significant number of other disablers, and is therefore stated as the first problem.

Precondition 1: Avoid the traditional construction culture on LCC determining positions.

Individuals with the traditional setting should be avoided on determining positions for Life Cycle Costing in the project. On the other hand, also advantages of the traditional culture should be recognized and used, e.g. the procurement of work to subcontractors remains the same; the procurement of subcontractors is perfected by the traditional construction sector.

Problem 2: Construction companies lack experience with DBFM (D15)

Quote: "DBFM differs significantly from traditional procurement"

As explained in the previous problem statement and in section 3.2, DBFM and traditional procurement differ significantly. Because of the limited number of DBFM Road projects even some of the top-3 construction companies, have not yet experienced the realization of a Dutch DBFM Road Project (Appendix A). Because of this limited DBFM experience, construction companies lack experience with Life Cycle Costing. This lack of experience with LCC hinders the application of LCC in DBFM projects. This lack of experience influences many of the other elements (Table 8).

Precondition 2: Involve companies experienced in Life Cycle Costing.

The lack of experience of construction companies can be accommodated by companies which are experienced in Life Cycle Costing. These companies can take various forms, this can be construction companies with experience in DBFM, consulting companies but also companies from other sectors in which Life Cycle Costing is already more common (Oil&Gas). The involvement of these companies in the project does not necessarily mean that these companies should also be shareholders in the consortium.

Problem 3: Conflicting interests due to shareholder involvement (D3;D4;D8;D16)

Quote: "Shareholders, participating in a consortium with the main reason of securing turnover during realization, are certainly present (D3)"

The main reasons for shareholders to participate in a consortium differ and may conflict. In the current consortia there are shareholders who participate to secure turnover by means of subcontracting during realization. Shareholders with this stance may oppose additional investments if this is not directly compensated by additional subcontracting; therefore it hinders the application of Life Cycle Costing. This is related with the short-term perspective of the traditional construction culture.

Quote: "By agreeing in advance about subcontracting or sub subcontracting additional interests are created (D8)".

In current projects additional interest are created by contractually recording agreements about subcontracting. Subsidiaries are appointed as important subcontractors and therefore the EPC(M) is obliged to use the subsidiaries, if this does not happen the EPC(M) has to compensate the appointed subcontractors. Because of this guarantee the subcontractor is not incentivised to 'go the extra mile' for the consortium. Flexibility is therefore an issue which hinders Life Cycle Costing.

Quote: "The organizational structure of a traditional construction company is focused on managing partial interest, this works against the overall project objective (D4)".

Dutch construction companies are organized in multiple subsidiaries, more than hundred subsidiaries is not uncommon for a Dutch top ten construction company. These subsidiaries are often arranged by discipline and controlled by individual (profit) targets. Because of these individual targets a subsidiary will try to optimize their own business model; if a parent company is shareholder in a DBFM project this does not automatically mean that a subsidiary shares the same interests. The interest of the subsidiary often conflict with the project interest and thus with Life Cycle Costing. For example, changes due to a LCC consideration in the scope of a contract with a subsidiary benefits the total project and thus the parent company, but can reduce the scope of a subsidiary (less income). The governing of construction companies is strongly related to the traditional construction culture.

Quote: "Because the shareholders of the Project Company and the EPC sometimes differ, courtesy between shareholders has to take place (D16)".

As already presented in the case study the shareholders of the Project Company and EPC(M) sometimes differ. Subsidiaries are shareholder of a part of the project team, instead of the parent company. Subsidiaries are inclined to optimize their own business model, as discussed in the previous section. Therefore, naming subsidiaries shareholder in different parts of the project team contributes to the optimization of the separate project parts instead of the overall project. e.g. a DBFM project with a separate entity for engineering, procurement and construction (EPC), with shareholders that differ from the Project Company, are not inclined to optimize the total NPV of the project (LCC) because maintenance cost are not borne by the EPC shareholders.

The four elements discussed cause conflicting interest due to involvement of different shareholders. If the consortium would exist of only one company these conflicts could be partially avoided. However, only the largest construction company of the Netherlands is capable to execute small DBFM projects single-handed. This means that in the coming years most DBFM projects still will be executed by consortia of different companies, and therefore the mentioned elements will remain. Based on this the following precondition can be established (next page).

Precondition 3: The main criterion for the selection of consortium partners is the contribution to the overall project interest.

The overall project interest is the design, build, finance and maintenance of the most optimal solution (highest return on investment/most positive NPV) over the total contracting period, within the terms of the DBFM contract. The selected shareholders should comply with this interest. The expertise of a company should not be the main reason for selecting a company as consortium partner. It is true that more different companies lead to more knowledge and more experience and possible better solutions. Also expertise regarding disciplines is assumed to positively correlated with control over risks; therefore desirable. But th risk of conflicting interests also increases. These conflicting interests can negate the positive contributions; expertise can also be obtained without naming a company shareholder. Because of the organizational structure of construction companies, the position of construction companies as shareholding companies should not be undisputed. More companies which act as 'pure' shareholder (p. 45) should be involved in the project. To avoid as much of the conflicting interests: no agreements are made in advance (before realization) with reference to subcontracting; subsidiaries are considered and treated as external companies.

Problem 4: Limited engagement Project Company (D7;D9;D10)

Quote: "The Project Company is mainly focused on their own balance sheet (D10)"

Quote: "In the prevailing opinion the Project Company is free of risks (D9)"

The Project Company has in most of the current DBFM projects solely the responsibility for the finance component. The DBM components are contracted fixed price and back-to-back to the EPC(M). Through this method of contracting the Project Company safeguards their own financial model. Expenses are fixed during realization and exploitation, and the income is secured because shortcomings (e.g. availability reductions) can be recovered from the EPC(M). During tender negotiations is ensured that the risks of the Project Company are either: mitigated, put to the EPC(M), or insured. This method makes sure that the financial model is secured and financers have the largest possibility on retrieving their loan. Because of the back-to-back contracting the Project Company does not benefit from possible LCC optimizations, the Project Company do needs to approve major changes of the EPC(M) and has therefore the possibility to block LCC. From this perspective the Project Company can disable Life Cycle Costing.

Quote: "The Project Company exists of 4 functions; some of them are not even full time (D7)"

Because of the considered main task (finance) of the Project Company, staffing is limited. Often the company exists of a project director, contract manager, financial manager and administration. The Project Company is supervised by a board; the board exists of persons of the shareholding companies. For changes in the contracts or budget overruns the Project Company has to seek approval from the board. The board is responsible for the appointment of the management of the Project Company. The limited capacity of the Project Company is caused by the limited tasks associated with finance of the project. Due to this occupation it is not possible, as a Project Company, to be substantively involved with the DBM components of the project.

Although the power to influence with reference to Life Cycle Costing is significant, the Project Company is often not affected (positive or negative) by optimizations. With the limited staffing of the Project Company it is impossible to be substantively involved with the DBM components of the project.

Precondition 4: The Project Company is financially involved with the risk and the opportunity of Life Cycle Costing.

To ensure that the Project Company does not disable possible optimizations, the Project Company itself should share in the benefits of LCC. In current projects this incentive should be present as the EPC(M) and Project Company consist of the same shareholders. As earlier mentioned also subsidiaries act as shareholding companies, with the previous mentioned effects. The shareholding companies are represented in the Project Company board, but the board only interferes by changes of the financial model. The management of the Project Company is held accountable for staying within budget. With the current practices there is no incentive for the management of the Project Company to support LCC.

Problem 5: Lack of mutual understanding between finance and technology (D12;D13)

Quote: "The technical and financial sector often ignore each other (D13)"

The knowledge of the technical sector about finance and the knowledge of the financial sector about technology are often limited. With the current scale of the DBFM projects and current economic climate, finance and the cost of finance becomes increasingly important. Life Cycle Costing in DBFM projects covers both financial elements (interest, availability payments, return on investment, etc.) as technical elements (lifetime, execution methods, etc.); the lowest LCC represents an optimal combination financial and technical choices made. Both are equally important and in both areas much progress can still be made. Within the technical sector fear exists to oppose the wishes of financial parties, this is caused by a lack of knowledge.

