

Adaptive Subcontractor Management

A case study at luxury yacht builder Oceanco

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Delft University of Technology
Master of Science Thesis

Adaptive Subcontractor Management

A case study at luxury yacht builder Oceanco

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in partial fulfilment of the requirements for the degree of

Master of Science

in Systems Engineering, Policy Analysis and Management

at the Delft University of Technology,

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Preface

This document represents my final work as a Systems Engineering, Policy Analysis & Management Master student. It represents the final step in finishing my studies at the Delft University of Technology. During my studies I have always been exploring and discovering new fields. I believe this final step is the beginning of a new adventure.

I came into contact with Arie van Andel, Director of Projects at Oceanco, via my studentjob as private driver. During an assignment I had to drive a client home from a party. The drive was already pleasing, as I was driving a Tesla Model S - a truly remarkable and impressive piece of engineering – but got even more interesting when at one point the client asked me whether there was something he could help me with. After some exploration regarding my wishes for a Master thesis graduation project he asked me whether I knew Oceanco. I did not know this company yet, so he explained what they did; this got me excited. The next day I sent him an email with a motivation letter and my resume, which he would send to his contact at Oceanco. Two weeks later I got an email from the secretary of Arie van Andel to set up a meeting: my graduation project was in the making.

Some say that your Master thesis is your first and only project in your life that you will truly be executing on your own, but I do not agree with this statement. I am indebted to numerous people who have helped me write this thesis, of which I would like to thank a few in particular.

I want to thank Arie van Andel for making this graduation project possible. I also would like to thank Jeroen Mulder, for his sharp feedback and continuous support. In addition I owe a thanks to all colleagues at Oceanco who helped me by answering all my questions.

Next I would like to thank my supervisors at TPM. First Alexander Verbraeck, for chairing my committee and support me with sharp feedback, even from the other side of the world. Second, I want to thank Jos Vrancken for his role as first supervisor, in which he helped me keeping my schedule and the balance between a scientific research and a practical advice. Third, I wish to thank Wijnand Veeneman for the productive discussions on the balance between a process and systems way of thinking. Additionally I want to thank the interviewees for the time they accorded me to answer my questions.

Finally a special thanks to Krijn Hoornstra for his tireless efforts to provide me with an insight and peer review to my work, Meghan Rens for the correction of grammar mistakes, and thanks to all of my family and friends that supported me during my studies.

Delft, University of Technology
July 6, 2015

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Abstract

Main contractors managing large engineering projects increasingly rely on subcontractors in successfully realizing their projects. They have decentralised and decomposed their work to cooperate with an increasing number of subcontractors. Although this working model offers many advantages, such as the transfer of risk and economies of scale, it also poses new challenges for main contractors in managing their projects successfully. The growing dependency of the main contractor upon their subcontractor is arguably the most important of these challenges.

The strands of literature on the management of subcontractors seem to be largely disconnected. One side favours a directive style of control and stresses the need for extensive management of decent planning and control, while the other questions the systematic method through which project complexities and uncertainties are regarded in this approach, and claims that the focus should be prioritized on the interest of stakeholders.

There is no consensus on the approach to subcontractor management to follow in large engineering projects. The main research question in this research is therefore formulated as follows:

Which approaches to subcontractor management are effective in large scale, complex, engineering projects that are characterized by a high amount of change orders and uncertainties, and under which circumstances?

The methodology to scientifically address this research question consists of an explorative research with a case study approach. An in-depth research is performed at Oceanco to identify the barriers and challenges of subcontractor management. Subsequently, a literature study is performed to gain knowledge on how to best address these challenges. The synthesis of the knowledge gained from the case study and the academic literature led to a process design on subcontractor management. This process design is contrasted with practise from several project managers managing large engineering projects in the construction industry, offshore industry, semiconductor industry, healthcare and real estate development.

Oceanco, a shipyard of the upper segment luxury yachts, is the subject of the case study. Oceanco is a prime example of a main contractor that makes extensive use of subcontractors in realizing its projects, as 90-95% of its work is outsourced. The dependency on the performance of subcontractors is therefore large. Oceanco operates in a challenging environment as their projects make use of state-of-the-art technologies and are characterized by a high number of change orders. Furthermore, the market characteristics give some of Oceanco's subcontractors a considerable power position. Through the case study it has been derived that subcontractor management is centred around the interactions that take place between the relation, the negotiation and the project (performance). The constructed model of subcontractor management raised a number of questions that provided guidance in performing the literature study.

The literature study reveals what actually constitutes a project, what is considered project success and determines the influence of risk and changes in project scope to the performance of a project. Furthermore, a typology of subprojects and subcontractors is drafted using literature. The process of negotiation and the influence of contracts are investigated, after which the relation between the main contractor and subcontractor is scrutinized.

Based on the findings of the case study and the knowledge base, a process design was developed which maps multiple decision moments in subcontractor management. The decision moments in

subcontractor management take place at multiple levels of the main contractors' organisation and are driven by three main input variables: the type of subproject, the type of subcontractor and the relation with the subcontractor.

By means of the formulated sub-questions, relevant knowledge was gained from both theory and practise to answer the main research question. Effective subcontractor management approaches were found to be highly circumstantial. The complexity of the subproject is the main indicator determining the subcontractor management approach. The largest gains in subcontractor management are to be made in managing the complex subprojects and subcontractors. Two main aspects are of the essence in managing these subprojects: the relation with the subcontractor and the allocation of risk. The required flexibility in managing these subcontractors is only possible if the relation between the main contractor and subcontractor is good; this can be assessed using key relation indicators. Risk allocation is at the centre of these subprojects as it encompasses the uncertainty of the project. The risks in a subproject should be assessed beforehand together with the subcontractor and transferred to the party that can best take this risk. The type of contract can enable the subcontractor to excel in its performance.

The process design presented in this research was found to be comprehensive and useful; both to Oceanco, as well as to other main contractors. The most important feedback on the process design was its lack of guidance in the management approach to choose. This lack of guidance is the consequence of the effort to create a design that is useful, while keeping enough discretionary room for needed flexibility and adaptability in the management approach. Nevertheless, an effort was made to create a subcontractor management canvas that gives more guidance in the approach to be chosen. The canvas gives advise on the subcontractor management approach to follow, while accounting for the interplay between the decision moments and the interrelatedness of the input variables. The canvas was received well by Oceanco, but could not be validated for other main contractors due to time constraints.

The degree of influence change orders have on the subcontractor management approach was found to dependent on the complexity of the respective subproject. Complex subprojects therefore require a certain degree of flexibility in the agreement/contract between the main contractor and subcontractor. Furthermore, the crux of handling the change orders lies in a systematic way of handling these change orders, which emphasizes the importance of identification and allocation of risk.

Subcontractor management takes place at multiple levels of the organisation of the main contractor as it exceeds the project boundaries and is largely influenced by previous interactions, as well as potential future interactions. Subcontractor management therefore requires an integrated approach, in which feedback from the operational level to the strategic level of the organisation is a precondition for improvement. Improving subcontractor management can therefore be time-consuming, but is considered to be worth the effort in the long term.

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1

Introduction

In 2005 the Economist published an article filled with scathing criticism on the performance of project management; “*When George Stephenson built a railway from Liverpool to Manchester in the 1820s, it cost 45% more than budget and was subject to several delays as it made its way across the treacherous Chat Moss bog. In the intervening 180 years the management of large-scale projects seems to have improved but little*” (The Economist, 2005). This article touches on sore points of the on-going challenge of keeping projects within budget and on time.

Years after the publication of this article, the same phenomenon can still be observed; many large engineering projects continue to face late completion dates, budget overruns and technical difficulties (Koppenjan *et al.*, 2011). Compared to the notorious debacle around the High Speed Rail project, one may say George Stephenson performed quite well. The costs of this project are estimated to exceed 80% of the set budget; a significant part of this cost overrun is due to poor procurement (FD, 2015).

This problem is becoming increasingly relevant as the boundaries of organisations are shifting through companies’ increasing usage of capability sourcing to create sustained value (Forbes, 2010; The Economic Times, 2013). Companies have been struggling for decades to define their core competences and translate them into what should be kept in-house and what should be outsourced. Many of them have now chosen to reduce their number of staff and return to their core competences in order to stay competitive (Andersen, 1999; Aritua, Smith, & Brower, 2009). As a consequence, main contractors in large engineering projects have decentralised and decomposed their work by co-operating with an increasing number of subcontractors. Although offering many advantages, such as allocation of risk and economies of scale, this working model also poses new challenges for main contractors in managing their projects successfully (Williams, 2005). Arguably, the most important of these challenges has become the main contractor’s dependency upon their subcontractors.

Oceanco is a prime example of a main contractor managing large engineering projects, which returned to its core competences in 2005¹. As a shipyard of the upper segment luxury yachts varying in length from 80 to 110 meters, it has made the strategic decision to outsource all production work needed for the construction of a yacht, thereby relying on subcontractors to perform 90-95% of the work in their projects. This has created an important dependency on these subcontractors’ performance for project success¹.

Traditionally, the working relationship between main contractor and subcontractor has been mainly hierarchical and transactional in nature, with both parties seeking to secure added value at minimum cost (Miller, Packham, & Brychan, 2002). This traditional adversarial approach does not leave much

¹ Interview confidential

room for the subcontractor to excel, because there are few interactions between the main contractor and subcontractor. Instead of a personal relationship between the actors, the procurement is done purely based on price. This entails the contract to be the strict guider of the subcontractor's performance, as disputes are resolved by formal interpretation of the contractual obligations (Larson, 1995). A pure price-based selection may be problematic as it entices tenderers to lower their bids in order to win a contract, relying on subsequent claims to recover their costs (O'Conner, 2009). Bazerman *et al.* call this the 'self-serving bias'; bidders often make overly optimistic assumptions on the costs and revenues to secure a project (Bazerman, Loewenstein, & Moore, 2002). Moreover, written agreements provide an information vacuum as contracting parties may interpret contract clauses differently (Rahman & Kumaraswamy, 2004) (Hartman, Snelgrove, & Ashrafi, 1997) and for their own benefit (Clegg, 1992). Other selection criteria are therefore necessary to redress the mismatch between client and contractor, but also to reduce the gap between expected and actual performance (Mills & Skitmore, 1999).

The classical contractual arrangement calls for a clear and definitive allocation of risks, but in practise these are seldom foreseeable (Campbell & Macneil, 2004). Large engineering projects are often faced with a multitude of change orders. The classic adversarial approach may work in a static environment with a clearly defined scope and limited complexities (Anvuur & Kumaraswamy, 2007), but the increasing complexity of projects, combined with higher reliance on subcontractors requires a different approach to subcontractor relationships (Koppenjan *et al.*, 2011). Additionally, contracting parties often work through the motivation created by divergent objectives and hidden agendas, thereby showing strategic behaviour (Rahman & Kumaraswamy, 2004; De Bruin & ten Heuvelhof, 2008). The traditional approach does not provide enough room to manoeuvre in this complex environment. Many companies managing large engineering projects are therefore searching for a new approach to subcontractor management (Bygballe, Jahre, & Sward, 2010).

Literature provides several softer alternatives to the traditional adversarial approach. An example of this is the approach known as partnering (Walker, Hampson, & Peters, 2000). This method is mainly founded on an element of mutual cooperation by allowing companies to specialize in core activities and rely on external partners for additional technological input (Wood & Ellis, 2005). This approach creates interdependencies between the main contractor and subcontractor and leads the way to cooperation (Anvuur & Kumaraswamy, 2007; White & Marasani, 2014). However, partnering also conserves certain drawbacks, as its informality may lead to unprofessional behaviour, condoning mistakes and result in underperformance (Alderman & Ivory, 2007).

Several steering mechanisms are available to manage subcontractors. The contrast between these approaches proves that it's unlikely that there is such a thing as a 'plug and play solution' to subcontractor management. It is unclear in what situation which approach would fit best. The applicability of these approaches seems largely determined by the circumstances in which they are applied. Furthermore, it is also unclear how approaches such as Partnering should take shape in practise. How should these approaches be implemented in the complex environment of large engineering projects that use state-of-the-art technologies and are characterized by a multitude of change orders?

This thesis aims to provide guidance for main contractors when dealing with subcontractors. The general goal is to provide main contractors with a framework that allows them to make an informed decision on their subcontractor management approach.

2

Research elements

This chapter presents the elements of interest researching subcontractor management approaches in complex large engineering projects. First the paradigm of subcontractor management approaches is briefly introduced (section 2.1). Secondly, the projects of interest for the case study in this research are defined (section 2.2). The problem statement is presented thirdly (section 2.3), followed by the research objective and research questions (section 2.4). Finally the methodology and the outline of the research are given in section 2.5 and section 2.6.

2.1 Subcontractor management

The introduction of this thesis gave a brief outline of the contrasting adversarial and partnering approaches to subcontractor management presented in literature. This paragraph shall intend to develop a more elaborate outline of the spectrum of approaches to subcontractor management.

A strong body in literature stresses the need for extensive management of decent planning and control (Nicholas & Steyn, 2012; Project Management Institute, 2008; Burke, 2003; Davies, 2002).. This 'planning approach' follows a strong systems engineering approach to project management that provides instruments to ensure that a project follows its predicted outcome by breaking down the complexities into measurable and controllable pieces. It relies on a directive style of control by the problem owner/main contractor (Collyer & Warren, 2000).

On the other side of the spectrum lies a body of literature that questions the systematic method through which project complexities and uncertainties are regarded. This 'soft paradigm' claims that focus should be prioritized on the interest of the stakeholders as their decision-making is capricious and unstructured (De Bruijn, ten Heuvelhof, & in 't Veld, 2010; Aritua, Smith, & Brower, 2009). By taking the strategic behaviour of stakeholders into account, this 'learning approach' approach to project management is less hierarchical and is designed to reach consensus and commitment for the project by being more participative (De Bruin & ten Heuvelhof, 2008) (Collyer & Warren, 2000). It is in strong contrast with the directive style found in the hierarchical planning project management approach. An example of such a participative approach is called 'Relational Contracting'; by arguing that flexibility is to be key for success, the relation between contracting parties forms the foundation for the management (Veen & Korthals Altes, 2011).

The strands of literature on management approaches are largely disconnected (Koppenjan *et al.*, 2011) and often rather one-sided, favouring either a strong hierarchical approach to project management, or a softer approach focused on the interests of the stakeholders involved. Furthermore, few studies have addressed the influence of the relationship between main contractor and subcontractor on project performance (Meng, 2012). It is unclear how main contractors work with these approaches in practise and how these approaches affect the relationship between main contractor and subcontractor.