Quote: "The Project Company has little awareness of the activities of the EPC (D12)"

As explained in the previous problem statement, the main focus of the Project Company is the finance component, while The EPC(M) is mainly focused on the technical execution of the project. The described ignorance between finance and technology is thus also a topic within the project team. The limited staffing of the Project Company contributes to the mutual awareness between the Project Company and the EPC(M).

Precondition 5: The financial consequences of technical solutions are easy available operational level.

Public payments are dependent on the availability of the infrastructure and the performance of the consortium. The repayment of the loan, the finance cost (interest), and the time value of money can have a major impact on possible optimizations. To make informed decisions which improve the business case these consequences must be included in the considerations. Therefore it is important that in the EPC(M), at the level where the technical assessment takes place, the financial consequences of the technical solutions are easy and quickly available.

Precondition 6: Shareholding companies have sufficient financial and technical knowledge available.

The organization of DBFM projects is much influenced by the use of project finance. Providers of project finance have a major influence on the DBFM project. This influence partly precludes the application of LCC. The technical companies, which represent the majority of the shareholding companies, have limited financial knowledge. This is one of the reasons why the influence of the project financiers is that large. In a project where finance is one of the major components, the shareholders should have sufficient financial knowledge; in order to understand the interest of the financiers, partly counterbalance the influence of the financiers and thereby improve the application of LCC. If both parties have a better understanding of each other's interest more optimal solutions can be reached.

Problem 6: Creating conflicting interest with fixed price contracting (D2)

Quote: "Consortia create conflicting interest; contracts are aimed at fighting each other, instead of fighting for each other (D2)".

Separating project disciplines and project phases creates conflicting interest within the project team. The case study as well as the interviews confirm that this way of contracting, with fixed budgets, disables Life Cycle Costing in DBFM contracts. Splitting realization and exploitation (budget wise) leads to minimization of the cost of realization instead of optimizing the total life cycle cost. The further break-up of the project team into separate disciplines governed with fixed budgets, only introduces more conflicting interests.

Precondition 7: The responsibility for both realization and exploitation is with the EPCM.

The same group of shareholders and the same management is responsible for the design, build and maintenance (realization and exploitation) of the DBFM project. The benefits and the possible additional investment cost, related to LCC optimizations, boil down to the same place. The base of the LCC decisions is the business case (total NPV).

Problem7: Wrong person in the wrong position (D5)

Quote: **"Key positions are filled by people who maintain the confrontation culture (D5)"**

One person can disable the application of LCC, key positions for the application of LCC are filled with persons raised with the traditional construction culture. For most of these persons it is hard to change to the DBFM context which, as explained, differs significantly. The reason why these persons hold important positions is because the overall project interest is not the most important selection criterion. E.g. Management of the EPC(M) is often selected firstly on shareholder representation before project- or substantive knowledge; this is strongly related with securing turnover (Precondition 3).

Precondition 8: Persons for key project positions are first selected on capabilities instead of shareholder representation.

The wrong person on a key position can exert such influence that it hinders the application of LCC. It is therefore important that persons on key positions are first of all selected on propagating and understanding the overall project interest. These key positions are present on the strategic level, tactical level and operational level. The management of the project team should be assessed on representing the overall project interest. A DBFM project is too complex to understand for the entire project team. Therefore the selection of key persons is important. These key positions should direct the operational part of the project team. The key person is responsible for translating the DBFM context in understandable components at the operational level.

Problem 8: Relapse between tender and realization (D14)

Quote: **"The transfer of tender to realization is not working well, this causes rework during realization (D14)"**

The relapse described in section 2.4 between tender and realization is present in current projects and negatively influences the application of Life Cycle Costing. Persons involved in tender do often not work in realization of the project, decisions made during tender are not properly documented, and the organization of consortium grows exponentially. This has as a consequence that the vision of the tender team is not properly adopted by the realization organization, this causes rework and therefore time pressure, which reduces the possibilities for further optimization of the design. What remains from tender is the established budget. This problem can also be attributed as a lack of design (management) skills. The problem is strongly related with the previous problem (wrong person on the wrong position) and the traditional culture.

Precondition 9: Gradually build-up the realization organization.

Important is that the line of reasoning from the tender is adopted and expanded during realization. The key persons (Precondition 8) start the project and determine the outline of the project. At the moment that this outline is determined the project organization increases gradually until full strength. Ideally, the persons involved during tender are included during realization. Even though this precondition seems obvious, this has not gone well in the current DBFM projects.

Problem 9: Ambiguity relating to the Life Cycle Costing process.

Quote: **"It was totally unclear where the benefits of LCC optimizations would end up (D6)"**

As explained, Life Cycle Costing is a way of decision making. Simply put, this means that a given input is needed (alternatives, involved risks, NPV, etc.); based on this input someone takes decisions; and this decisions has a certain output (additional cost, change of scope, etc.) which has certain consequences (positive or negative) for actors involved. If the potential positive consequences are not clear, there is no incentive to initiate the process. This is the case in the current DBFM projects. Additionally, there is no appropriate decision maker for LCC. In current projects this decision maker should be the Project Company director, as explained the Project Company is not capable of taking these decisions and does not benefit of from these decisions (precondition 4).

Precondition 10: For the initiators of Life Cycle Costing it is clear what the benefits should be and who the decision maker is.

Part of the ambiguity relating to LCC is already taken away by creating an EPCM (precondition 7). The other part of the ambiguity can be reduced by clearly stating responsibilities regarding to the LCC process and making the benefits of possible optimizations visible (see also precondition 5). By making the benefits visible more optimizations will be initiated.

Problem 10: Uncertainty of Information relating to technical life time (D11)

Quote: "The contractor often does not have the data to make an informed choice (D11)"

There is much uncertainty about the technical life time of elements, in particular asphalt, this complicates the application of LCC. This uncertainty could be managed, but at this moment uncertainty is avoided. Therefore this uncertainty stimulates safe choices, failure cost is significant, and therefore this reduces the possibilities for LCC. In the traditional setting there was no use for construction companies to collect information regarding to lifetime, also government agencies cannot provide this information. In addition, the knowledge transfer within construction companies is insufficient, the same mistakes are made on successive projects, and this is related to the segmented organization of construction companies (Precondition 3).

Precondition 11: Transfer of knowledge is embedded in the project organization.

Although this precondition might seem obvious, it is a current problem in DBFM projects, and therefore necessary to state. The knowledge obtained in previous DBFM projects should be embedded in the project organization of new projects. The easiest way to embed this knowledge is by acquiring experienced staff for the project organization. There are multiple ways to include uncertainty in the application of Life Cycle Costing. Precondition 2, states that parties experienced with LCC are involved in the DBFM project, this experience can be used regarding dealing with uncertainty.

7.4 SINGLE-ACTOR FRAMEWORK

Table 10 displays the single-actor framework. The framework is a compact overview of the preconditions established in section 7.3. The supporting conditions in the third column, are the most important elements from the explanation of the preconditions. The supporting conditions improve comprehensibility of the preconditions without compromising the clarity of the framework.

TABLE 10 SINGLE- ACTOR FRAMEWORK

No.	Precondition	Supporting conditions
1	**Avoid the traditional construction culture on LCC determining positions.**	1. LCC determining positions are identified. 2.Traditional persons are avoided on determining positions. 3. Strengths of the traditional construction culture are used.
2	**Involve companies experienced in Life Cycle Costing.**	1. Experience from other sectors is considered (Oil&Gas, Process industry, etc.) 2. Experience from the construction sector is considered.
3	**The main criterion for the selection of consortium partners is the contribution to the overall project interest.**	1. Shareholders are not selected primarily for their specific knowledge. 2. There are no assigned important subcontractors. 3. Subsidiaries are treated as external companies. 4. There are no long-term subcontractors.
4	**The Project Company is financially involved with the risk and the opportunity of Life Cycle Costing.**	1. The Project Company shares in losses and benefits with the EPCM. 2. Management of the Project Company is assessed on NPV. 3. The Project Company has the capacity to steer the EPCM.
5	**The financial consequences of technical solutions are easy available at operational level.**	1. Availability payments, time-value of money, cost of finance, etc. are available to include in LCC considerations.
6	**Shareholding companies have sufficient financial and technical knowledge available.**	1. Shareholding companies understand the technical risks and challenges of the project. 2. Shareholding companies have sufficient financial knowledge to obtain a strong negotiating position.
7	**The responsibility for both realization and exploitation is with the EPCM.**	1. Design, realization and exploitation are the responsibility of the same management. 2. The EPCM management is assessed on NPV of the project.
8	**Persons for key project positions are first selected on capabilities instead of shareholder representation.**	1. On strategic, tactical and operational level an important selection criterion is understanding and propagating the project interest. 2. (excluding the board) Shareholder representation is not a selection criterion.
9	**Gradually build-up the realization organization.**	1. The vision of the tender is adopted and expanded during realization. 2. Realization starts with the identified key positions. 3. Staff involved during tender is involved in the realization.
10	**For the initiators of Life Cycle Costing it is clear what the benefits should be and who the decision maker is.**	1. LCC responsibilities (initiating, decision making, implementing) are defined. 2. Benefits of LCC optimisations are noticeable/visible.
11	**Transfer of knowledge is embedded in the project organization.**	1. Experiences from previous DBFM projects are embedded in the project organization.

The single-actor framework is, as explained, from the perspective of the consortium regardless of the multi-actor environment. The next sections combines this single-actor framework with the multi-actor environment to establish the multi-actor framework.

7.5 Composing the Multi-Actor Framework

This section discusses the establishment of the multi-actor framework. The multi-actor framework takes the perspectives of the most important actors into account and is therefore more applicable then the single-actor framework, but time-bound. The goal of the framework is still the application of Life Cycle Costing in the consortium. This section answers the sub questions: *What are the perspectives of the actors regarding the established preconditions? & Which preconditions can be established including the actor perspectives?*

The four types of actors discussed in chapter 6 are considered. If the power position and stances &interests of the actors conflict with one of the preconditions, the precondition is adapted. The perspective of the actors is discussed using the typology discussed in section 6.1 (de Bruijn & ten Heuvelhof, 2008). Table 11 shows an example for the representation of the actor perspectives, the two characteristics are displayed beneath each actor.

TABLE 11 EXAMPLE FOR DEVELOPMENT OF THE MULTI-ACTOIR FRAMEWORK

Precondition no.: "description of precondition"							
Lenders		**Shareholders**		**Rijkswaterstaat**		**Subcontractor**	
Stances & Interests	Power Position	Stances & Interests	Power Position	Stances & Interests	Power Position	Stances & Interests	Power Position

As discussed in chapter 6, the shareholders and subcontractors intermingle. The perspective of the shareholders discussed in this chapter is the perspective of a "pure" shareholder. The subcontractor perspective discussed is the perspective of a subcontractor but with the power position of a shareholder.

Precondition 1: Avoid the traditional construction culture on LCC determining positions.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Diffuse	**Opponent**	**Blocking**	Fence Sitter	Diffuse	Fence Sitter	Diffuse

The precondition states that persons with the traditional mind-set should be avoided on key positions within the Project Company and EPCM. These key positions can be found at strategic, tactical and operational level, and therefore also include the higher project positions, which are usually obtained by persons experienced in the (traditional) construction industry (project management, project board, etc.). This means that part of the persons, who used to fulfil these higher project positions, no longer do so because of their more traditional mind-set. However, these persons often have significant influence on a shareholding construction company and can thereby block the precondition. Therefore, it is almost impossible to avoid more traditional persons on determining positions. Precondition 1, as stated in section 7.4 is thus not considered realistic and is therefore revised.

Precondition 1: Acknowledge, reduce the influence of, and make use of the traditional construction culture.

Besides that it is not possible to completely avoid the traditional construction culture, also the benefits should be acknowledged. The more traditional persons in higher project positions often have much knowledge and experience, for instance in project management, this should be used and is valuable for the DBFM project. An effort should be made to reduce the influence of the more traditional persons and increase the influence of the LCC minded persons.

Precondition 2: Involve companies experienced in Life Cycle Costing.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Proponent	Blocking	**Proponent**	**Promoting**	**Proponent**	Blocking	**Fence Sitter**	**Diffuse**

Different perspectives and more experience leads to better solutions. Lenders, shareholders, and to a lesser extent Rijkswaterstaat, value the experience of a consortium. Shareholders are in the position to actively search for experienced companies to involve in the project. Involving more experienced LCC companies will lead to more companies with a 'pure' shareholder perspective in the project, which will lead to less certainty for subcontractors. This is on the condition that experienced companies have a significant say in the way the project is organized and executed. Subcontractors can therefore oppose this precondition and can block (as shareholder) the involvement of these experienced companies. However, more 'pure' shareholding companies means less shareholding construction companies which are capable of performing subcontracting, and therefore less competition. From this point of view a subcontractor will support and promote the precondition. The position of a subcontractors is therefore diffuse. The precondition as stated in section 7.4 can be adopted in the multi-actor framework.

Examples of this involvement are already there, Fluor a company originated from the oil&gas industry is currently active in the Dutch DBFM market, the involvement of Fluor is experienced as positive by multiple parties.

Precondition 3: The main criterion for the selection of consortium partners is the contribution to the overall project interest.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Blocking	Proponent	Promoting	Opponent	Blocking	Opponent	Blocking

For precondition 3 the same applies as for precondition 2. It will lead to an increase in 'pure' shareholders, which will decrease the certainty but also decreases the competition for subcontracting. Additionally precondition 3 introduces the possibility of a consortium without the involvement of any construction companies as shareholding companies. Besides that this will lead to more no certainty regarding subcontracting, Rijkswaterstaat will block a consortium without major construction companies. Rijkswaterstaat uses eligibility requirements during tenders, the requirements can refer to experiences with technology (e.g. tunnelling), integrated projects (e.g. DC experience) and contract value (e.g. min of 50 mil). If a consortium does not meet these criteria it will be excluded from participation (Rijkswaterstaat, 2012). In this way RWS can influence the composition of a consortium. Lenders already finance consortia without major construction companies, an example of this is the tax office in Doetichem (DBFMO) that is won by Facilicom Bedrijfsdiensten a facility service provider (PPS Netwerk, 2013). However, lenders do not express any preference regarding a consortium with or without construction companies. As a consequence of the opposing position of RWS precondition 3 is revised.

Precondition 3: The main criteria for the selection of consortium partners are the contribution to the overall project interest, and the clients eligibility requirements.

There can be a number of reasons for RWS to apply the eligibility requirements for instance, they believe it increases the certainty of proper project completion, but it can also be to protect the Dutch construction sector. In either way RWS will not drop these requirements on the short term and therefore a consortium without shareholding construction companies will not be possible in the coming years.

Precondition 4: The Project Company is financially involved with the risk and the opportunity of Life Cycle Costing.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Opponent	**Blocking**	Fence Sitter	Blocking	Fence Sitter	Diffuse	Fence Sitter	Diffuse

Precondition 4 means that the project is not contracted back-to-back in its total; the Project Company bears part of the project risk and thus also benefits from optimizations. However, as stated in section 6.2, a DBFM project is currently not financeable without total back-to-back contracting. Lenders will therefore certainly block precondition 4. Shareholders will be indifferent about the distribution of the risk between the EPCM and the Project Company, because in either way they will bear the risk. Rijkswaterstaat and subcontractors will not be influenced by a different risk distribution. Because of the blocking position of the lenders precondition 4 is revised.

Precondition 4: The DBM components are contracted 'back-to-back' to the EPCM, the Project Company is expanded with staff responsible for adopting LCC within the EPCM.

By expanding the Project Company with additional staff, with the responsibility of LCC in the EPCM, the integration between the Project Company and EPCM improves. By placing this responsibility with the Project Company, also the Project Company is more focused on LCC. The additional staff must have authority and power to influence.

Precondition 5: The financial consequences of technical solutions are easily available at operational level.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Diffuse	**Opponent**	**Blocking**	Fence Sitter	Diffuse	Fence Sitter	Diffuse

Precondition 5 provides an improved integration between technical solutions and financial consequences. This should partly be done by providing insight in the DBFM contract conditions, and partly by providing insights in the financial model (return on investment, cost of capital, time value of money, etc.). This second part can lead to an opposing stance from shareholder perspective. Inside in finances is often considered as sensitive information. In addition shareholding companies may be careful with sharing information, partners in the current project can be competitors in the next project.