2.2 Projects of interest

Although projects are generally considered to be unique, they nevertheless conserve certain similar theoretical similarities. In effect, they all go through certain phases (Turner, 2008), and are all influenced by risk and changes in scope, which subsequently influence project performance. In order to be able to give an advice on how main contractors in large engineering projects can improve their subcontractor management, a comparison must be made with other projects available on the market to derive a series of characteristics. This section dives deeper into the characteristics of the projects of interest for this research in order to find a suitable case study to provide more in-depth practical data about subcontractor management as well as to test the findings of this research in practise.

The introduction of this thesis has explained that the use of subcontractors is increasing as a result of an increasing complexity of projects. This complexity can be translated into four characteristics:

Characteristic I: Size

Koppenjan *et al.* (2011) argue that the size of a project is an important indicator (amongst others) for the complexity of a project, as most often the larger the project the more complex it becomes by nature. For the focus of this thesis it is important that the project of interest is large enough for a main contractor to have multiple subcontractors. However, the project should not be so big that every subcontractor functions on its own again as main contractor for several subcontractors. The project's size is translated into its budget. An operationalized assumption is made that the budget/size of a project of interest should be somewhere in the range between 100 to 250 million euro's.

Characteristic II: Commonly practiced change orders

Another important characteristic of complex large engineering projects is that change orders are often of common practise. The main contractor has direct interaction with the client (end-consumer) and wants to comply with the client's wishes. As a consequence, the main contractor has to manage change orders if the client desires to change the scope of the project. The number of change-orders (the so-called change-order rate) is expected to influence the relationship between the main contractor and subcontractor. Although the number of change orders can differ quite significantly per project (varying from 25 – 250 for example²), a similar form of influence is present in each project.

Characteristic III: Use of state-of-the-art technologies

Complexity is often increased in projects that use of state-of-the-art technologies, as the use of state-of-the-art technologies implies uncertainties.

Characteristic IV: Out-sourcing of the majority of the work

Because this research is about subcontractor management, the final core characteristic of a project of interest should logically be that the majority of the work is outsourced, rather than be performed in house. The organisational structure of such a main contractor can be compared with the organisational structure of a project developer, whose own workforce is relatively limited.

Outsourcing, combined with the previously mentioned characteristics of size, commonly practised change orders, and use of state-of-the-art technologies describes the characteristics of the projects of interest for this master thesis.

² Interview confidential

2.3 Problem statement

The core of the research problem focuses on how to solve the challenges that main contractors face when managing their subcontractors in large and complex engineering projects, characterised by a high amount of change orders and uncertainties. Available literature fails to provide an appropriate response to these challenges, as it mainly takes an analytical stance in writing about project and subcontractor management and is often one-sided favouring either a planning/project management approach, or a learning/process management approach. The uniqueness of the large engineering projects makes it seem unlikely that there is a 'plug & play' solution for subcontractor management, and that a mix of these approaches should be conducted to these neither black nor white situations. A clear overview of comparative models on subcontractor management could therefore help main contractors to make an informed decision on their approach to subcontractors.

Additionally, there is a need to contrast literature with the practise of managing subcontractors in large engineering projects. Due to the lack of empirical data few frameworks on subcontractor management have been constructed and validated. Combining the current theories on subcontractor management with expertise from project managers could provide the right ingredients for such a framework and give guidance to Oceanco and other main contractors searching for the right approach to manage their subcontractors.

The problem statement that forms the central theme in this research is formulated as follows:

It is unclear how main contractors in complex large engineering projects should shape their management approach towards subcontractors to improve both the relationship with the subcontractor, as well as project performance

To elucidate this problem, a systems engineering approach is used as a starting point to analyse this complex environment. This approach aims to define, develop and deploy large-scale systems with a complex character (Sage & Armstrong, 2000) and can be used to design a framework for subcontractor management. This framework shall not be interpreted as a decisive formal tool, but rather as a framework that assists the main contractor in making an informed decision, for it is recognised that decomposing such a complex system may oversimplify certain aspects and underexpose soft variables. Additionally, it is also acknowledged that all projects, due to their unique character, require a specific and tailored management approach contingent upon the project's context or environment (Shenhar & Dvir, 2007; Bosch-Rekveltdt, 2011).

2.4 Research objective and research questions

Many projects managers and scientists regularly question what determines the successful performance of a project. Why do some projects perform well and other do not? Because scientific research is too one-sided and empirical data remains scarce, this research aims to gather experiences from professionals from the case study of Oceanco to contrast with the available theoretical knowledge, in order to understand how subcontractor management influences project performance. Although subcontractor management is often performed based on the gut feeling of the stakeholders involved, it is possible to identify trends in this arbitrary behaviour. This research thus attempts to identify subcontractor management practises that lead to successful project performance. The research aims to determine which practices are most adapted to a certain situation in order to obtain optimal performance. The criteria used to determine this optimal performance will be elaborated upon in Chapter 4; the Knowledge Base (Cooke-Davies, 2002).

The limited amount of time for this research will limit its extensiveness to adequately validate the findings. The proposed process design is meant to give companies a better understanding of the possibilities of subcontractor management in their projects, based upon literature, a single case study, and interviews from professionals in the market. This process design will be validated through an application on Oceanco. The possibility of application to other companies on the market will also be explored.

Main research question

After considering the problem statement presented in the previous paragraph, the main question of this research is formulated as follows:

Which approaches to subcontractor management are effective in large scale, complex engineering projects, that are characterized by a high number of change orders and uncertainties, and under which circumstances?

The chosen methodology to scientifically address this research question is presented in the next paragraph (§2.5). The research questions that are used to answer the main research question are presented below. These research questions shape the structure of this master thesis.

Sub-research questions

Subcontractor management case study;

1. How does Oceanco manage their subcontractors in practise?
2. Which barriers and challenges does Oceanco face in managing their subcontractors?

Subcontractor Management in theory

3. What can theories on projects and their management teach about the way subcontractors are approached in large engineering projects?
4. What are the main trends in literature on subcontractor management in large engineering projects?
5. Which elements in subcontractor management are assumed to affect the project performance indicators?

Synthesis of knowledge gained

6. How can the literature on subcontractor management be used to improve the process of subcontractor management at Oceanco?
7. How can Oceanco improve their subcontractor management?

Application of the study

8. Which elements of the process design on subcontractor management are representative for other main contractors managing large engineering projects and which elements are specific to Oceanco?

2.5 Research methodology

We are interested in finding effective approaches to subcontractor management in complex large-scale engineering projects that are characterized by relatively many change orders. The research aims to find the root causes for the problems related to subcontractor management, which cause projects to underperform on their project performance criteria. The meta-model by Mitroff *et al.*

(1974), shown in figure 1, presents that there is no single way of problem-solving, but that all elements should be iteratively developed in order to find a solution. The process of problem solving is adapted from Mitroff *et al.* (1974) and follows a deductive line of reasoning, which starts with an identification of the perceived problem (to be found in the previous section), followed by the construction of a conceptual model on subcontractor management (based on the case study and available literature) and an empirical model (based upon experts reviews and application of the conceptual model to the case study).

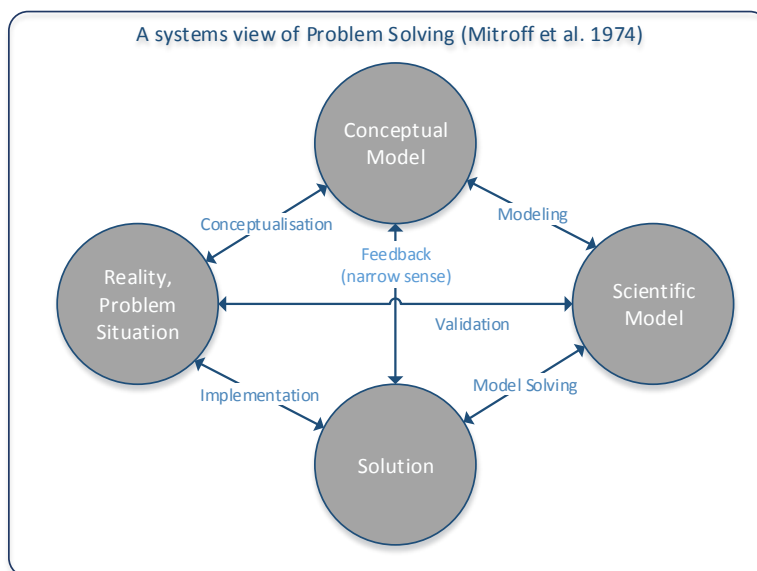


FIGURE 1 A SYSTEMS VIEW OF PROBLEM SOLVING, ADAPTED FROM MITROFF ET AL. 1974

An explorative research with a case study approach will be followed, because we are studying a contemporary real-life situation on which the researcher does not have a strong influence (Yin, 2003; Bosch-Rekvelde, 2011). For the case study an in-depth research is performed at a main contractor that manages projects with the characteristics defined in section 2.2.

The luxury yacht builder Oceanco will be the subject of the case study as its projects fulfil the criteria determined in section 2.2 and therefore appears to be a good match with the research's projects of interest. In effect, it fulfils characteristic I as the budget of the project varies from 100 to 250 million³. Characteristic II is also present in this company. Oceanco works under the principle that the client is king; as this client usually changes its mind a number of times during the project, change orders are indeed common practice. Moreover, characteristic III is fulfilled, as Oceanco's clients only want the best that the market has to offer, thereby requiring the use of state-of-the-art technologies. Finally, because 90-95% of the work to be performed in Oceanco projects is outsourced, characteristic IV is also fulfilled³. Oceanco is therefore selected to be subject for the case study in this research.

The case study is focused on gathering information about how Oceanco is currently managing their subcontractors (i.e. sub-question 1). Specifically, we are interested in how the characteristics of its projects influence the way they manage their subcontractors. This information will be gathered by use of available yearly reports, publications, and interviews with employees. Analysing the current approach to subcontractor management attention will be paid to the barriers and challenges Oceanco faces (i.e. sub-question 2).

³ Interview confidential

A three-step desk research on subcontractor management shall be conducted in parallel of the gather of the information from the case study. First, theories on projects and their management are explored to derive knowledge on how subcontractors are approached in large engineering projects. Next, trending theories in literatrue on subcontractor management are gathered (sub-question 4). The final step in this desk study involves identifying the trigger elements for project performance indicators (sub-question 5). Together these steps will form the knowledge base of this research, which will be used as input for the creation of a process design on subcontractor management, to answer research question 6. Therefore, articles as well as websites and other available written materials are analysed. Scientific articles are obtained from Scopus, ScienceDirect, Google Scholar and Web of Science.

The process design, or conceptual model, on subcontractor management is based upon the knowledge base and the case study at Oceanco. The verification of this process design is the application to Oceanco, which will result in an advice on the improvement of their subcontractor management practise, answering research question 7.

After verification an evaluation of the process design is presented, in which the scientific value of the process design is analysed by consulting different experts from the market (project managers managing projects of interest as described by the criteria delineated in section 2.2). This will show the applicability of the study for other main contractors facing similar challenges, answering research question 8. The process design is also compared to the results of the literature study. Together this forms the justification & evaluation of the process design.

2.6 The research outline

The research is performed in a series of stages, which form the outline of this research report. They are visualized in figure 2.

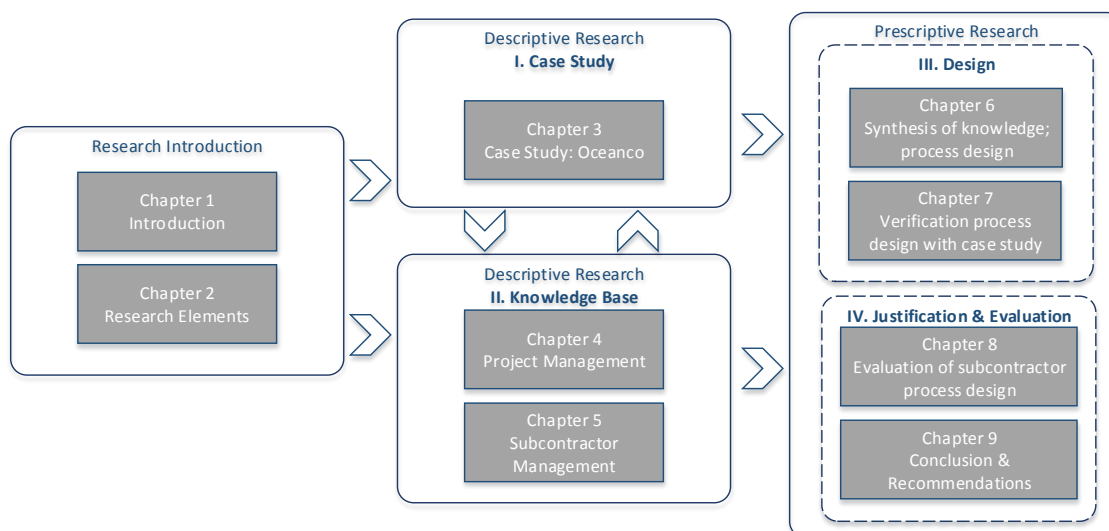


FIGURE 2 RESEARCH OUTLINE

Chapter 1 presents the introduction and reasons for this master thesis on subcontractor management in large engineering projects.

Chapter 2 gives an overview on the research elements of this master thesis, including the problem statement, research questions and a description of the methodology.

I CASE STUDY

Chapter 3 dives deeper into Oceanco, the case study of this research, to find the challenges and obstacles they face in managing their subcontractors.

II KNOWLEDGE BASE

Chapter 4 presents and reviews, based on the results of the case study, relevant literature on projects and their management, to explore the context in which subcontractor management is embedded.

Chapter 5 gives an in-depth analysis of subcontractor management theories in literature and the role of relations, structured by the model on subcontractor management introduced in chapter 3.

III DESIGN

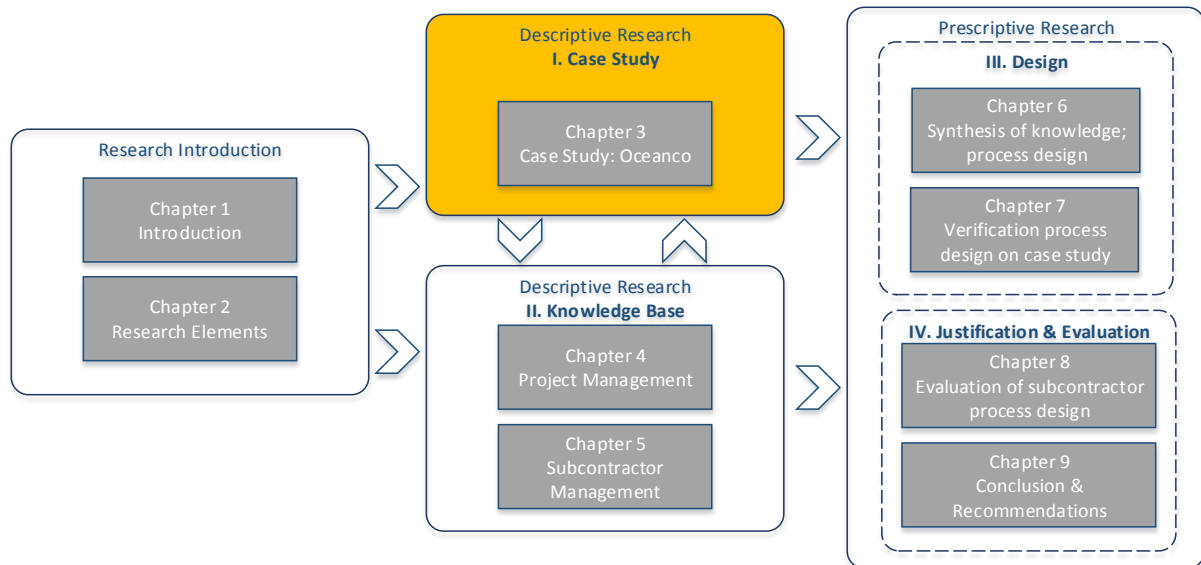
Chapter 6 introduces a process design on subcontractor management in large engineering projects, as a synthesis of the knowledge base and insights from the Oceanco case study. Chapter 7 presents an advice towards Oceanco by applying the process design on subcontractor management to their organisation. It furthermore evaluates the applicability of the process design with feedback from Oceanco and introduces a subcontractor management canvas.