Precondition 5: At operational level different technical solutions can be compared on Life Cycle Costing.

It is not necessary to share the sensitive information as long as at operational level the right tools are available to asses potential optimizations. If the assessment of optimizations only takes place at tactical or strategic level, this can lead to lack of motivation to optimize at operational level.

Precondition 6: Shareholding companies have sufficient financial and technical knowledge available.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Proponent	Diffuse	Proponent	Promoting	Fence Sitter	Diffuse	Fence Sitter	Diffuse

Precondition 6 establishes an improved mutual understanding between finance en technology. Through increased knowledge about each other's positions more optimal solutions can be achieved for both parties. Important is to not only know what position is taken but also why this position is taken. Parties like a LTA try to improve the mutual understanding but always represent the interest of the lenders, therefore it is important that shareholding companies have sufficient financial knowledge as well as technical knowledge. Lenders will support this precondition but will not actively be involved. Shareholders support this precondition and have the possibility to promote.

Precondition 7: The responsibility for both realization and exploitation is with the EPCM.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Diffuse	Proponent	Promoting	Fence Sitter	Diffuse	Fence Sitter	Diffuse

Lenders will have no problems with a different organization of the EPC(M) as long as the total project is transferred back-to-back. For Rijkswaterstaat and the subcontractor nothing changes with reference to current projects. Shareholders are influenced by the precondition; one EPCM means that the same shareholders are responsible for both the construction and maintenance. In the situation of a separate EPC and a Maintenance company, construction companies can appoint different subsidiaries as shareholders. In this way there is one shareholder which is liable for the relatively short but capital intensive construction period and another shareholder is liable for the long but less capital intensive maintenance phase. Assumed is that the number of projects where a shareholder can take liability for is limited, therefore the EPCM construction can possibly limit the number of projects where a shareholder can engage in. However, these financial aspects for shareholders are no part of this research and thus this cannot be stated with certainty. What can be stated with certainty is that the EPCM organization is the preferred model for the upcoming projects, the shareholders are therefore displayed as proponents.

Precondition 8: Persons for key project positions are first selected on capabilities rather than shareholder representation.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Diffuse	**Opponent**	**Blocking**	Fence Sitter	Diffuse	**Opponent**	**Blocking**

There are a number of conceivable reasons for the shareholder representation on project management level. The first, as already discussed, is to secure subcontracting for the shareholding company. Another reason is mentioned in the interviews as healthy distrust, e.g. if a subsidiary is responsible for the construction of the asphalt a manager originating from another shareholding company should supervise this activity. Reasoning from the current Dutch DBFM sector, where construction companies represent a fast majority of the shareholding companies and subcontracting performed by shareholders is a topical issue, shareholders will oppose and block this precondition. Subcontractors will for the first mentioned reason oppose this precondition. Both lenders as Rijkswaterstaat have no interest in this precondition.

Precondition 8: Persons for key project positions are first selected on capabilities, shareholder representation is considered over the total project organization.

Capabilities are still the first selection criterion for a key project position. Shareholder representation is considered but overall. A project position is thus not automatically assigned to one of the shareholders (e.g. the function of project manager). All key functions together should reflect about the distribution of shareholders.

Precondition 9: Gradually build-up the realization organization.							
Precondition 11: Transfer of knowledge is embedded in the project organization.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Diffuse	**Proponent**	**Promoting**	Fence Sitter	Diffuse	Opponent	Blocking

Lenders, subcontractors and Rijkswaterstaat will be indifferent about precondition 9. Shareholders will support this precondition and have the power to promote it. The shareholding companies are responsible for the build-up of the project organization and the appointment of the management. The same applies to precondition 11, the shareholders have the possibility to actively search for persons experienced in DBFM projects, and in this way promote the knowledge transfer.

Precondition 10: For the initiators of Life Cycle Costing it is clear what the benefits are and who the decision maker is.							
Lenders		Shareholders		Rijkswaterstaat		Subcontractor	
Fence Sitter	Diffuse	Fence Sitter	Diffuse	Fence Sitter	Diffuse	**Proponent**	Diffuse

Subcontractors may be a source for LCC optimizations. Contractors will therefore support clearly stated responsibilities regarding to the LCC process, in this way it is clear for a subcontractor where to go with possible optimizations. Of course, a subcontractor will only suggest a optimization if the subcontractor also profits of the optimization.

7.6 Multi-Actor Framework

Based on section 7.5 the multi-actor framework can be composed, Table 12 displays the multi-actor framework. The supporting conditions in the third column, are the most important elements from the explanation of the preconditions. The preconditions that did not change are taken over from the single-actor framework.

TABLE 12 MULTI-ACTOR FRAMEWORK

No.	Precondition	Supporting conditions
1	**Acknowledge, reduce the influence of, and make use of the traditional construction culture.**	1. LCC Determining positions are identified. 2. Traditional cultural strengths are used.
2	**Involve companies experienced in Life Cycle Costing.**	1. Experience from other sectors is considered (Oil&Gas, Process industry, etc.) 2. Experience from the construction sector is considered.
3	**The main criteria for the selection of consortium partners are the contribution to the overall project interest, and the clients eligibility requirements.**	1. Shareholders can be selected for specific knowledge. 2. There are no assigned important subcontractors. 3. Subsidiaries are treated as external companies. 4. There are no long-term subcontractors.
4	**The DBM components are contracted 'back-to-back' to the EPCM, the Project Company is expanded with staff that is responsible for adopting LCC within the EPCM.**	1. The additional staff has authority and power to influence the EPCM. 2. The additional staff has authority and power to influence the Project Company. 3. The additional staff is assessed on NPV
5	**At operational level different technical solutions can be compared on Life Cycle Costing.**	1. The tools to assess potential optimizations are available at operational level.
6	**Shareholding companies have sufficient financial and technical knowledge available.**	1. Shareholding companies understand the technical risks and challenges of the project. 2. Shareholding companies have sufficient financial knowledge to obtain a strong negotiating position.
7	**The responsibility for both realization and exploitation is with the EPCM.**	1. Design, realization and exploitation are the responsibility of the same management. 2. The EPCM management is assessed on NPV of the project.
8	**Persons for key project positions are first selected on capabilities, shareholder representation is considered over the total project organization.**	1. On strategic, tactical and operational level an important selection criterion is understanding and propagating the project interest. 2. Key positions are not restricted to a certain shareholder.
9	**Gradually build-up the realization organization.**	1. The vision of the tender is adopted and expanded during realization. 2. Realization starts with the identified key positions. 3. Staff involved during tender is involved in the realization.
10	**For the initiators of Life Cycle Costing it is clear what the benefits are and who the decision maker is.**	1. LCC responsibilities (initiating, decision making, implementing) are defined. 2. Benefits of LCC optimisations are noticeable/visible.
11	**Transfer of knowledge is embedded in the project organization.**	1. Experiences from previous DBFM projects are embedded in the project organization.

The stances and power positions of the actors, in respect of the single-actor framework, are used in section 7.5 to establish the multi-actor framework. The overview of the stances and power positions are displayed in Table 13 (next page).

TABLE 13 STANCES INTERESTS AND POWER POSITIONS OF THE ACTORS REGARDING THE SINGLE ACTOR FRAMEWORK

S = Stances & Interests O = opponent F = Fence Sitter P = Proponent	P = Power Position B = Blocking D = Diffuse P = Promoting	Lenders		Shareholders		Rijkswaterstaat		Sub- contractors		Implementability
No	**Precondition**	**S**	**P**	**S**	**P**	**S**	**P**	**S**	**P**	**1-11**
1	**Avoid the traditional construction culture on LCC determining positions.**	F	D	O	B	F	D	F	D	7
2	**Involve companies experienced in Life Cycle Costing.**	P	D	P	P	P	D	F	D	10
3	**The main criterion for the selection of consortium partners is the contribution to the overall project interest.**	F	B	P	P	O	B	O	B	11
4	**The Project Company is financially involved with the risk and the opportunity of Life Cycle Costing.**	O	B	F	B	F	D	F	D	8
5	**The financial consequences of technical solutions are easy available at operational level.**	F	D	O	B	F	D	F	D	7
6	**Shareholding companies have sufficient financial and technical knowledge available.**	P	D	P	P	F	D	F	D	5
7	**The responsibility for both realization and exploitation is with the EPCM.**	F	D	P	P	F	D	F	D	3
8	**Persons for key project positions are first selected on capabilities instead of shareholder representation.**	F	D	O	B	F	D	O	B	9
9	**Gradually build-up the realization organization.**	F	D	P	P	F	D	F	D	3
10	**For the initiators of Life Cycle Costing it is clear what the benefits are and who the decision maker is.**	F	D	F	D	F	D	P	D	1
11	**Transfer of knowledge is embedded in the project organization.**	F	D	P	P	F	D	F	D	3

The line of reasoning is that a precondition is more difficult to implement for a consortium, if more actors have an interest in that specific precondition. Despite that the multi-actor framework includes the actors interest, the actors will be more likely to interfere with that precondition. On this basis something can be said about the how easy a precondition of the multi-actor framework can be implemented, in comparison with the other preconditions. For a value judgement, in terms of difficult/easy to implement, more research is needed. The preconditions are ranked relative to each other, this is added in Table 13 (last column). The higher the ranking, the more difficult to implement compared to the other preconditions. Table 14 displays the multi-actor framework with the ranking of the preconditions, the table starts with the relatively easiest to implement precondition.

TABLE 14 MULTI-ACTOR FRAMEWORK

Ranking*	No.	Precondition	Supporting conditions
1	10	**For the initiators of Life Cycle Costing it is clear what the benefits are and who the decision maker is.**	1. LCC responsibilities (initiating, decision making, implementing) are defined. 2. Benefits of LCC optimisations are noticeable/visible.
3	7	**The responsibility for both realization and exploitation is with the EPCM.**	1. Design, realization and exploitation are the responsibility of the same management. 2. The EPCM management is assessed on NPV of the project.
3	9	**The build-up of the realization organization is gradually.**	1. The vision of the tender is adopted and expanded during realization. 2. Realization starts with the identified key positions. 3. Staff involved during tender is involved in the realization.
3	11	**Transfer of knowledge is embedded in the project organization.**	1. Experiences from previous DBFM projects are embedded in the project organization.
5	6	**Shareholding companies have sufficient financial and technical knowledge available.**	1. Shareholding companies understand the technical risks and challenges of the project. 2. Shareholding companies have sufficient financial knowledge to obtain a strong negotiating position.
7	1	**Acknowledge, reduce the influence of, and make use of the traditional construction culture.**	1. LCC Determining positions are identified. 2. Traditional cultural strengths are used.
7	5	**At operational level different technical solutions can be compared on Life Cycle Costing.**	1. The tools to assess potential optimizations are available at operational level.
8	4	**The DBM components are contracted 'back-to-back' to the EPCM, the Project Company is expanded with staff that is responsible for adopting LCC within the EPCM.**	1. The additional staff has authority and power to influence the EPCM. 2. The additional staff has authority and power to influence the Project Company. 3. The additional staff is assessed on NPV
9	8	**Persons for key project positions are first selected on capabilities, shareholder representation is considered over the total project organization.**	1. On strategic, tactical and operational level an important selection criterion is understanding and propagating the project interest. 2. Key positions are not restricted to a certain shareholder.
10	2	**Involve companies experienced in Life Cycle Costing.**	1. Experience from other sectors is considered (Oil&Gas, Process industry, etc.) 2. Experience from the construction sector is considered.
11	3	**The main criteria for the selection of consortium partners are the contribution to the overall project interest, and the clients eligibility requirements.**	1. Shareholders can be selected for specific knowledge. 2. There are no assigned important subcontractors. 3. Subsidiaries are treated as external companies. 4. There are no long-term subcontractors.
* preconditions are ranked from easy to implement (1) to difficult to implement (11) compared with each other			

7.7 VALIDATION OF THE FRAMEWORK

The framework has been validated in two different ways, an Internal expert meeting with staff of the graduating company, and an external expert meeting with two external advisors of the graduating company. The relevant outcomes of the validation are already incorporated in the frameworks.

INTERNAL VALIDATION

For the validation of the framework an internal expert meeting has been organized. The expert meeting was held with employees of the graduating company, the attendees all work in the field of study. The goal of the meeting was to assess the recognisability and the completeness and the value of the framework. This section discusses the result of this expert meeting.

The problems the framework addresses are recognized from experiences in previous en current projects. The framework gives a clear picture of the current state of LCC in DBFM projects. Especially the influence of the traditional culture (precondition 1) and the separating project phases and tasks (precondition 7) is considered significant. Stated is that the way in which money is earned in DBFM projects differs significantly from traditional procurement, individuals have difficulties adjusting.

The framework is considered to be complete by the internal validators. In addition to precondition 7, the personal commitment of key project players, it can also be examined if it is possible to create an individual incentive for LCC next to the shareholder interest. It is stated that this is a difficult system to implement because it will be difficult to assign an optimization to one person.

The framework is valuable and describes the current problems clearly. The framework describes solution directions, but does provide many directly implementable solutions. The question is if this is possible given the focus of the research and the size and complexity of DBFM projects. Some of the preconditions described in the framework seem obvious but do addresses current issues, these preconditions have to be mentioned for the completeness of the framework.

EXTERNAL VALIDATION

An expert meeting was held with Bruno Gerard, CEO of the Oxand group (parent of Iter Fidelis) and Willem Verbaan, advisor of Iter Fidelis, lector and independent consultant. The attendees were asked to give a judgement, based on their experience and knowledge of the construction sector, with respect to the validity of the framework. The attendees were also asked to reflect, with their experience and knowledge of other sectors, on the findings of the research.

The problems the framework addresses are recognized from the experiences of these experts. The experts emphasize the necessary change of mind-set (traditional culture) and admit that when Road infrastructure is compared to other sectors, regarding LCC, road infrastructure is lacking behind. Industries, like Oil&Gas, where maintenance is difficult (offshore) are more developed when it comes to alignment of construction and maintenance. The infrastructure can learn from, and should use this knowledge and experiences. By focussing more on the business plan also the application of LCC should improve. The business plan should be leading in the decision making.

The problems that are caused by the characteristics of construction companies are recognized. An examples of a consortium without major construction company is the Dutch Tax office in Doetichem (PPS Netwerk, 2013), however this is a real-estate project with a much lower contract value than is usual in the Road Infrastructure.

The research is considered valuable, in the field of study is still lot to be gained. Both nationally as internationally the research is a current topic.

7.8 CONCLUDING REMARKS

This chapter answers three sub question:

1. *Which preconditions can be established based on the elements identified?*
2. *What are the perspectives of the actors regarding the established preconditions?*
3. *Which preconditions can be established including the actor perspectives?*

The preconditions based on the identified elements are represented in the single-actor framework (section 7.4) the perspectives of the actors regarding the single-actor framework are described in section 7.5. The preconditions that include the actors perspectives form the multi-actor framework (section 7.6). The single-actor framework contains the preconditions which most improve the application of LCC, and therefore describes a more perfect situation. However, considering the multi-actor environment, the single-actor framework is unrealistic and thus not implementable. The multi-actor framework is realistic and implementable, but therefore also time-bound. To continue the validity of this research both frameworks are presented. The single-actor framework is less time-bound and can therefore in future situations be combined with a changed multi-actor environment to create again a realistic and implementable framework.

8 CONCLUSION & RECOMMENDATIONS

8.1 CONCLUSION

This research shows that there is still considerable room for improvement, in terms of Life Cycle Costing (LCC), in the realization phase of Dutch DBFM road projects. The fundamental goal for shareholders of DBFM consortia, maximization of shareholder value, equals optimization in terms of LCC. However, current organizational forms, contracts, and methods used prevent these from reaching this overall goal.