IV JUSTIFICATION & EVALUATION

Chapter 8 evaluates the applicability of the singly study process design for other main contractors managing large engineering projects using expert interviews and confrontation with academic literature.

Chapter 9 presents the conclusion & recommendations of this research.

I. Case Study



The first part of this research explores the problem space of subcontractor management in large engineering projects. Oceanco, luxury yacht builder in Alblasterdam, is subject for the case study in this research. In this chapter a closer look is taken into the process of subcontractor management at Oceanco. The first two research questions (1) how is Oceanco currently managing their subcontractors, and (2) which barriers and challenges does Oceanco face in managing their subcontractors are answered in this chapter. The findings in this chapter will be used as input for the knowledge base research, and will provide substance for the subcontractor management process design to be constructed in the third part of this research.

3

Case study: Oceanco

This chapter presents an in-depth analysis of Oceanco, the case study for this research. An introduction to Oceanco is presented in section 3.1. Section 3.2 explores the challenges faced at Oceanco considering the management of subcontractors. Section 3.3 covers Oceanco's organisational structure, after which a general scheme of Oceanco's projects is discussed in section 3.4. An in-depth analysis of Oceanco's strategy for subcontractor management is given in section 3.5. Section 3.6 provides insight in Oceanco's risk and change management. The conclusion on the case study can be found in section 3.7.

3.1 Introduction to Oceanco

Oceanco was founded in 1987 by a consortium of South African investors, who wanted to build superyachts using Dutch craftsmanship⁴. It began building yachts with hulls and superstructures made in Durban, South Africa. The yacht was then brought to the Netherlands, where the finishing and commissioning took place at multiple facilities. In 2002 Oceanco changed strategy and started focussing on building in the niche market of 80m+ superyachts from their own shipyard in Alblasterdam. Since April 2010 the company is in the hands of an Omani investor (Oceanco, 2013).



FIGURE 3 IMPRESSION OF AN OCEANCO YACHT

Yachts constructed at this shipyard are custom built with state-of-the-art technologies and vary in length from 80 to 140 meters. Whereas shipyards usually have their own large workforce to perform their activities, Oceanco employs a rather unique business model in the yacht-building market, based on in-house knowhow and maximum outsourcing. To illustrate: one of the main competitors, Royal

⁴ Interview confidential

van Lent, employed 358 fulltime employees in 2011 to produce a comparable turnover to Oceanco's, with only 81 workers (RVL Holding, 2011; Oceanco, 2013). A prime advantage of this maximal outsourcing is that it enables Oceanco to benefit from the highly field-specialised expertise of its subcontractors. However, it also comes with certain drawbacks, such as the dependency on the subcontractor's performance for the success of the business model and consequently the yachts being built.

3.2 Problem exploration

The success dependency leads risk management and quality control to be two main areas of interest for Oceanco⁵. The performance of the key subcontractors in the construction process is recognized as being of vital importance, as failure to complete a yacht to specification, quality level or delivery date can significantly affect the company's reputation (Oceanco, 2013). Additionally, uncertainty in the financial markets may seriously impact the timing of newly built luxury yacht projects. Oceanco has therefore secured a strong forward order book to reduce the risk of not having new projects in future. This however increases pressure on the on-time delivery of yachts, as these forward orders also have to be delivered on time.

The fact that work is performed directly for the end-consumer is another unique aspect of Oceanco's and the rest of the super yacht industry's business model. Because client is king, and the client often changes its mind during the project, change orders are of common practise for Oceanco. Oceanco's slogan *'the perfect yacht can only be the perfect yacht when it is the owners' perfect yacht'* clearly shows their commitment to satisfy their clients' wishes (Oceanco, 2013). The change orders do not only impact the timeline of the respective project, but can also influence the general planning of the yard. If one project takes longer to finish, another project will be delayed as well. To illustrate; Oceanco currently has 7 projects running simultaneously. Due to the large amount of change orders on one project that is now in the construction phase in the shed of Oceanco, 3 other projects are endangered of being delayed as well⁶. The management of chain is therefore an essential component within subcontractor management.

Besides, the costs for these change orders cannot, or are not, always charged on to the client. Small change orders are often not billed to the client in the guise of Oceanco service. However, this trade-off does influence the profit margin of the project. Change orders also have a large impact on the management of their subcontractors, because Oceanco has to plan for flexibility in their contracts and collaborations. Finally, they also challenge the subcontractors, since they are expected to be flexible in working with these change orders too.

There is a limited availability of subcontractors. This is because Oceanco operates in a challenging market; the yachts are equipped with state-of-the-art-technologies and are increasing in size each year, thereby requiring an extremely high level of performance to reach the desired level of quality. Such a restricted niche market gives subcontractors a certain power position.

Despite these challenges Oceanco is performing very well, as the market for luxury yachts continues to flourish and Oceanco remains a key player responding to the growing demand for luxury yachts⁵. Nevertheless, the company wants and needs to grow to meet the demand for these yachts and not lose market share to its competitors. In order to facilitate the growth, Oceanco wants (and probably needs) to improve the management of their subcontractors. Considering their niche market it is likely

⁵ Interview Confidential

⁶ Interview Confidential

that Oceanco's subcontractors need to grow as well. Thus, the pressure on the subcontractors will probably increase. It is unclear which approach to subcontractor management is most effective on the long term, considering the challenging environment in which Oceanco operates. Furthermore it is not clear how the internal organisation of Oceanco may be affected by certain approaches to subcontractor management.

3.3 Organisational structure Oceanco

The organisational structure of Oceanco can be summarised into the following figure. Due to the scope of this research the organisational division of operations is specified, where the HR, financial and marketing department are not.

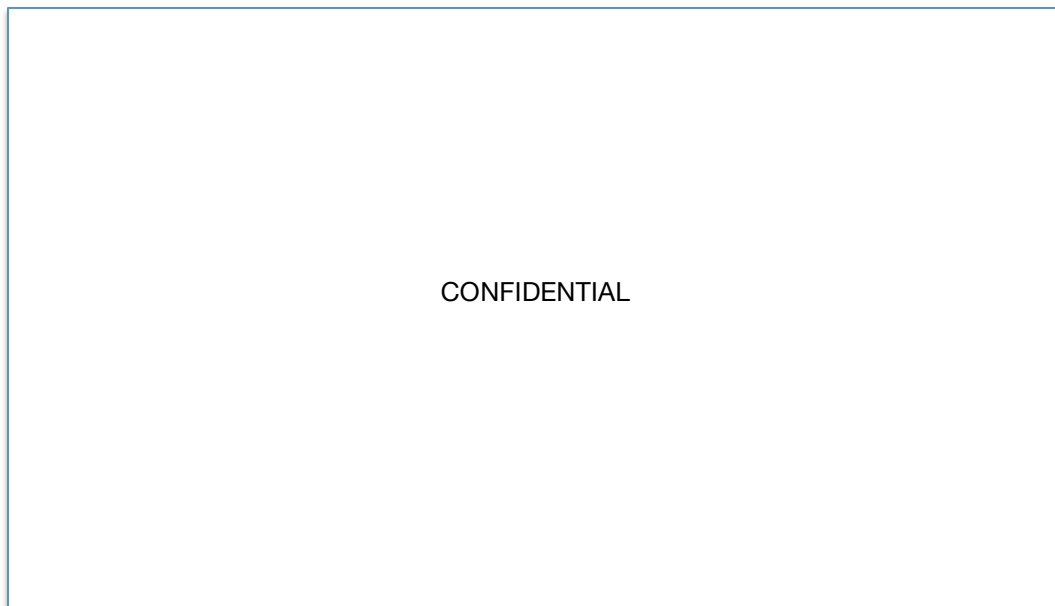


FIGURE 1 OCEANCO ORGANISATIONAL STRUCTURE: CONFIDENTIAL

All projects that Oceanco is working on simultaneously are overseen by the Chief Operating Officer. Project management functions as spin in the web and communicates with the departments within Oceanco entrusted with the engineering, production & purchasing. Furthermore, project management is responsible for the management of all subcontractors, which are initially approached by the purchase & subcontracting department. In the next sections an elaboration about this process is presented.

3.4 Oceanco Project Scheme

To gain better understanding of the business cycle that Oceanco runs through from first contact with the client until delivery, a basic project flow scheme is drawn. This figure shows when the respective departments are involved in the value chain and is used to identify where (i.e. at what stage) initial contact with the subcontractor is established and how this contact is managed.

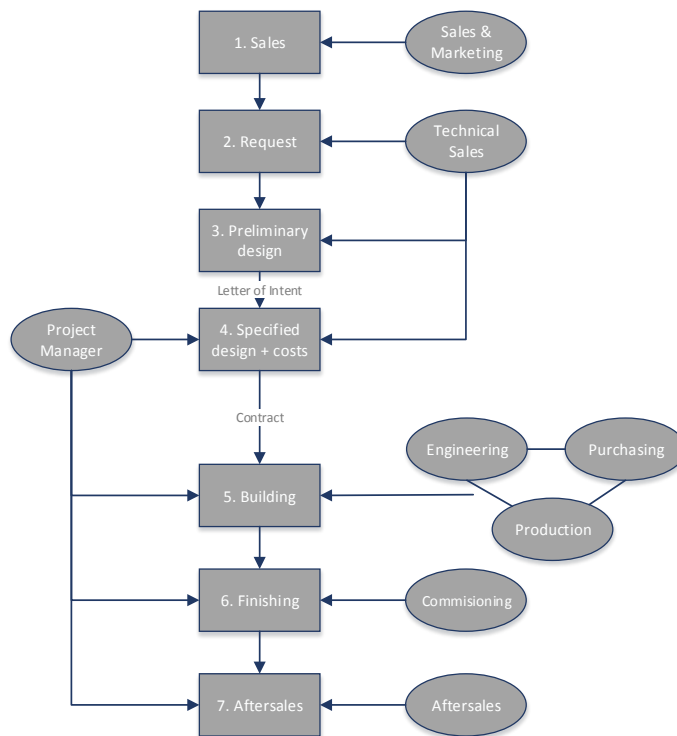


FIGURE 2 BASIC PROJECT FLOW SCHEME

The total throughput time of one yacht is usually around 36 months (Looff, 2011). The superstructure and hull are constructed at the subcontractor after the specified design has been made. The construction of the hull takes roughly 15 months and the construction of the superstructure approximately 8 months. During the period the hull and superstructure are constructed at the respective subcontractors, the pre-outfitting activities like installation of machinery, piping, and insulation take place.

The hull and superstructure are connected together at the shipyard in Alblasserdam. Afterwards the critical path of outside painting starts, which takes roughly 12 months. At least 14-15 months are used for the inside and outfitting, after which three months are needed for commissioning and sea-trials. The schedule of such a process looks roughly like figure 3.

Oceanco currently has yachts in production in different stages of the described project process. The newly built dry-dock should facilitate this capacity and enable further growth of Oceanco in future. An overview of the detailed production process (with quality control moments incorporated) can be found in appendix I.

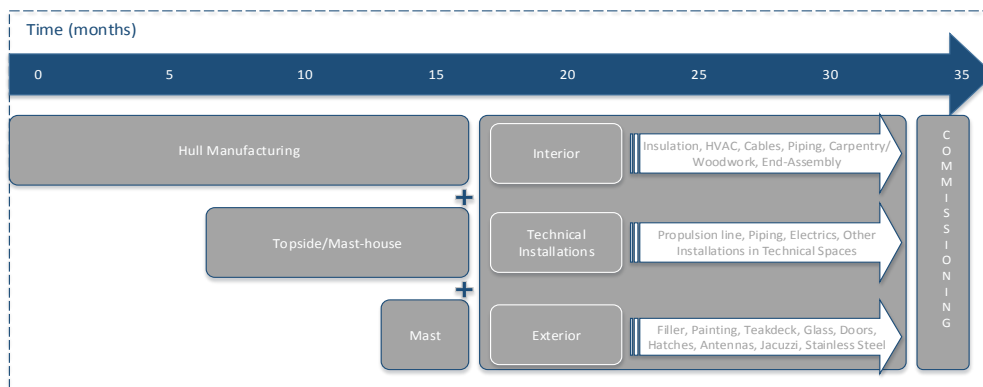


FIGURE 3 ROUGH SCHEDULE OF PRODUCTION PROCESS (ADAPTED FROM DE LOOFF 2011)

3.5 Oceanco and their management of Subcontractors

Oceanco relies on subcontractors in realizing their projects. In fact, more than 90% of work is outsourced to subcontractors⁷. As a consequence Oceanco is constantly searching for the best approach in managing these subcontractors. The purchasing department establishes the first contact with potential subcontractors. Their role is to gather the necessary parts and manpower to realize the projects. Their influence on the relationship with the contractor is as a result interesting. First the purchasing process is discussed, after which the classification of subcontractors, used by Oceanco, is presented.