Considering the main questions of this research:

> *What are the preconditions for improving the application of Life Cycle Costing during the realization phase of Dutch DBFM Road projects, and how can consortia combine the preconditions and the actors' interests?*

Case study and expert interview research led to the identification of disablers of LCC, from the perspective of the private consortia. Using these disablers ten problems are described which hinder the application of LCC. The solutions of these problems are eleven preconditions for improving the application of Life Cycle Costing during the realization phase of Dutch DBFM road projects. These are the following conditions:

1. Avoid the traditional construction culture on LCC determining positions.
2. Involve companies experienced in Life Cycle Costing.
3. The main criterion for the selection of consortium partners is the contribution to the overall project interest.
4. The Project Company is financially involved with the risk and the opportunity of Life Cycle Costing.
5. The financial consequences of technical solutions are easy available at operational level.
6. Shareholding companies have sufficient financial and technical knowledge available.
7. The responsibility for both realization and exploitation is with the EPCM.
8. Persons for key project positions are first selected on capabilities instead of shareholder representation.
9. The build-up of the realization organization is gradually.
10. For the initiators of Life Cycle Costing it is clear what the benefits are and who the decision maker is.
11. Transfer of knowledge is embedded in the project organization.

This collection of preconditions is established using only the perspective of the consortia, and is therefore called the single-actor framework. In the single-actor framework the preconditions are explained by supporting conditions. This answers the first part of the main question. The total framework can be found in section 7.4.

For answering the second part of the main question, "*how can consortia combine the preconditions and the actors' interests?",* an actor analysis is executed. From the actor analysis appears that the considered most important actors (lenders, shareholders, Rijkswaterstaat and subcontractors) have an interest in, and have the power to influence the private consortium; a Dutch DBFM road project is a multi-actor environment. The consortia (or project team), should consider this multi-actor environment. If the single-actor framework is in this research combined with the current multi-actor environment, it appears that the interests and influences of the different actors limit the solutions in the single-actor framework. This combination is called the multi-actor framework. In the multi-actor framework the eleven preconditions of the single-actor framework are adapted for the interest of the actors. The multi-actor framework thus also consists of eleven preconditions. To answer the second part of the main question: Consortia can combine the preconditions and the actors' interest by mapping the multi-actor environment and adapting the single-actor framework to this multi-actor

environment, this establishes a multi-actor framework. The current multi-actor framework of this research is presented in section 7.6.

Comparing both frameworks: the preconditions in the single-actor framework will eventually lead to more improvement regarding LCC, and therefore describes a more perfect situation. However, considering the multi-actor environment, the single-actor framework is unrealistic and thus not implementable. The multi-actor framework is realistic and implementable, but therefore also time-bound. The single-actor framework is less time-bound and can be combined with a changed multi-actor environment to create again a realistic and implementable framework.

Although, this research focusses on the private perspective, insights are gained about the public perspective as well. The use of project finance introduces lenders to the project. The lenders replace in many ways Rijkswaterstaat as traditional client. The advantage for Rijkswaterstaat is that there is more pressure to stay within budget and set time. The disadvantage is that Rijkswaterstaat has to deal with a reduced flexibility during the realization.

This graduation project leads to improved 'Value for Money' (VfM). From this research appears that the main drivers of VfM are not optimally utilized in the current projects: the distribution of risks between private and public party (e.g. private responsibility for stakeholder management); the use of output specification or functional requirements; and the application of the payment mechanism (which leads to opportunistic behaviour of the contractor); can be improved on public side.

Both private and public parties acknowledge that the principles behind Life Cycle Costing differ significantly from the traditional way of working. The transition from traditional procurement to DBFM is therefore still in progress. Despite the fact that this transition does not go without a struggle, the need and desire for this transition is recognized on both sides. This research contributes positively to the achievement of this change, and improves Life Cycle Costing in DBFM projects. Both private and public party will, in de long run, benefit from an improved application of Life Cycle Costing.

8.2 RECOMMENDATIONS

Based on this research recommendations can be made. These recommendations arise from the findings and conclusions of this research and the thereby identified gaps. Also recommendations can be made regarding the graduating company, Iter Fidelis.

GENERAL RECOMMENDATIONS

The frameworks established in this research should be used for the further improvement of the application of LCC in the realization of Dutch DBFM road projects. Current and future DBFM consortia are recommended to use the frameworks.

The multi-actor framework should be used in the current projects and projects starting on the short term. Although multiple of the preconditions should be considered at the start of the project, when consortia are formed, there are preconditions that can be implemented in projects already started.

The single-actor framework should be used at the start of future projects, in which the multi-actor environment is changed. The single-actor framework can be combined with a new multi-actor environment, to establish a new multi-actor framework.

ADDITIONAL RESEARCH

Because of the focus of this research (strategic and tactical level) the framework covers a broad spectrum of solutions. The framework is thereby complete but does not deliver turnkey solutions. Therefore it is recommended that using additional research more specific solutions are developed.

An example of this is additional research into the basis for cooperation between shareholders in a DBFM consortium. This research shows that the overall project interest, government eligibility requirements, and experience with LCC should be included, but does not provide all selection criteria.

Another example is additional research into the relapse between tender and realization. This research identifies the relapse as hinder for the application of LCC and provides some causes for the relapse (change of team, growth of organization etc.). For the exact problem and directly implementable solutions, additional research is required.

ITER FIDELIS

The goal of this research for Iter Fidelis was to increase their knowledge level regarding the strategic level in DBFM road projects. This research describes a clear picture of the current challenges on this level. Recommended is that Iter Fidelis uses this knowledge to improve their advice and activities in current and future DBFM projects.

In addition this research identifies opportunities for Iter Fidelis. The identified lack of mutual understanding between technical companies and financial parties is an opportunity for Iter Fidelis, they are able to bring both sides closer together because this lack of understanding does not exists within Iter Fidelis. This research describes the possibility and the necessity for different shareholding companies in DBFM projects, this can also be an opportunity for Iter Fidelis.

As last it is recommended that Iter Fidelis uses this research to create awareness within the current DBFM industry. This research is a documented picture of the problems in the past and current DBFM projects, which should be avoided in future projects.

9 REFLECTIONS

In this chapter is reflected on the approach of this research (section 9.1) and the findings and deliverables (section 9.2).

9.1 RESEARCH APPROACH

The results of this qualitative research are based on findings from a case study and expert interviews.

In the case study two different projects are described. Both projects are projects with different shareholding companies, the possibility of one shareholding company is not considered in this research. In the Netherlands only BAM has this possibility, this is only possible on the smaller projects.

The findings of this case study are only valid for the projects studied in this case study. It is impossible to say with certainty that these findings are also valid for other Dutch DBFM projects. With interviews is selected on persons originating from different companies and involved in different DBFM projects. The findings of the interviews will therefore have a greater validity when it comes to Dutch DBFM projects in general.

The interviews were limited by the availability of experts. Because of the limited projects there are not many people having experience in DBFM Road infrastructure projects. The DBFM projects which are currently in realization have so far not been entirely successful, this limits the time and the willingness of experts currently involved in the projects. In addition, the persons interviewed are all working in the Dutch DBFM sector and are therefore easily influenced by professional literature, actual political reports or opinions of eminent persons in the industry. The results of the interviews can be influenced by this.

The interviews are semi-structured, this leaves room for discussions. It is therefore possible to influence, as researcher, the interviewee. This can have influence on the findings of the interviews. During the interviews is tried to avoid this.

Because the research is conducted in collaboration with a company, it is possible that the interviewee does not consider the interviewer as completely independent. Therefore it is possible that the interviewee withholds information. This can have consequences for the findings.

The transcriptions of the interviews are summarized by the interviewer and this summary is approved by the interviewee, the interpretation of the interviewer influences the summary. From the summary general elements are identified again the interpretation of the researcher can influence the findings.

9.2 THESIS FINDINGS AND DELIVERABLES

The challenges this research mentions are partly identified by the industry itself. Therefore, some of the established preconditions have also been devised by the industry. This does not mean that this research is outdated. Contrary, this research adds to the changes currently taking place.

Because of the choice to focus on the strategic and tactical level of DBFM projects, it is hard to deliver specific solutions. The preconditions stated can therefore appear abstract. The framework gives a good and complete picture of the current challenges for the application of LCC, but does not deliver specific solutions for all of the challenges mentioned. The framework does provide directions in which the solution should be sought. Other factors that contributes to this, is the complexity of DBFM projects combined with the limitations of a graduation research.