3.5.1 PURCHASING PROCESS

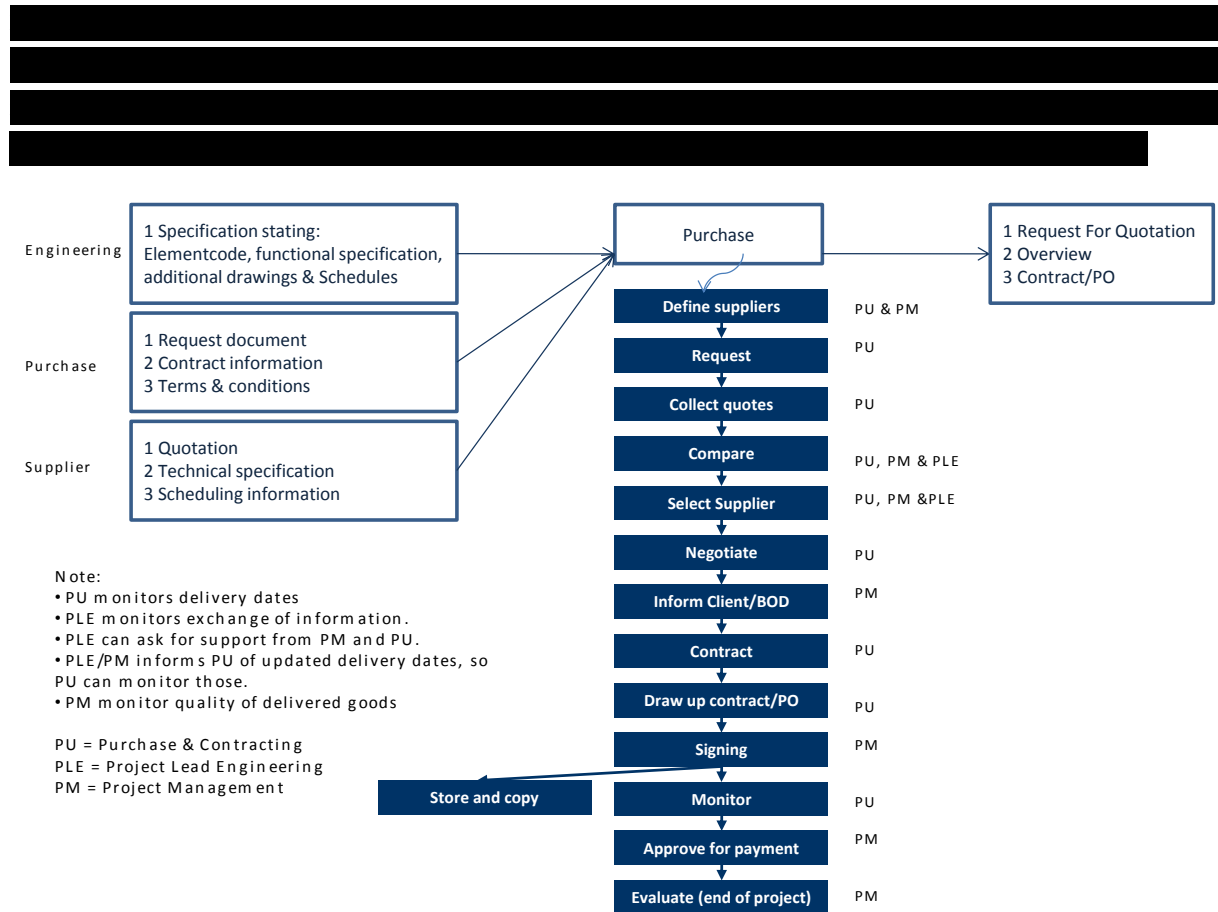


FIGURE 4 PURCHASING PROCESS (ADAPTED FROM OCEANCO, 2010)

The purchasing process is specified in figure 4. It is interesting to see that the procedure does not provide information on how each step should be performed: for example on how the request step should be approached. The procedure only identifies the different steps and divides responsibility over the decisions to be made for each step. An interview with the purchase manager of Oceanco reveals that this purchasing process is in practise less formally organised and mainly relies on the tacit knowledge of the employees⁸

The purchasing process roughly goes as follows; first the purchasing department sends tender requests, containing technical specifications, planning and purchasing conditions, to selected

⁷ Interview confidential

⁸ Interview confidential

companies. The responses are subsequently reviewed by a team, which consists of an engineer, a production employee, a purchaser and the respective project manager. This is to ensure all aspects are actually covered. Subcontractors that are evaluated positively are invited by the purchaser to review their proposal. Based on these reviews the tender is given to a subcontractor, or divided amongst subcontractors if the subproject is too large for one subcontractor (or to spread risk).

Before a purchase is made, the engineering department has made the functional requirement for the purchase. The figure below shows the input needed for the process, and the output it generates. Interestingly enough no relationship aspects are mentioned in this procedure. It merely shows which tangible input is necessary for the purchasing department to start the process of subcontractor selection.

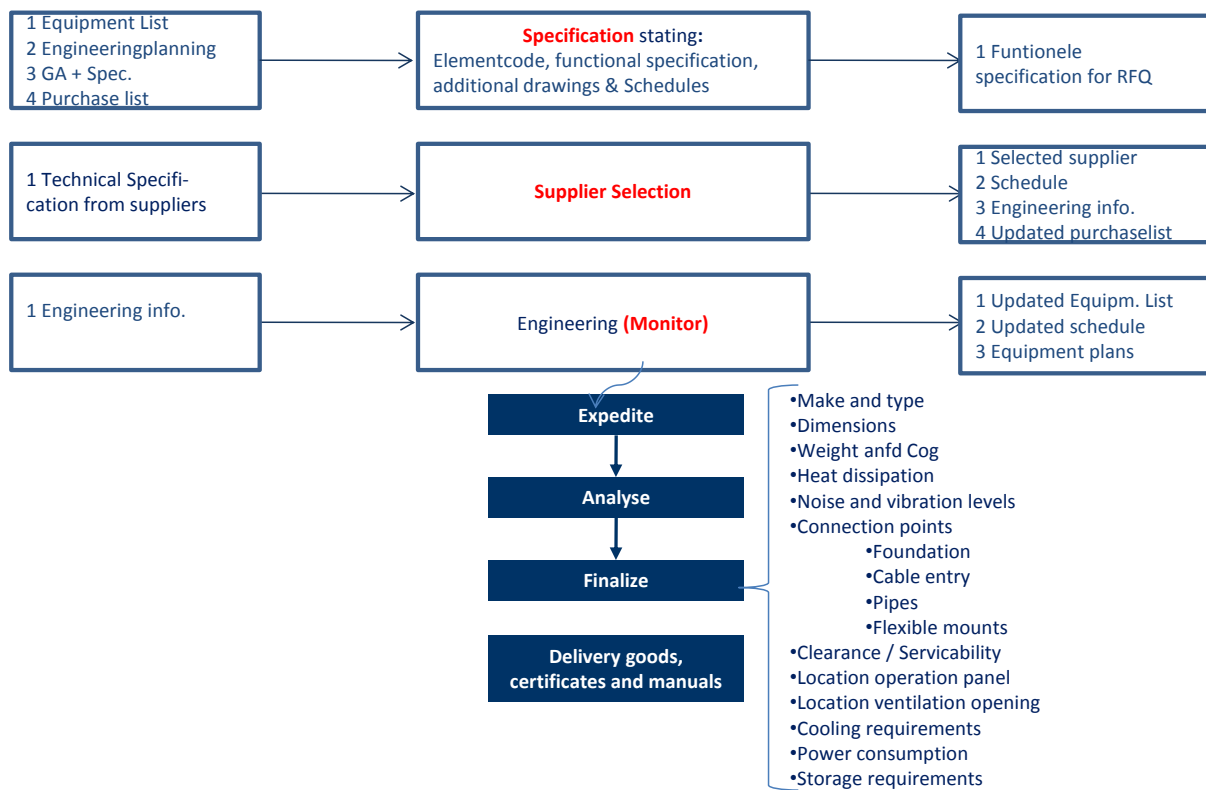


FIGURE 5 ENGINEERING TENDER TO PURCHASE PROCEDURE (ADAPTED FROM OCEANCO, 2010)

3.5.2 SUBCONTRACTOR CLASSIFICATION BY OCEANCO

Because not all subprojects are evenly complex, and some subcontractors are used more often than others, Oceanco has divided its subcontractors in three rough categories; free market suppliers, preferred suppliers and strategic partners (co-makers). A list of specified subcontractors and their characteristics is included in appendix III.

Strategic Partners

The yachts constructed at Oceanco are one-off, which makes each project is unique. However, the vital components of a yacht are the same in each project. Oceanco works with specialized subcontractors for each of these components. Some of these subcontractors are co-makers; this means that Oceanco and this subcontractor always work together in realizing their projects. The

basic idea behind this co-makership is that the subcontractor shares in risk and responsibility with Oceanco and puts the project's interest before their own companies' interest. In return they get the security of being involved in each project Oceanco takes on. The co-makers are treated as monopolist, since Oceanco only works with these parties. The subcontractors responsible for the hull, superstructure, electrics and air-conditioning are co-makers of Oceanco.

Co-makers get involved with the project in a relatively early stage, even before Oceanco has gotten the client's official confirmation to pursue the project. Based on the first concept design that the technical sales team of Oceanco draws, these subcontractors make a price offer, which is subsequently used by the calculation division to present a realistic cost estimation of the total project to the client. To assess the offer made by the co-makers Oceanco uses benchmarks available from their experience, but also statistical research provided for example by the CBS. The eventual contract includes an extensive punchlist in which as many specifications are written out as possible.

Preferred Suppliers

Preferred suppliers are subcontractors with which Oceanco regularly works because they have had positive experiences with them in previous projects. These subcontractors are generally involved in the tendering procedure, but have no guarantee to be granted the contract, as opposed to the co-makers. Usually Oceanco puts the component out to tender for 4 or 5 subcontractors, of which 2 or 3 are selected. The selection for tendering is mostly done drawing upon experiences in the past, but also on quality, financials and references from the market. The evaluation of the bids is done based on a team evaluation; this means that both the engineering and production department go over the offer, as well as the purchase department and the project manager. This is to ensure that the subcontractors' offer matches the specifications and requirements of the client. The work is then divided between the selected subcontractors to reduce the risk for Oceanco and to speed up the process.

Non-critical Suppliers

For relatively simple components or elements of the project Oceanco uses an open procedure to find the right subcontractor. The purchasing department asks for multiple tenders and decides upon these offers which subcontractors they shall use. The selection here is mainly done based on price, quality and previous experience.

3.6 Oceanco risk and change management

Risks and change form an integral part of each project. This paragraph presents the methodology used by Oceanco to identify and manage risks in their projects. It also presents the procedures used by Oceanco to cope with change.

Risk Analysis

Oceanco acknowledges the importance of risk management in their projects. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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The risks are identified and analysed based on two axes: the impact of the risk and the probability of the risk to occur. Subsequently it is decided whether the risk should be monitored or prevented, and who will be assigned with the responsibility for this action.

Practise shows that the risk analysis procedure, as it is formally written down, is not actively used⁹. Project managers do not use the described methodology, so there is no formal risk analysis being done. The approach at Oceanco towards risk can therefore best be identified as reactive, as it purely relies on the experience and insights of the project managers. [REDACTED]

Change Orders

There are two main causes for change orders; either the client decides to change the scope of the project, or a change order is needed because a mistake has been made in the design. Oceanco's biggest challenge does not lie in the first type of change order that is caused by the client deciding to change the scope of the project. If the client desires to make a change in the project, which falls outside the initial scope of work specified, Oceanco will inquire the relevant subcontractors the estimated financial, timely and weighted impact of the desired change. Once this information has been given to the client, and the latter gives its consent based upon a fully completed Change Order Request Form (appendix II), the change order will be approved and implemented.

It must be noted that Oceanco does not constantly want to charge the client for small changes. For Oceanco it is therefore important to be as flexible as possible, without compromising the quality, as well as other aspects of project performance. Currently this flexibility is not in place with the type of collaboration Oceanco has with their subcontractors³.

In case of a mistake in the design the responsibility may either lie at Oceanco or at the respective subcontractor concerned with the sub-project. To formalize the process of change orders Oceanco has set up a change order control procedure that guides changes in the initial scope of work specified. Therefore they make use of a Change Order Request Form (CORF), which is included in Appendix II. No work is to be performed without an approved CORF.

⁹ Interview confidential

In response to the eventual case of a clash during the construction phase of the project, Oceanco has set up a procedure that guides the actions to be made. The clash is likely to be noticed by the subcontractor, which is requested to report this to Oceanco's on-site production manager. Subsequently, a sketch of the situation will be delivered to Oceanco's engineering coordinator, who will review the clash based upon the Cadmatic model and earlier change orders. Additionally, a fully completed CORF needs to be submitted by the subcontractor, specifying consequences of the required change in cost, weight and time schedule. Based upon the Cadmatic model it is decided who is accountable for the clash, after which the subcontractor may or may not declare its additional costs made. This process is visualized in figure 6.

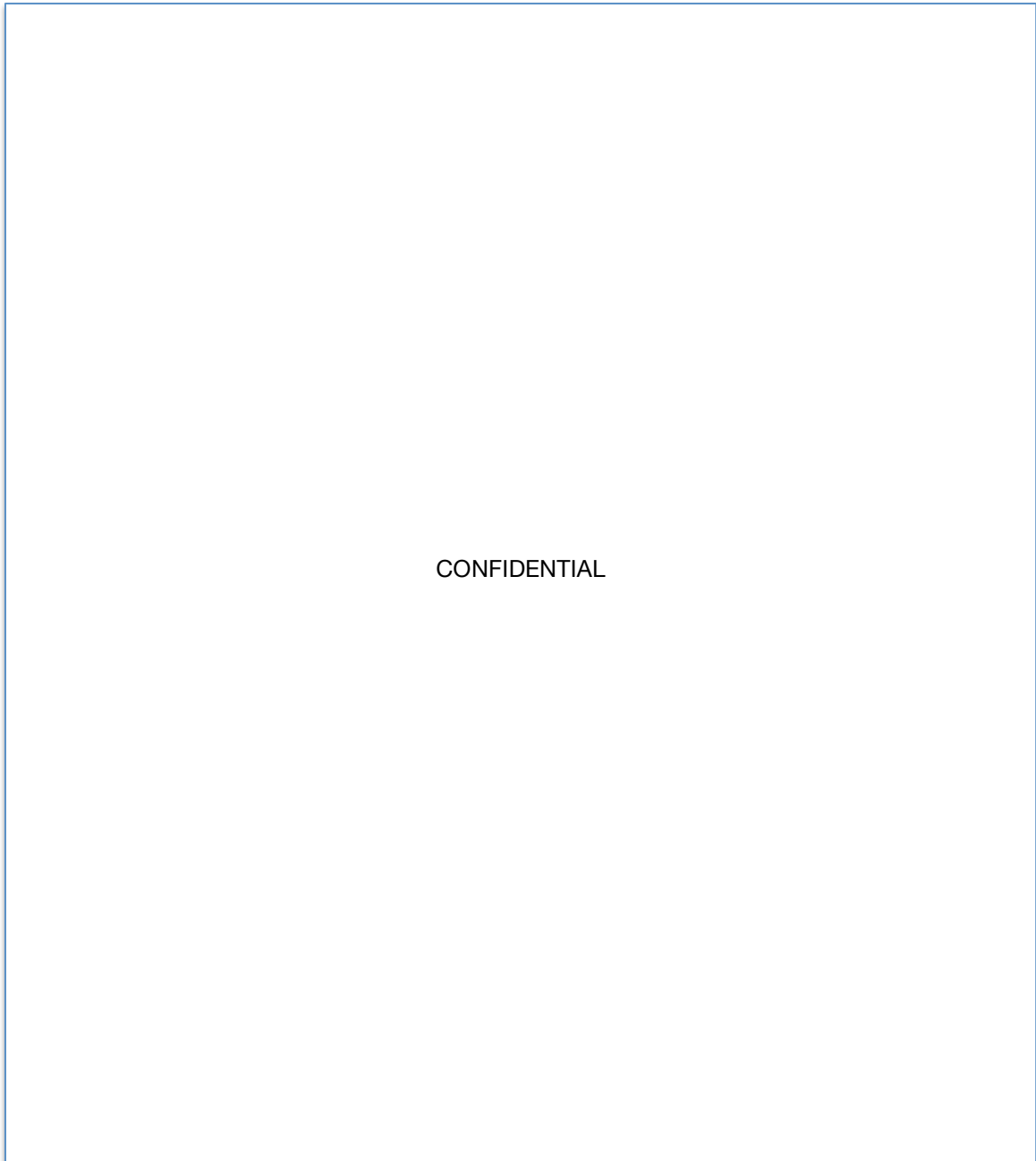


FIGURE 6 PROCESS TO RESOLVE CLASHES (CONFIDENTIAL)

3.7 Conclusion case study Oceanco

Oceanco conserves a relatively unique business model in the yachting industry, since it outsources 90 to 95% of its added value to subcontractors. Their business model seems to be perceived well by the client, since Oceanco has experienced large growth during previous years (Oceanco, 2013). To facilitate this growth, which naturally brings additional challenges, Oceanco is continuously searching for ways to improve their business model and hence the process of building yachts. In this chapter a comprehensive overview is given of the approach Oceanco takes in managing their subcontractors, answering research question 1:

1. How is Oceanco currently managing their subcontractors?

Generally their approach can be considered as quite traditional; although they distinguish types of subcontractors and work with so-called ‘co-makers’, in practise their collaboration is rather similar regardless of the type of subcontractor and quite formal with use of lump-sum contracts. Additionally, the procedures that have been written down are not followed by the employees and seem to neglect the impact of the relationship with subcontractors, or in general the soft variables that influence the subcontractor management approach. The management of subcontractors is therefore to a large extent based on the gut feeling and tacit knowledge of the purchase manager and the project manager.

[REDACTED]

The case study of Oceanco has brought to light a number of challenges and barriers they experience in the management of subcontractors. As a result, the second research question of this research can also be answered.

2. Which barriers and challenges does Oceanco face in managing their subcontractors?

The following challenges and barriers haven been identified during the case study at Oceanco. These challenges in subcontractor management are even more complicated when confronted to the company’s desire for sustainable growth:

- Oceanco operates in a challenging environment. Indeed, the increasing use of state-of-the-art technologies, as well as the building process tailored directly for the end-consumer, who is likely to change his mind during the project life cycle of four years, certainly complicates the process for the yacht-building company.

[REDACTED]

Oceanco has recently opened a new facility that can host the construction of yachts measuring up to 140 meters. The opening of this facility fits within the strategy and desire of Oceanco to grow in the coming years. This growth means that Oceanco faces a challenge of finding new subcontractors that can facilitate this growth. However, some critical

subcontractors also need to grow in their capacity to enable this growth, [REDACTED]

- Implementation of new procedures is difficult. The 2010 report made by Oceanco containing many procedures was not implemented. The advice towards Oceanco should therefore account for the context in which it should be implemented to ensure its usage in practise.

In the process of designing a framework for subcontractor management that accounts for these challenges, available literature is reviewed in the knowledge base; part II of this research.

Analysing the case study subcontractor management seems to be embedded in multiple levels of the organisation and not bound by project boundaries. Exceeding the boundaries of a project means subcontractor management also takes place at portfolio level. Oceanco often works with a subcontractor on multiple projects and thus builds a relationship with these subcontractors on the long term. This relation, or history, with the subcontractor is likely to influence the choices made by the purchasing department and the project manager in subsequent projects. This history will therefore influence the negotiations between the main contractor and the subcontractor. The outcome of the negotiations is the set of agreements that will determine how the subcontractor is evaluated & rewarded, and how the risks and changes of scope are managed within the project. The outcome of the negotiation shall therefore influence the performance of the project.

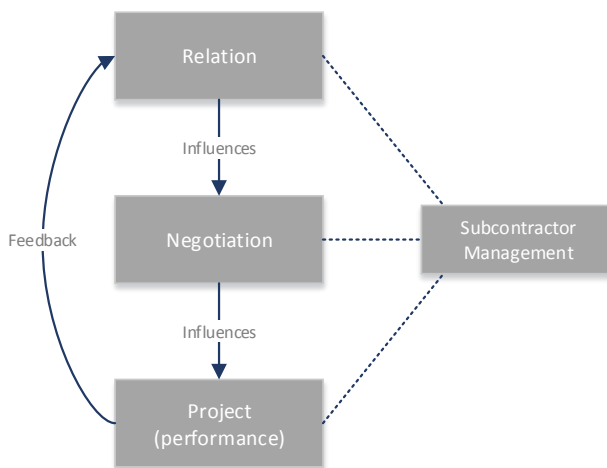


FIGURE 7 MODEL OF SUBCONTRACTOR MANAGEMENT

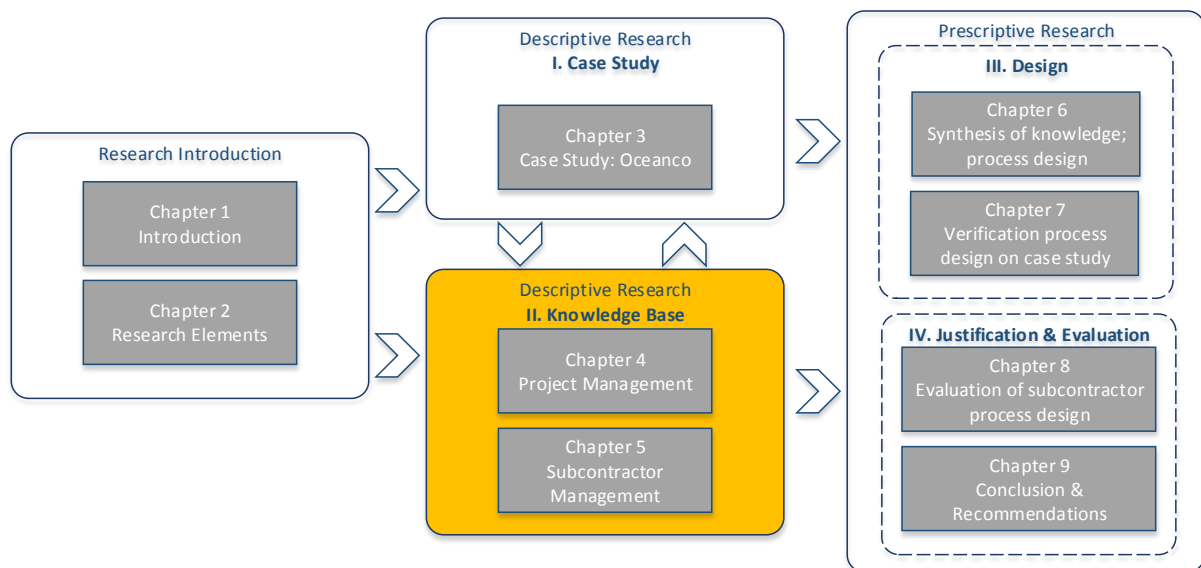
It is assumed that subcontractor management is embedded in interactions between relation, negotiation and project (performance). The project performance will eventually influence the relationship by means of a feedback loop, as experiences and interactions shape the relation between the main contractor and subcontractor. The developments in the relation will subsequently influence the negotiation and performance of the next project and thus is the feedback loop complete. Putting this in a figure (7) has led to a model of subcontractor management.

The model provides structure for the knowledge base, as it uncovers the fields of interest that need further consideration in this research. The model raises questions that can be answered by conducting an in-depth literature study: what constitutes a relation, and what indicators can positively or negatively influence the relation between a main contractor and subcontractor? What are the elements that determine the process of negotiation? How does the relation between the main contractor and subcontractor influence this process? Which variables or attributes play an important

role in negotiations and how can they be used/shaped? What do we consider to be a project, and what is project performance?

The tacit knowledge embedded in the interactions between main contractors and subcontractors that is not captured in the literature reviewed in the knowledge base will, where possible, be added using empirical data from the interviews at Oceanco. In a later stage the process design will also be subjected to evaluation from project management professionals from other companies.

II. Knowledge Base



The identified challenges and barriers for Oceanco considering subcontractor management form the base for an academic literature review, which is conducted in this second phase of the research. First, literature on project management is reviewed in chapter 4 to assess how subcontractor management is embedded into project management, answering research question (3) what theories on projects and their management can teach about the way subcontractor are approached. Second, chapter 5 presents the main theories in literature on subcontractor management in large engineering projects (research question 4) and identifies the elements in subcontractor management that are assumed to affect project performance indicators (research question 5). This theoretical base, together with the information gathered from the case study, provides the input for the process design on subcontractor management, which will be introduced in part III of this research.

Projects and their management

This chapter covers the theoretical base on projects and their management. More specifically, we dive into the level of project (performance) of the subcontractor model introduced in chapter 3. A number of questions with regards to the concept of a project arise, which are shown in figure 8 and answered in this first part of the knowledge base.

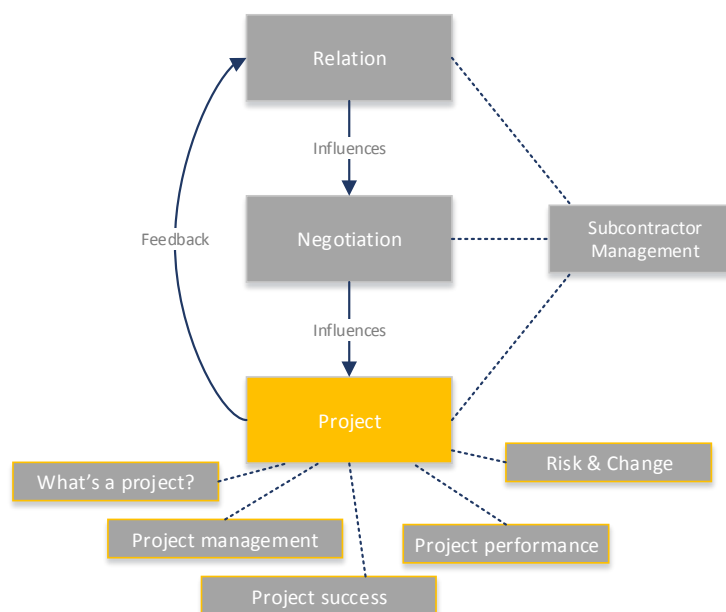


FIGURE 8 KNOWLEDGE BASE FOCUS PART I

Section 4.1 explores the concept of a project and section 4.2 presents the development of project management throughout the last decades. Section 4.3 discusses the trends in project management research, after which section 4.4 covers the concept of project success and discusses the use of performance criteria. The role of risk and change orders in projects is investigated in section 4.5. Finally, section 4.6 presents the conclusion of this chapter.

4.1 What constitutes a project?

Sometimes you need to take one step backwards in order to go two steps forward. Up until this chapter we have concentrated on finding the challenges of subcontractor management in large engineering projects. However, it is not yet established what exactly can be considered a project. Improving subcontractor management in complex large engineering projects starts with understanding what projects exactly are and what they entail. This section of the knowledge base therefore specifies the concept of a project.

The Project Management Institute considers a project to be “A temporary endeavour undertaken to create a unique product, service or result” (Project Management Institute, 2008). PRINCE2, another well-known management method defines a project similarly as “A temporary organisation that is created for the purpose of delivering one or more business products according to an agreed Business Case “ (Murray, 2009).

These definitions show that a project is characterized by its temporary nature and thereby indicating that there is a definite beginning and end. A project can thus be seen as a planned set of interrelated tasks, to be executed over a certain period of time (Bosch-Rekvelde, 2011). The project ends when the objectives of the project have been reached or when the project is terminated because it will not achieve the objectives. Projects are therefore (continuously) evaluated using certain project performance parameters (elaborated upon in section 4.4).

Projects are generally unique (Koppenjan *et al.* 2011). Nevertheless, there remain a number of generic phases that are present in every project (Bosch-Rekvelde, 2011). Turner (2008) has defined four stages within a project, that together form the project life cycle (see figure 9); Proposal & initiation, Design & Appraisal, Execution & Control and Finalization & Close out.

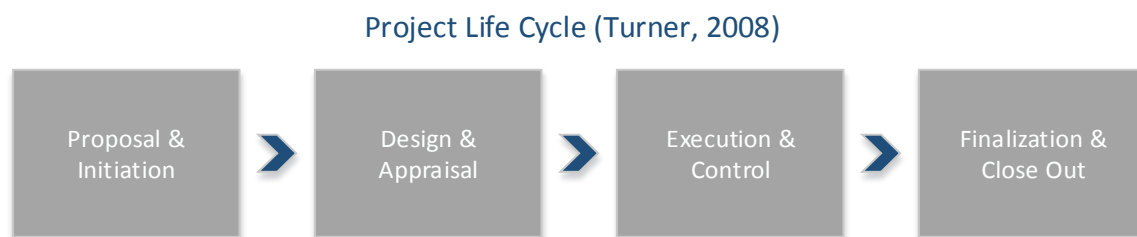


FIGURE 9 PROJECT LIFE CYCLE (ADAPTED FROM TURNER, 2008)

The first stage in this project life cycle, the Proposal & Initiation phase, is also known as the front-end development phase of a project. In the second phase the design of the project is engineered and subcontractors can be involved via tendering. In the phase of execution & control the actual construction takes place, after which the finalization stage of the project life cycle takes over and the close out of the project is started. The stages in the project life cycle described by Turner (2008) (logically) show resemblance with the general project scheme of Oceanco presented in chapter 3.

Between the different stages described by Turner evaluation takes place resulting in go/no-go decisions (Murray, 2009). This evaluation helps controlling the project performance criteria (section 4.5). The management team of the project performs the evaluation. Different approaches exist and have been developed to manage projects, which will be elaborated upon in the next section.

4.2 The development of project management

Project management evolved “from craft into a profession, into a (semi-) discipline, but still theory development in project management is in its early years” (Bosch-Rekvelde, 2011, p14). In this section a brief history of the development of project management is given, largely built upon the extensive Morris’ (1994) book “The Management of Projects”. He claims that the historical development of project management can be divided into three major stages (Bosch-Rekvelde, 2011);

Pre 1950s: no generally accepted or defined project management methods

Up until World War II project management was just emerging as an embryonic discipline, and was mainly used in the military and process engineering industries (Morris, 1994). The Second World War consisted of many military operations having a project-like nature; clear objectives, careful planning, heavily reliant on the quality of leadership and followed an operational life cycle that required clear communications and control (Morris, 1994). The Manhattan Project (US efforts to make an atomic bomb) was an especially valid contributor to the subsequent practise of project management.