10 REFERENCES

Algemene Rekenkamer, 2013. *Contractmanagement bij DBFMO-projecten ,* Den Haag: Sdu Uitgevers .

Altamirano, M., 2010. *Innovative Contracting Practices in the Road Sector.* Delft : Next Generation Infrastructures Foundation .

Andersen, A., 2000. *Value for Money Drivers in the Private Finance Initiative.* London : Arthur Andersen and Enterprise LSE.

BAM, 2013. *Jaarverlsag 2012,* Bunnik, The Netherlands: sn

Bosch-Rekveldta, M. et al., 2011. Grasping project complexity in large engineering projects: The TOE (Technical, Organizational and Environmental) framework. *International Journal of Project Management,* Augustus2011(Volume 29, Issue 6), p. 728–739.

Boskalis, 2013. *Annual Report 2012,* sl: sn

Brealy, R. A., Myers, S. C. & Allen, F., 2008. *Princples of Corporate Finance.* sl:McGraw Hill.

Bruggeman, E., Chao-Duivis, M. & Koning, A., 2010. *A Practical guide to Dutch Building Contracts.* The Hague : Stichting Instituut voor Bouwrecht .

Business Dictionary, 2013. *Business Dictionary.* [Online] Available at: http://www.businessdictionary.com/ [Accessed July 2013].

Clift, M., 2003. Life-cycle costing in the construction sector. *UNEP Industry and Environment,* pp. 37-41.

Cobouw, 2012. Cobouw Top 50. *Cobouw*, November, pp. 10-11.

de Bruijn, H. & ten Heuvelhof, E., 2008. *Management in Networks.* sl:Routledge .

Demirag, I., Khadaroo, I., Stapleton, P. & Stevenson, C., 2011. Risk and the financing of PPP: perspective from the financiers. *The Britisch Accounting Review,* pp. 294-310.

Di Paola, L., 2009. *International Construction Law Review.* [Online] Available at: http://www.i-law.com/ilaw/doc/view.htm?id=230160 [Accessed 1 2013].

Fikkers, H., Nieuwenhuizen, L., Nijsen, J. & Schaap, H., 2012. *Op weg naar werken met BIM,* Gouda: Bouw Informatie Raad.

Freedman, D., Pisani, R. & Purves, R., 2007 . *Statistics.* Fourth Edition red. New York : W.W. Northon & Compnay .

Glaser, B. G. & Strauss, A., 1967. *The discovery of grounded theory: strategies for qualitative research.* sl:Aldine Publishing Company.

Grant Thornton, 2008. *Maximizing shareholder value.* [Online].

Grimsey, D. & Lewis, M., 2005. Are public private partnerships value for money? Evaluating alternative approaches and comparing academic and practitioner views. *Accounting Forum,* pp. 345-378.

Hardcastle, C., Edwards, P., Akintoye, A. & Li, B., 2005. Critical Success factors for PPP/PFI projects in the UK Construction Industry: A factor Analysis Approach. *Construction Management and Economics,* pp. 459-471.

Heuckelum, v. J. M. et al., 2007. The roots to conflicting interests among different partners in a dbfm consortium. *CIB World Building Congress' Construction for Development,* pp. 433-440.

Iter Fidelis, 2013. *Businessplan 2013-2015,* Utrecht: Iter Fidelis.

Jefferies, M., Gameson, R. & Rowlinson, S., 2002. Critical Succes Factors of the BOOT Procurment System: reflections from the Stadium Australia Case Study. *Engineering, Construction and Architectural Management,* pp. 352-361.

Koster, J. et al., 2008. *DBFM-Handboek 'een verkenning van de contractonderdelen',* Den Haag : Defensie; Ministerie van Financien; Rijkswaterstaat; VROM; Rijksgebouwendienst.

Lenferink, S. a., 2012. *Towards sustainable infrastructure development through integrated contracts: Experiences with inclusiveness in Dutch infrastructure projects.* sl:sn

Ministerie van Financien & Rijkswaterstaat, 2012. *Handleiding Aanbestedingsleidraad DBFM Infrastructuur [2012],* Den Haag, Nederland: Ministerie van Financien en Rijkswaterstaat.

Ministerie van Financiën, 2012. *Voortgangsrapportage DBFM(O),* Den Haag: Ministerie van Financiën.

Ministerie van Financiën, 2013. *Evaluatie Inflatiegerelateerde pilot N33,* Den Haag: Directie Financiering.

Ministerie van Infrastructuur en Milieu, 2012. *9,9 miljard voor infrastructuur, verkeersveiligheid, waterveiligheid en leefomgeving.* [Online]
Available at: http://www.rijksoverheid.nl/nieuws/2012/09/18/9-9-miljard-voor-infrastructuur-verkeersveiligheid-waterveiligheid-en-leefomgeving.html
[Accessed 25 Maart 2031].

Ministerie van Infrastructuur en Milieu, 2012. *Mirt Projectenboek 2012,* Den Haag, The Netherlands: Ministerie van Infrastructuur en Milieu.

Money, K. & Gardiner, L., 2005. Reputational management: ignore at your own peril. *Handbook of Business Strategy ,* pp. 43-46.

OECD, 2004. *Principles of Corporate Governance ,* Paris, France : OECD.

OED, 2013. *Oxford English Dictionary.* [Online]
Available at: www.OED.com
[Accessed 2013].

Partnerships Bulletin, 2012. *The Global PPP Market 2012,* sl: Partnerships Bulletin.

PPS Netwerk, 2013. *Projecten Database.* [Online]
Available at: www.ppsnetwerk.nl
[Accessed July 2013].

Rijkswaterstaat, 2011. *Handleiding EMVI Rijskwaterstaat 2011,* Den Haag, Nederland: Rijkswaterstaat.

Rijkswaterstaat, 2012. *Selectieleidraad Project A9 Gaasperdammerweg,* sl: Ministerie van Infrastructuur en Milieu.

Rijkswaterstaat, 2013. *Organisatiestructuur.* [Online] Available at: http://www.rijkswaterstaat.nl/over_ons/organisatiestructuur/ [Accessed september 2013].

Rijkswaterstaat, 2013. *Over ons.* [Online] Available at: www.rijkswaterstaat.nl/over_ons [Accessed august 2013].

Rijkswaterstaat, 2013. *Publiek-private samenwerkingen.* [Online] Available at: http://www.rijkswaterstaat.nl/over_ons/missiekerntaken/publiek_private_samenwerking/ [Accessed 14 1 2013].

Rijkswaterstaat, 2013. *Selectie- en gunningscriteria.* [Online] Available at: http://www.rijkswaterstaat.nl/zakelijk/zakendoen_met_rws/inkoopbeleid/aanbesteden/selectie_en_gunningscriteria/ [Accessed 8 2013].

Sleight, C., 2012. CE100; Ranking Europe's top 100 contractors. *Construction Europe ,* Volume 2012.

Tax Consultants International, 2013. *Tax Consultants International.* [Online] Available at: http://tax-consultants-international.com/read/about_TCI

The Institute of Asset Management, 2012. *Asset Management - an anatomy,* Bristol, United Kingdom: The Institute of Asset Management.

United Nations, 2006. Enhancing Regional Cooperation in Infrasttucture Development Including that Related to Disaster Managemetn.

van Ham, H. & Koppenjan, J., 2002. *Publiek-private samenwerking bij transportinfarstructuur.* Utrecht : LEMMA .

Verbraeck, A., 2012. *Project Management ,* Delft : sn

VolkerWessels, 2013. *Jaarverslag 2012,* Amersfoort, the Netherlands: sn

Winch, G. M., 2002. *Managing Construction Projects.* Oxford : Blackwell Publishing .

Xueqing, Z., 2005. Critcal Success Factors for Public-Private Partnerships in Infrastructure Development. *Journal of Construction Engineering and Management.*

Yescombe, E., 2007. *Public-private partnerships, Principles of Policy and Finance.* Oxford: Elsevier.

Yescombe, E., 2012. *Principles of Project Finance.* London, U.K. : Academic Press.

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APPENDICES

A List of Dutch DBFM Projects

Project	Consortium	Dutch construction (related) companies	Foreign construction (related) companies	Financial parties	Estimated contract value
N31	Waldwei.com B.V.	Koninklijke BAM Dura Vermeer Ballast Nedam	-	-	135
A59	De Poort van Den Bosch B.V.	Koninklijke BAM Boskalis Westminister Fluor			218
Realization					
Tweede Coentunnel	Coentunnel Company b.v.	Arcadis Dura Vermeer TBI Bouw	Besix CFE Vinci Dredging International		600
A12- Utrecht Lunetten-Veendendaal	Poort van Bunnik B.V.	BAM PPP BAM Wegen BAM Civiel BAM Infratechniek			373
A15 Maasvlakte – Vaanplein	A-Lanes b.v.	Ballast Nedam Strukton	STRABAG	John Laing	1.200
A1/A6 Diemen – Almere Havendreef	SAAone B.V.	Boskalis Westminister Volker Wessels	HOCHTIEF	DIF	1.000
N33 Assen- Zuidbroek	Poort van Noord B.V.	Volker Wessels BAM PPP		PGGM	190
Tender/Initiation			**Planned Realization Period**		
A12 Ede-Grijsoord			2014-2015		
N18 Varsseveld- Enschede			2015-2018		
A9 Gaasperdammerweg			2014-2021		
A9 Badhoevedorp - Holendrecht			2016-2020		
A6 Almere Havendreef - Almere Buiten-Oost			2016-2020		
In consideration					
A27/A1 Utrecht-Knooppunt Eemnes - Amersfoort					
VIA15 (bereikbaarheid Arnhem-Nijmegen)					
A1-zone/ A1 Corridor					
A13/A16/A20 Rotterdam					
A10 Zuidas					
Ring Utrecht					
A27 Hooipolder - Lunetten					
A58 Sint Annabosch-Galder					
Nieuwe Westelijke Oeververbinding Rotterdam					

B Interview Protocol

ACHTERGROND

Dit interview protocol is bestemd voor het afnemen van interviews in het kader van het afstudeeronderzoek van Erwin de Witt, student Construction, Management and Engineering aan de Tu Delft. Het afstudeeronderzoek richt zich op hoe besluitvorming Life Cycle Costing (LCC) kan faciliteren in DBFM weginfrastructuur projecten. Dit wordt gedaan door middel van het identificeren van kritisch succes factoren voor het faciliteren van Life Cycle Costing. De interviews worden gebruikt om deze succes factoren te identificeren. Alle interviews worden afgenomen door Erwin de Witt. Een geïnterviewde persoon wordt geselecteerd op basis van ervaring met DBFM contracten en de rol die de geïnterviewde in de organisatie speelt.

DOEL VAN HET INTERVIEW

De doelstelling van de interviews is het identificeren van succes factoren. Deze empirische data moet uiteindelijk bijdrage aan het beantwoorden van de in het onderzoek gestelde hoofdvraag. Door het identificeren van succes factoren kan LCC in DBFM projecten verbeterd worden, hierdoor dragen de interviews bij aan het verbeteren van DBFM projecten.

RESULTAAT VAN DE INTERVIEWS

Het resultaat van de interviews is een ranking van succesfactoren. De ranking van succes factoren wordt gebruikt in het verdere onderzoek. Daarnaast leveren de interviews informatie over de huidige toepassing van LCC in Nederlandse DBFM Weg-infrastructuur projecten.

WERKWIJZE PER INTERVIEW

1. De te interviewen personen worden benaderd of zij bereid zijn mee te werken aan het interview. Bij de uitnodiging hoort ook een toelichting van het onderwerp en de richting van het afstudeer onderzoek. Bij akkoord wordt een afspraak gemaakt.
2. Van te voren wordt de werkwijze van het interview toegestuurd. Een aantal belangrijke kenmerken van het interview worden gemeld:
    a. Het betreft een semigestructureerd interview
    b. Het gaat om een inventarisatie van persoonlijke visies en afwegingen niet om standpunten van organisaties
    c. Uitgangspunt is dat het interview maximaal anderhalf uur in beslag neemt In de opbouw wordt uitgegaan van 60 minuten, om enige speling in te bouwen.
    d. Het interview zal indien de geïnterviewde geen bezwaar heeft worden opgenomen ten behoeve van de rapportage. Opnames en aantekeningen zullen niet in een andere context dan dit gebruikt worden.
    e. Een concept uitwerking zal ter goedkeuring aan de geïnterviewde worden gestuurd, waarop deze nog correcties kan aanbrengen. Voor de correcties wordt een redelijke tijd gegeven.
    f. De verslagen worden vertrouwelijk behandeld en niet gepubliceerd in het openbare afstudeerrapport.
    g. De geïnterviewde zal na afronding van het afstudeeronderzoek een management samenvatting toegestuurd krijgen.

3. De interviews worden opgenomen en naderhand uitgewerkt. Concept versie van de uitwerking worden naderhand toegestuurd aan de geïnterviewde persoon. Deze krijgt 10 dagen om de interviews te corrigeren. Als na 10 dagen nog geen reactie is ontvangen wordt aangenomen dat geen opmerkingen zijn op de verslag legging.

4. Na de reeks met interviews worden de geïdentificeerde succesfactoren gerangschikt naar belang en stuurbaarheid van de succesfactor. Dit wordt gedaan door middel van een survey onder de geïnterviewde personen.

Het interview

Introductie (10 minuten)

- Wederzijdse kennismaking
- Toelichting gang van zaken
- Toelichting afstudeeronderwerp
    - Definitie LCC
    - Definitie succes factoren
    - Focus op besluitvorming

Belang LCC en de huidige toepassing van LCC (10 minuten)

- Kunt u het algemeen belang aangeven van LCC bij de Nederlandse DBFM weginfrastructuur projecten? (Groot/middel/Klein)
- Kunt u het belang aangeven van LCC voor u organisatie in de Nederlandse DBFM weginfrastructuur projecten? (Groot/middel/Klein)
- Kunt u een waardering geven van de huidige toepassing van LCC binnen de DBFM projecten die u nu heeft meegemaakt? (Goed toegepast/Redelijk toegepast/Niet goed toegepast).

Identificeren van de Factoren (30 minuten)

Vrijuit laten praten voor het identificeren van 'nieuwe factoren' (15 minuten)

Vragen naar onderstaande richtingen (indien niet genoemd) (15 minuten)

- Relaties, contracten en risico verdeling
    - SPV- Banken
    - SPV –RWS
    - SPV-EPC
    - SPV-Shareholders
    - EPC-Subcontractors
- Opbouw organisatie
    - SPV
    - EPC
    - M
- Samenstelling consortium
- Aannemers Cultuur(cost minimization)
- Conflicterend belangen (intern SPV/EPC)
- Integratie in management systeem

Afsluiting (10 minuten)

- Heeft u nog tips voor de invulling van mijn onderzoek?
- Verdere/Vragen opmerkingen?
- De verwerking van dit interview zal worden teruggekoppeld, door middel van een samenvatting van dit gesprek en een survey aan het einde van de interview reeks.
- Het uiteindelijke resultaat van het onderzoek zal worden teruggekoppeld in een management samenvatting
- Bent u op een later tijdstip bereikbaar voor aanvullende vragen?

C Expert Interview Memo's – Confidential

Removed because of confidentiality.

D Interview Matrix - Confidential

Removed because of confidentiality.

E Matrix Direct Relationships between Disablers

Index	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16
D1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1
D2	1	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
D3	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0	1
D4	1	0	1	1	0	0	0	1	0	0	0	0	0	0	1	1
D5	1	0	1	0	1	0	0	1	0	0	0	1	1	1	1	0
D6	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0
D7	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0
D8	0	0	1	1	1	0	0	1	0	0	0	0	0	0	1	0
D9	0	1	0	0	0	0	1	0	1	1	0	1	1	0	0	0
D10	0	1	0	0	0	0	1	0	1	1	0	1	1	0	0	0
D11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
D12	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	0
D13	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	0
D14	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0
D15	1	0	0	1	1	1	0	1	0	0	1	1	1	1	1	1
D16	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1

1= direct relation; 0 = no relation

F Actor Interviews Memo's – Confidential

Removed because of confidentiality.