1950s: one golden standard for project management, based on US numerical methods

During the 1950s several tools and techniques around topics such as scheduling and cost control were developed to support the management of complex projects, mainly based on a systems approach that treated the project as a mechanical activity (Bosch-Rekveltdt, 2011). Work breakdown structures, earned value analysis and other tools were developed to handle costs as well as to control the schedule of the projects. The defence and aerospace industry was responsible for the largest share in the development of these tools. A major contributor was the US Air Force, which came up with a formal division of projects in several phases (concept formulation, system definition, acquisition (detailed design) and operation), thereby enabling an integrated approach towards project development and control (Morris, 1994; Bosch-Rekveltdt, 2011). This division relates to the project life cycle presented in the previous section, and shows that the model of the US Air Force, although slightly adapted, still remains valid.

The Apollo project of NASA to land a man on the moon and return him safely to the earth formed an accelerator for the development of project management, mainly because of size of the project and the time pressure that was put on the project (Morris, 1994). The size of the Apollo project prevented the NASA workforce from being able to staff the entire project office at the time. In order to keep up, NASA therefore ten-folded its staff. By also using additional knowledge wherever available, NASA was one of the first organisations to employ subcontractor management. All the interdependent components (i.e. over two million parts) of the project needed to be integrated, creating the need for interface control. New forms of incentive-based contracts were introduced to place more responsibility on those actually performing the work, as to reduce the frequent overruns in both cost and schedule (Morris, 1994).

1990s: a contingent approach based on strategy

The third stage is characterized by the changing context in which projects were taking place; increasingly complex and large projects were being incorporated into programs (Bosch-Rekveltdt, 2011). It has been stated that the project management approach should be contingent upon its context (Shenhar, Dvir, Levy, & Malz, 2001). However, as has been discussed in chapter 2, there appears to be no agreement determining which project management approach works best. Indeed, a large share of project management literature focuses on providing instruments to ensure that the project follows its predicted outcome as much as possible (Nicholas & Steyn, 2012; Hillson & Simon, 2007; Project Management Institute, 2008; Sage & Armstrong, 2000; Collyer & Warren, 2000), while another strong body in literature questions the systematic and structured way by which this systems perspective deals with complexity and uncertainty (Bygballe, Jahre, & Sward, 2010; De Bruijn, ten Heuvelhof, & in 't Veld, 2010; Wood & Ellis, 2005; Aritua, Smith, & Brower, 2009; Anvuur & Kumaraswamy, 2007). We will dive deeper into the trends of project management in the next section.

4.3 Developments in project management research

“The theoretical field of project management (PM) can be described as a set of models and techniques for the planning and control of complex undertakings” (Packendorff, 1995). Packendorff identifies three main shortcomings of PM research (in 1995). First, the author claims that PM is seen as general theory and a theoretical field in its own right. Second, Packendorff argues that the research on PM is not sufficiently empirical. The final shortcoming is that under project management projects are seen as tools instead of organizations. Packendorff calls for the employment of a diversity of theoretical perspectives in field research on temporary organisations (projects) in order to construct middle-range theories on different types of projects (Packendorff, 1995). Although this article seems out-dated, as it was written 20 years ago, it touches upon an issue which is still present today: the lack of empirical data, combined with the desire to box and generalize problems into measurable and understandable components. The research questions the systematic approach that, in abstract terms, sees projects as tools instead of organisations, and calls for management theories adapted to different type of projects.

Several authors have given their thoughts and ideas on how project management should develop in future. A prominent theme in literature is the fact that all projects require a specific, tailored management approach (Bosch-Rekvelde, 2011). Williams (1999) emphasized the need for new paradigms that could deal with the increasing complexity and time pressure of projects by using simulation models to improve the classical methods; these could be top-down holistic models such as System Dynamics and the combination of hard quantitative data with soft data, for example. Shenhar & Dvir (2007) suggest that different theoretical perspectives could be used and further developed to tackle specific project management problems, emphasizing the multi-disciplinary character of projects (Bosch-Rekvelde, 2011; Shenhar & Dvir, 2007). Morris *et al.* (2006) reemphasize this point made by Shenhar & Dvir by arguing that the development of the PM Bodies of Knowledge (PMBok) should be focused on developing an approach where practitioners could make their own informed decisions based on principles, concepts, models and techniques, rather than being focused on developing a ‘one size fits all’ approach (Morris, Crawford, Hodgson, Shepherd, & Thomas, 2006).

Bosch Rekvelde (2011) presents a strong body of literature that argues project management could, or should, be made contingent upon the project’s context or environment (Engwall, 2003; Howel, Windahl & Seidel 2010; Sauser et al 2009; Shenhar, 2001; Smyth & Morris, 2007; Williams, 2005). This basically constitutes that the project management approach should be adapted based on certain project characteristics. Project based research is moving away from the tools and techniques of project management, as described in for example the PMBoK, to more behavioural aspects (Bosch-Rekvelde, 2011). Pryke & Smyth (2006) described this development of conceptual approaches and grouped them into four categories:

1. Traditional project management approach
2. Functional management approach
3. Information processing approach,
4. Relationship approach

The traditional project management approach uses techniques and tools, such as program evaluation review technique (PERT), critical path method (CPM), work breakdown structures (WBS) and Gantt charts, which tend to have a production or assembly orientation focused upon efficiency (Pryke & Smyth, 2006). The functional management approach includes mainly task-driven agendas such as strategic management of front-end development, supply chain management and partnering. Information processing approaches are based upon technocratic input-output models where

information flows are essential. Finally, the relationship approach argues that project performance and client satisfaction is achieved through an understanding of the way in which a range of relationships between people and firms, as well as between firms and project actors, operate and can be managed (Pryke & Smyth, 2006).

Koppenjan *et al.* (2011) distinguish a hard (project) approach from a soft (process) approach to project management (as described in section 2.1). A strong body of literature stresses the need for descent planning and control, with extensive risk management (Burke, 2003). This approach has a strong systems engineering perspective on how projects should be managed (see for example Sage & Armstrong, 2000). De Bruijn *et al.* describe a new approach towards the management of projects; process management (De Bruijn, ten Heuvelhof, & in 't Veld, 2010). Process management argues that decision-making is capricious and unstructured; the main thought behind process management can be explained by the analogy of plate spinning. The performer (or project manager) is constantly trying to keep multiple plates (i.e. contractors/actors) spinning to achieve his goal (i.e. the project). The conditions and required actions to keep the plates spinning are constantly changing. If one plate fails, the act fails, and the project is delayed, the set budget is exceeded or does not meet the required quality standards. Process management offers a range of strategies that can be used in this environment.

	Key questions/issues investigated	Dominant project idea	Project management maxim
Optimization School	How to manage/plan a project?	Complex set of criteria	Optimizing project implementation by planning
Factor School	What determines project success?	Complex task	Targeting project management by factors
Contingency School	Why do projects differ?	Organizational structure	Adapting project organization to contingencies
Behaviour School	How do projects behave?	Organizational process	Shaping processes of project organization
Governance School	How are projects governed	Complex transaction	Governing project organization/transactions
Relationship School	How are the early stages of projects managed and how are projects formed?	Multi-actor network	Developing relationships and projects
Decision School	Why are project instigated, why do they continue to live?	Large-scale investment	Politicking and influencing decision-making processes

TABLE 1 SCHOOLS OF PROJECT MANAGEMENT RESEARCH (ADAPTED FROM SÖDERLUND, 2011)

Söderlund (2011) categorized project management into seven schools of thought, based on 305 articles in 30 leading management and organization journals, to show the current state of project management research (see table 1). *'The schools vary in terms of their main focus and use of the project concept, major research questions, methodological approaches and type of theorizing'* (Söderlund, 2011, p153).

The schools of thought presented by Söderlund show the pluralism in the practise of project management. Söderlund embraces this pluralism and therefore does not strive for one unified theory, but stresses the importance of understanding each perspective; *"by embracing pluralism, project management research might be better equipped to explore and explain the difficulties of generating, forming, managing and even killing projects – such analysis would benefit from a comprehensive view on project processes and the use of multiple theories"* (Söderlund, 2011, p169).

In this thesis the schools of thought can be used to better understand the practise of project management at the respective companies for which the interviewed project managers work. Besides, the factor school will be subject to section 4.4, where project success is discussed. The contingency school is found in section 4.5, where the concept of risk is analysed. Additionally, the relationship school is interesting, as it dives into the multi-actor and social setting between main contractor and subcontractor, and relates to the relation level of the model on subcontractor management.

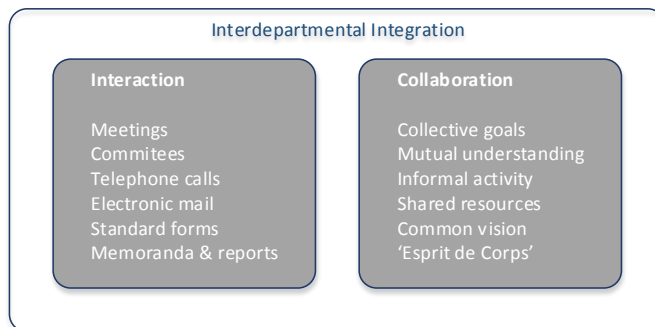


FIGURE 10 INTERDEPARTMENTAL INTEGRATION (ADAPTED FROM KAHN ET AL. 1996)

To illustrate that these relational approaches, such as partnering, might work, Kahn *et al.*'s research investigating interaction and collaboration between departments of a firm is interesting (1996). Their research showed that collaboration has a significant correlation with project/product performance. Naturally this result cannot be translated into relationship between main contractor and subcontractor, but it does show the difference between an organisation in which all departments share a common vision and work towards collective goals, instead of only working based on self-interest and having only the minimum required level of interaction. The relationship between main contractor and subcontractor is further researched in chapter 5.

Discussing the developments and trends of project management naturally leads to the questioning of when can a project be considered a success, how do you measure success and which criteria have influence on this success? These questions are discussed in the next section.

4.4 Project success and performance criteria

When a project is finished one often speaks about the success of the project. Whether a project can be considered successful is quite ambiguous and depends on the perspective one takes on the project (Morris, 1994). Different stakeholders in the project may (and will) have a different view on the success of a project (Bosch-Rekvelde, 2011). The concept of project success therefore has by definition a subjective character (Bryde, 2008). Project performance criteria are used to make the judgement about the success of a project more objective and less ambiguous.

4.4.1 PROJECT SUCCESS

Before diving into the project performance criteria one must first look deeper into the concept of project success. Shenhar *et al.* have defined four dimensions of project success, expressing different perspectives on a project related to the time dimension (Shenhar, Dvir, Levy, & Malz, 2001):

1. Project efficiency: meeting time and budget,
2. Impact on the customer: meeting requirements and customer satisfaction,
3. Business and direct success: impact of the project on an organisation,
4. Preparing for the future: organizational and technological infrastructure.

The first dimension of project efficiency expresses the short-term dimension of success within a project by looking at the resources, time limits and the specified budget and evaluating how the project has performed under these constraints (Shenhar, Dvir, Levy, & Malz, 2001). Although this provides insight in the success of the project itself, it is not guaranteed that this success will benefit the organisation on the long term. With the current increasingly competitive market this dimension is of vital importance for the continuity of the company.

The second dimension, impact on the customer, relates to the importance placed on the customers' requirements and satisfaction. An important finding by Shenhar *et al.* (2001) is that meeting performance measures, functional requirements and technical specifications, are all part of this dimension, as opposed to being part of the project efficiency. The impact on the customers is, especially for companies like Oceanco, one of the most important dimensions in assessing project success.

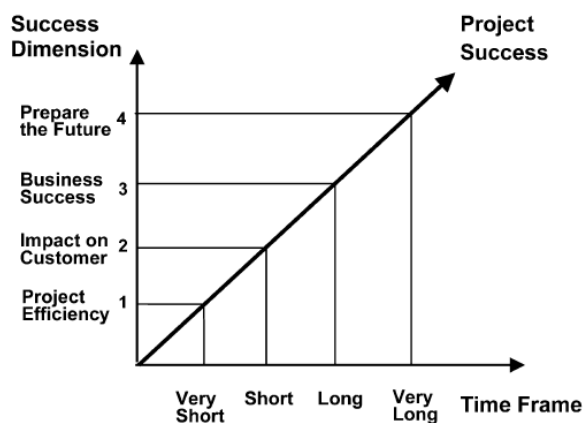


FIGURE 11 TIME FRAME OF SUCCESS DIMENSIONS (SHENHAR ET AL. 2001)

The direct impact the project has on an organisation is addressed in the third dimension: business success. Central to this dimension are questions including: Did the project provide sales, income and profit as expected (Shenhar, Dvir, Levy, & Malz, 2001)? This dimension also applies to projects that are not aimed at building new products but at improving processes, for example the process of manufacturing.

The fourth dimension assesses the long term development of the organisation by looking at how prepared/flexible an organisation is for the future; whether there is enough technology development within the organisation and whether they are exploring new markets, opportunities and ideas (Shenhar, Dvir, Levy, & Malz, 2001). The success dimensions are set against the axes of time in figure 11. When assessing project performance, a clear choice has to be made on which dimension of success is used, and which success measures, or performance indicators, are used.

4.4.2 PROJECT PERFORMANCE CRITERIA

'Project management is a learning profession' (Atkinson, 1999, p338). Project performance criteria are used to monitor whether a project is doing well, and afterwards to assess whether a project was successful. Traditionally the performance of a project is assessed using three criteria (the Iron Triangle, figure 12); time, cost & quality (Atkinson, 1999). However, professional companies interested in long-term competitive advantage and sustainable development, with reference to the previously mentioned success dimensions, may find this iron triangle too limited. Atkinson asks himself the following question; *"Doing something right may result in a project which was implemented on time, within cost and to some quality parameters requested, but which is not used by the customers, not liked by the sponsors and does not seem to provide either improved effectiveness or efficiency for the organisation, is this successful project management?"*.

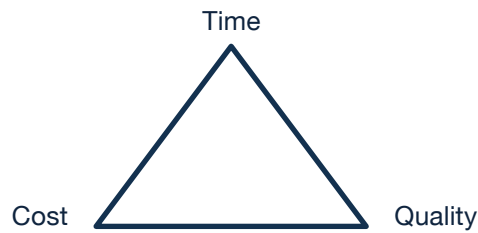


FIGURE 12 THE IRON TRIANGLE

Before discussing additional project performance criteria, it is important to realize that there are trade-offs to be made in these criteria for each individual project (Atkinson, 1999). The focus of a project can move from quality to cost or time, depending on the context of the project and the specific stage in the project. Atkinson introduces the square route to understanding project management criteria, which includes the iron triangle, but also pays attention to the benefits of a project (for both the organisation as well as the stakeholder community) and the information system. This square route looks like the following figure.

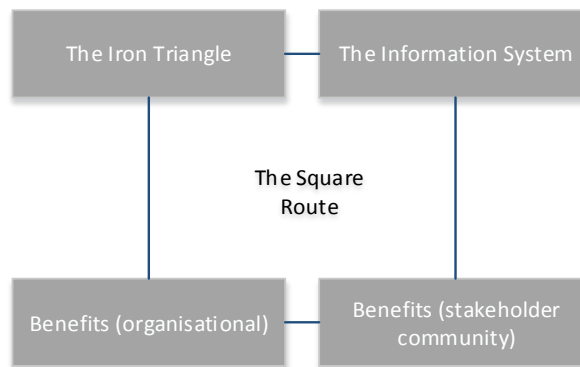


FIGURE 13 THE SQUARE ROUTE (ADAPTED FROM ATKINSON 1999)

The author also offers a breakdown of each of these criteria (table 2) based on suggestions made by other authors. This list is not exhaustive, but is merely meant to provide context to the idea behind the square route. It illustrates that project success is rather complex and cannot be captured by only considering the iron triangle of project performance criteria.

Iron Triangle	The information system	Benefits (organisation)	Benefits (stakeholder community)
Cost	Maintainability	Improved efficiency	Satisfied users
Quality	Reliability	Improved effectiveness	Social and environmental impact
Time	Validity	Increased profits	Personal development
	Information-quality	Strategic goals	Professional learning
	Use	Organisational learning	Contractors profits
		Reduced Waste	Capital suppliers, content project team, economic impact to surrounding community

TABLE 2 SQUARE ROUTE TO UNDERSTANDING SUCCESS CRITERIA (ADAPTED FROM ATKINSON, 1999)

Shenhar *et al.* (2001) point out that project management is a multi-dimensional concept because each project has its own specific dimensions; assessing project’s success requires one to understand these distinct dimensions and their varying relevant importance (Shenhar, Dvir, Levy, & Malz, 2001). To assess the performance of a project, de Wit (1988) argues that all stakeholders’ objectives must be considered. In the literature review of Eriksson & Westerberg (2011) three

additional performance aspects considered to be vital for sustainable success are identified: *environmental impact*, *work environment* and *innovation*. Gibson *et al.* (2006) and Nicolas (2004) use the number of change orders as a performance indicator in their Project Definition Rating Index (PDR), in which the amount of costs associated with change orders is linked to the successfulness of the project.

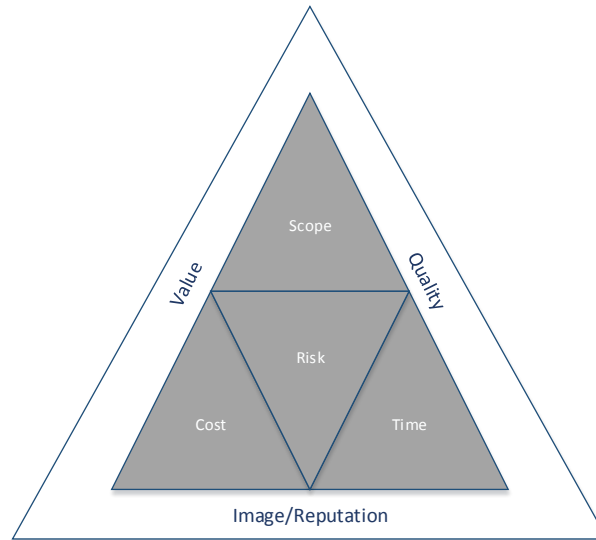


FIGURE 14 KERZNER'S COMPETING CONSTRAINTS MODEL

Kerzner (2013) re-emphasizes the argument made by Atkinson (1999) that there are trade-offs to be made between the indicators used to describe project performance; *“there may be secondary factors such as risk, customer relations, image and reputation that may cause us to deviate from our original success criteria of time, cost and performance”* (Kerzner, 2014, p45). At any time in a project trade-offs in the iron triangle might be necessary to be made and performance criteria might be changed. Kerzner calls this competing constraints and shows this by expanding the iron triangle with other secondary factors (shown in figure 14).

4.5 The role of risk and change orders in projects

Risks and change orders in projects are likely to influence the project performance. In this section the roles of risk and change orders are researched using literature.

4.5.1 THE ROLE OF RISK

As is shown in the competing constraints model of Kerzner (figure 14), risk is central to projects and thus the management of these projects. Regardless of the management style, a project manager adapts to the unexpected events that are bound to occur in the execution of complex engineering projects. The response to the strategies for dealing with risk in construction projects suggests that the construction industry is mostly risk averse; main contractors mainly try to transfer risks to sub-contractors, which results in risk premiums on the tender prices, or transfer risks via insurance premiums (Akintoye & MacLeod, 1997). Although this research is nearly 20 years old, it still seems valid today, as this was also seen in the case study at Oceanco.

There seems to be no consensus in literature on which approach to risk is best in the management of large engineering projects. Raz & Michael (2001) therefore investigated which tools are most widely used and those that are associated with successful project management (figure 15), by administering a questionnaire to a sample of project managers from the software and high-tech industries. One

important finding of this study was that it is considered to be relatively easy to identify risks and that one may not need a process for that purpose, but that a process for the more complicated tasks of analysing, tracking and controlling the project risks is needed (Raz & Michael, 2001). The authors have identified certain actions that successful organisations conduct which other do not. The most commonly used risk assessment tools employed that are associated with better performing project management practises (PMP=High) and that are used by practitioners who already have a good risk management process (RMC=High) are listed in the table below. A limitation of this research is that it was performed within the Israeli culture, that places high value on personal initiative, improvisation and on-the-spot problem solving and has less emphasis on disciplined work processes (Raz & Michael, 2001).

Tool Description with Significantly high use in RMC and in PMP

Risk impact assessment
 Risk classification
 Ranking of risks
 Periodic document reviews
 Periodic trend reporting
 Analysis of trends, deviations and exceptions

FIGURE 15 TOOLS WITH SIGNIFICANTLY HIGHER USE (ADAPTED FROM RAZ & MICHAEL 2001)

The first three techniques described by Raz & Micheal all consider an evaluation of the risks identified to determine a mitigation strategy. In systems engineering a Risk Breakdown Structure is used to identify the risks that can occur (Sage & Armstrong, 2000). This method is based on breaking down risks into external and internal risks. Additionally, a mitigation strategy is chosen for each risk. Internal risks are risks that can be mitigated or avoided within the project design, planning and structure. External risks lie outside of the project scope but can (heavily) affect the project. Besides, in identifying these risks the likelihood of occurrence is important, as it determines how regularly the risk occurs. Finally, the impact of the risks is estimated. Multiplying the likelihood of occurrence with the impact determines the mitigation strategy. This mitigation can be (1) accepting the risk, (2) avoiding the risk, (3) reduce the risk, (4) transfer the risk, (5) reserve for the risk or (6) make a contingency plan for the risk (Sage & Armstrong, 2000).

4.5.2 THE ROLE OF CHANGE ORDERS

Due to the complexity inherent to large engineering projects and unforeseen circumstances, changes in the scope of the project occur (risks that occur for example). Additionally, the client might also impose changes in the scope. The latter is not necessarily an issue for the main contractor, as the costs for the desired change can be transferred to the client. However, this does require adequate portfolio management, as a change within a project can result in time-delays that can impact other projects. The challenge in changes that are imposed by the client is the analysis of the implications of this change on the time, quality, and cost of the project (and potential other project performance criteria), so that an accurate estimate can be given on the impact of the change.

Unforeseen circumstances are more problematic for the main contractor, as he carries the responsibility for the project. Change management is closely related to risk management, as most changes in the project are implemented due to a risk that occurred. Therefore the focus within change management is often placed on the responsibility and transfer of risk.

4.6 Conclusion on projects and their management

In this chapter of the knowledge base available literature on projects their management approaches has been researched. By researching what exactly defines a project certain common phases in every project's life cycle have been identified. These phases form a project timeline where certain decision moments considering subcontractor management take place. These are interesting to investigate further in the next chapter, which will dive deeper into the relation and negotiation aspects of subcontractor management.

The development of project management research shows a transition in literature that moves away from the one-size-fits-all approach towards the belief that the project management approach should be contingent upon its context. Furthermore, the developments in project management research show that empirical data about project management is still needed. The argument that research should be focused on developing an approach where practitioners could make their own informed decisions based on principles, concepts, models and techniques, rather than developing a 'one size fits all' approach, is taken into account in this research. The process design on subcontractor management in this thesis is made to challenge current views and provide a guideline in making an informed decision on which subcontractor management approach to adopt. The schools of thought on project management by Söderlund have showed the pluralism in project management research. This pluralism was also found in the conceptual approaches presented by Pryke & Smith, as well as in the model of subcontractor management introduced in chapter 3. As this chapter mainly focuses on the factor and optimization school, attention will be paid to the relation school in the next chapter, diving deeper into the influence of relations on projects and their negotiations.

The literature on the concept of project success re-emphasizes the importance of time and scope within the definition of this concept; whether a project is successful depends on the level at which you determine success. This relates back to the subcontractor management model, which considers subcontractor management at both project and portfolio level, as the relationship between a main contractor and subcontractor exceeds project boundaries and influences subsequent projects.

Lastly, the role of risk and change has been investigated. Risk is central to complex projects and seems to be one of the main, if not the main, driver in project management. The construction industry is risk-averse and tries to transfer risks towards their subcontractors, because it is not the risk identification that is considered to be difficult, it is the mitigation strategy that one chooses.

With the knowledge gained in this chapter research question 3 can now be answered:

3. What can theories on projects and their management teach about the way subcontractors are approached in large engineering projects?

The literature study shows that there are a variety of methods available to manage projects. However, there is no consensus on which approach is best; literature generally concentrates on one side of the spectrum (for example project vs. process management). However, the uniqueness of large construction projects makes that there is no plug and play approach that will fit perfectly to every project. The theories on projects and their management therefore teach us that a process design on subcontractor management should not try to provide a one-size-fits-all solution, because such a solution will not be found. The framework should merely provide main contractors with the input to make an informed decision on how to approach the specific subcontractor.

Furthermore, a strong systems approach to project management or a softer process approach will have different influence on the relationship between main contractors and their subcontractors. Besides, the management approach influences the extent to which a subcontractor can deliver added value, as it basically determines its degree of freedom. The decision for a management approach seems to be largely dependent on performance indicators such as time, quality, and cost in combination with the market characteristics. Literature reveals that the relationship between the main contractor and subcontractor is often not considered in the choice for a management approach. It is interesting to contrast practise with theory, because it is assumed that the project management approach in practise is actually mainly based on the relationship with the subcontractor and the physical interaction between the project manager and the subcontractor.

5

Subcontractor management

This chapter forms the second part of the knowledge base. Within this chapter subcontractor management is discussed in greater detail, with a focus set on the relation and negotiation level of subcontractor management. Therefore the input for negotiation and relation is first discussed – the type of subproject and type of subcontractor – after which the management approaches are discussed in more detail. Then, literature on the concepts of negotiation and relation is presented (see figure 16).

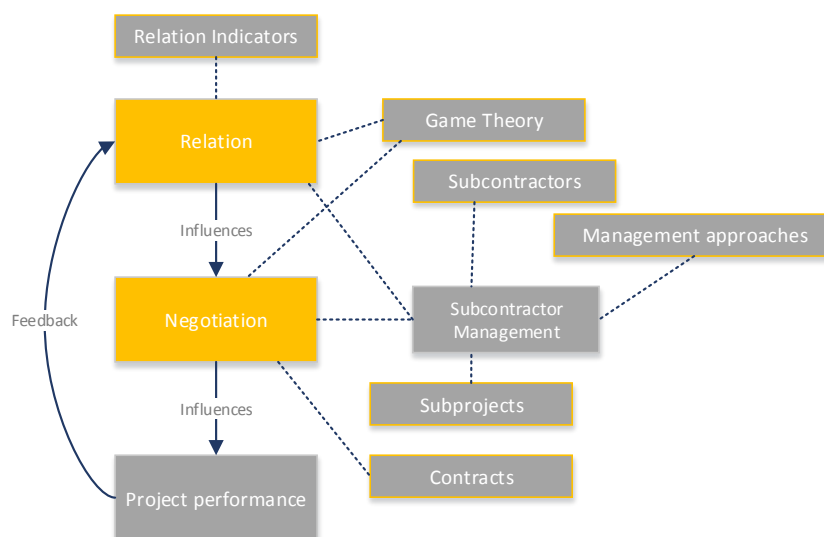


FIGURE 16 FOCUS KNOWLEDGE BASE PART II

More specifically, section 5.1 discusses subprojects and their characteristics. Section 5.2 presents insight in the type of subcontractors. Section 5.3 dives deeper into the trends of subcontractor management. Section 5.4 presents insights in the concept of negotiation, after which section 5.5 discusses the role of contracts in subcontractor management. Section 5.6 presents the indicators that influence the relationship between main contractor and subcontractor. The chapter ends with a conclusion about the knowledge gained (section 5.7).

5.1 Subprojects and outsourcing

Central to this thesis research is the question of when is a certain strategy for subcontractor management effective and when not. This is highly dependent on the type of subcontractor and the context of the sub-project. Using a systems perspective segmentation in type of subprojects and subcontractors is made, to enable giving an advice on which subcontractor approach to follow.

Projects are therefore usually decomposed in elements to reduce the complexity and be able to divide the work that needs to be done. A commonly used technique for this decomposition is a Work

Breakdown Structure. Within a Work Breakdown Structure subprojects are categorized, following the example below. It should be noted that the mutual dependency of some subprojects, where one subproject has to be finished before another one can start, is not included in such a Work Breakdown Structure. This can however influence the subcontractor approach that is chosen, which will be elaborated upon in the next section.

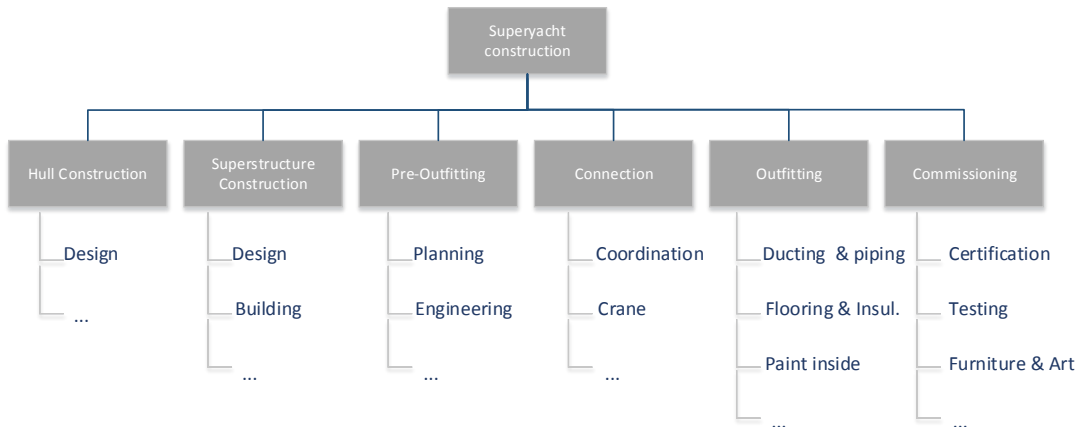


FIGURE 17 ROUGH SKETCH OF WORK BREAKDOWN STRUCTURE FOR A TYPICAL OCEANCO PROJECT

For each subproject the project manager has to decide whether it should be outsourced or done in-house. This depends on whether the subproject is considered to be one of the core activities a firm wants to perform. This decision is also influenced by the in-house capacity and capability of the main contractor’s workforce. For Oceanco the strategic decision has been made to keep the knowhow required for building a yacht in-house and outsource all the production work. McIvor (2000) provides a practical framework to understand and guide the decision process for out-sourcing (18).

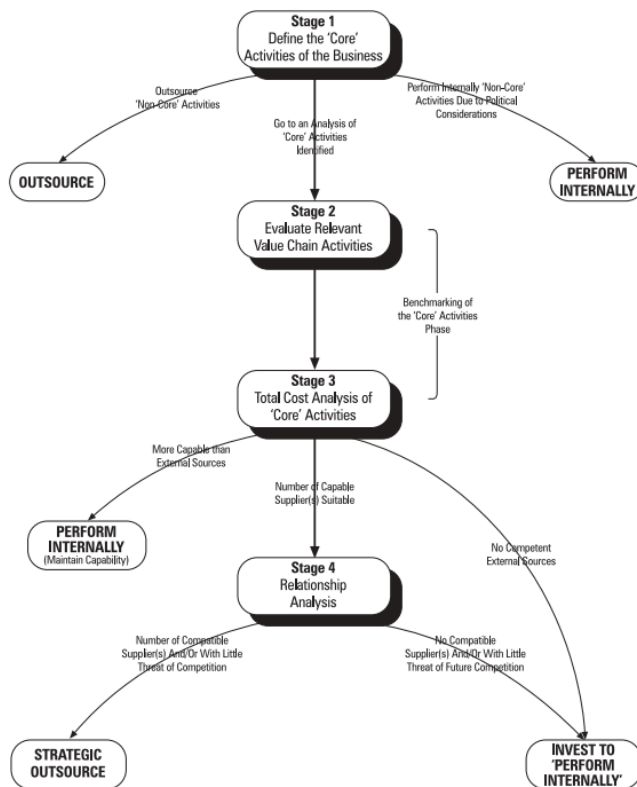


FIGURE 18 A PRACTICAL FRAMEWORK FOR EVALUATING THE OUTSOURCING DECISION (ADAPTED FROM McIVOR 2000)

Each subproject (following from the Work Breakdown Structure) is characterized by certain factors, determining the complexity of the sub-project. Williams (2005) relates project complexity to two dimensions; structural complexity and uncertainty. The structural complexity relates to the size and number of elements in the project. On the level of subprojects we call this technical complexity. Uncertainty is made up of uncertainty in project goals and uncertainty in defining the means to achieve these goals.

The complexity of the subproject determines whether knowledge of the subcontractor is desired. What is meant here is that with highly complex subprojects the main contractor is likely to need/want to use the knowledge of the subcontractor, as the subcontractor is specialized in this. This will influence the subcontractor approach to be chosen (discussed in next section), as it influences the dependency of the main contractor on the subcontractor. Additionally, the subcontractor approach is naturally influenced by the relation and negotiation, but this will be the subject of discussion in subsequent sections.

Literature does not provide a clear science-based suggestion for segmenting sub-projects. However, Turner & Cochrane (1993)'s classification of projects based on scope definition appears to be useful. The authors classify projects based on two axes; the certainty of the goals of the project and the methods used to achieve these project goals (clearly defined vs. uncertain). This directly relates to the uncertainty dimension of Williams (2005). Based on these two axes 4 types of projects are identified, and from these four types of projects it is possible to define four types of sub-projects with similar characteristics:

- Type 1 projects have a clear goal and method to achieve this goal. These projects have a great chance of success. These type 1 projects resemble sub-projects that are easy to completely specify because they are less complex. We therefore call these subprojects "*catalogue sub-projects*".
- Type 2 projects have a clear goal, but lack a clear method for achieving this goal, thereby using deliverables to define this work. A sub-project with a clear goal but lack of method for achieving this goal is ideal to out-source to a specified subcontractor, because the subcontractor's expertise would be very useful in determining the method for achievement. Such a sub-project could be out-sourced performance-based. We therefore call these subproject "*performance-based sub-projects*".
- Type 3 projects have a clear method, but no well-defined goal. This type of projects regularly occurs in the software development industry, where the users' requirements are very difficult to specify. The only subprojects that conserve these characteristics are those that directly involve the end-consumer in the design, therefore called "*exploration-driven sub-projects*".
- Type 4 projects neither have clearly defined goals nor specified methods. Turner & Cochrane typify these projects as organisational-development blue-sky projects. We call the subprojects without clearly defined goals and methods "*blue-sky sub-projects*".

The goals-and-methods matrix, as Turner and Cochrane (1993) call it, which summarises the four types of projects and their characteristics, looks like figure 19 (with authors' additions marked in red). Turner & Cochrane add an extra dimension to this model with the chance of success/failure. The authors argue that the chance of failure is larger when there are no well-defined goals or methods, and that therefore project with clearly defined goals and methods have a greater chance of success. This is related to the dimension of uncertainty defined by Williams (2005), as he argues that uncertainty derives from the uncertainty in project goals as well as in the means to achieve those goals. As uncertainty here influences the project complexity, high complexity can be related to the

chance of failure/success. Risk is added to the goals-and-methods matrix of Turner & Cochrane as an extra dimension, as the degree of uncertainty is directly related to the associated risk within projects and the chance of failure/success. Projects with a high degree of uncertainty have greater risks, or more risks compared to projects with a low degree of uncertainty.

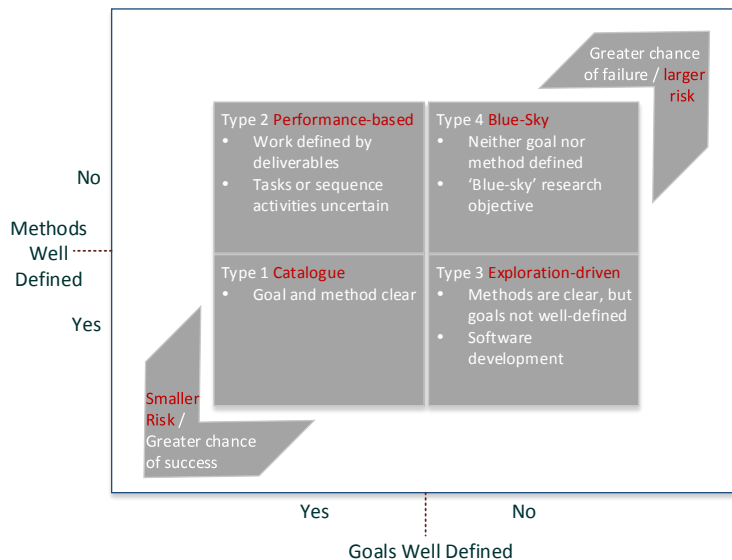


FIGURE 19 GOALS-AND-METHODS MATRIX (ADAPTED FROM TURNER & COCHRANE 1993)

The segmentation of types of sub-projects is useful and necessary to determine the strategy for the subcontracting relationship approach. The model by Turner & Cochrane provides an easy assessment tool to gain insight into the complexity of a certain sub-project. Sub-projects with clear goals and defined methods are considered to be less complex than sub-projects in which both goals and methods are not clear. This is likely to influence the subcontractor approach to be chosen. Sub-projects with a clear goal and defined method allows for a directive planning approach for example (Collyer & Warren, 2000).

The typology of sub-projects presented in this paragraph can thus be related to a (segmented) subcontractor management approach. Therefore, the next section presents segmentation of subcontractors and relates this to the type of subproject and desired management approach.

5.2 Type of subcontractors and their management

Just like every project (and subproject) is unique, every subcontractor is also unique. The management of subcontractors is strongly related to the project management approach that is adopted. To enable prioritizing and differentiating supply management practices amongst different suppliers, purchasing and supply management literature often segment suppliers (subcontractors) based on industry, suppliers, or relational characteristics (Camuffo, 2007). The influence of relation and thus past experiences with a subcontractor is often underexposed in these models. The segmentation models are therefore mainly useful as method for a quick scan of supply management practises. The influence of relation in subcontractor management will be subject for discussion in section 5.6.

The supply risk is a very relevant indicator: for example, sub-projects that are mutually dependent (because one cannot start before another is finished) have a high supply risk. Segmentation of type of subcontractors is therefore useful in the search towards effective approaches to subcontractor

management; there is no one-size-fits-all approach. Kraljic (1983) started segmentation by constructing a portfolio model of suppliers (subcontractors) using two classification criteria; the importance of the purchased item and the complexity of the supply market. The basic idea behind this portfolio model is to minimize supply risk and leverage buying power (Gelderman & Weele, 2002). Based on these classification criteria he identified four categories of suppliers: (1) non-critical, (2) leverage, (3) bottleneck and (4) strategic.

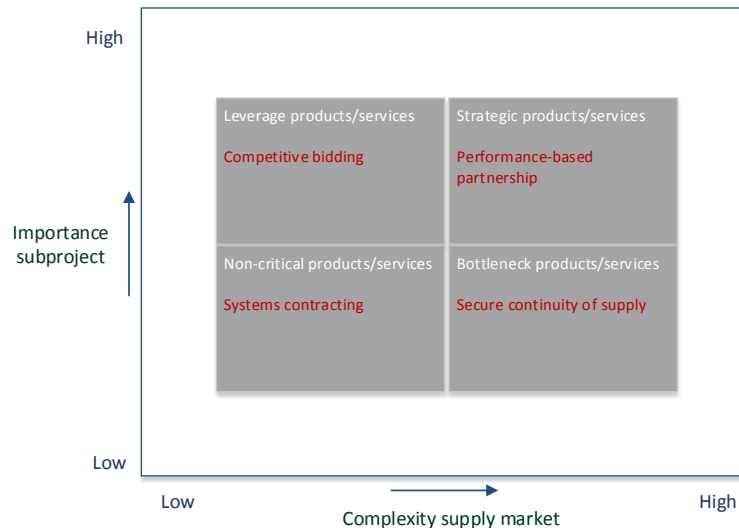


FIGURE 20 THE KRALJIC MATRIX; ADAPTED FROM GELDERMAN & VAN WEELE 2005

This purchasing portfolio analysis is used worldwide. Indeed, out of the large companies with more than 5000 employees, 85% uses the portfolio analysis (Gelderman & Weele, 2002). Portfolio models have been most widely used in strategic planning (Olsen & Ellram, 1997).

The management of certain types of sub-projects poses challenges for the main contractor in terms of keeping the power balance and control, whilst not harming the relation with the subcontractor. Building on the segmentation model of Kraljic, multiple authors have developed models with sourcing strategies to cope with these types of subcontractors. Van Weele (2005) associates four different sourcing strategies based on four types of subcontractors (strategic, leverage, bottleneck and non-critical suppliers) in the Kraljic matrix (see figure 20 in red):

1. Partnership with strategic suppliers (collaborative strategy)
2. Competitive bidding with leverage suppliers (exploiting full purchasing power)
3. Securing continuity of supply with bottleneck suppliers (volume insurance, supplier control etc.)
4. Systems contracting with routine suppliers (non-critical)

The strategies mentioned by Van Weele (2005) are mainly aimed at suppliers, who generally do not perform actual construction work/labour on site, but merely provide a component of the end product that is made. Therefore, the strategies are not directly applicable for the management of subcontractors that offer services/labour. For example, the proposed strategy of keeping stock to mitigate the purchasing risk of a certain product is not really applicable in one-off projects. Furthermore, Van Weele does not consider the complexity of the subproject itself, only its importance and the complexity of the supply market.

Olsen & Ellram (1997) have determined factors that describe the difficulty of managing the purchase situation for manufacturing companies purchasing a variety of products and services, and include the

complexity of the subproject. They describe three categories of characteristics; product characteristics, supply market characteristics and environmental characteristics. The product complexity here relates to the type of subprojects defined in the previous section. Within product characteristics novelty and complexity are given as factors influencing/describing the difficulty of managing the purchase situation. These factors are also directly applicable for subcontractors providing a service in a project, as the novelty and complexity will determine the type of project. The supply market characteristics refer to the suppliers’ power and their technical and commercial competence. Again this is valid for subcontractor management, as the subcontractors’ competences determine their added value in the project and, related to the product complexity, also influence their power position (as there are not many subcontractors capable/available in highly complex projects). The environmental characteristics given by Olsen & Ellram are risk and uncertainty. This directly relates back to Kraljic’s portfolio model based on risk and profit impact.

The type of subcontractor seems naturally related to the respective subproject that is outsourced. However, this link has not been made explicit in literature. Building towards a strategic framework for management of subcontractors in large engineering projects, this link is considered to be important to describe the input for the model. The type of sub-project, as presented in section 5.1, can be linked to the type of subcontractor that is presented in this paragraph; (1) non-critical, (2) leverage, (3) bottleneck and (4) strategic (figure 20).

Type of Sub-Project	Type of Subcontractor	Explanation
I. Catalogue	Non-Critical / Leverage	Catalogue sub-projects have clearly defined goals and methods. The risk of failing is relatively low and the tendering can be competitive on specified criteria. The subcontractor here are non-critical or leverage.
II. Performance-based	Leverage / Bottleneck / strategic	Performance-based sub-projects are still often approached with leverage contracts, but a strategic partnership might allow for better usage of their expertise. This is also dependent on the relation of the sub-project with other sub-projects. It might also be a bottleneck, dependent on the supply market; plenty or limited amount of suppliers.
III. Exploration-driven	Bottleneck	Exploration-driven subprojects are relatively unique in construction projects and could form a bottleneck for the performance criteria of the project. These sub-projects therefore require strong monitoring.
IV. Blue-sky	Strategic	Blue-Sky sub-projects can best be matched with strategic sub-contractors, as there are too many uncertainties for the main contractor to apply a more adversarial and formal approach.

FIGURE 21 SUB-PROJECTS LINKED TO TYPE OF SUBCONTRACTORS

In literature on subcontractor management a few trends can be observed on approaches/strategies that mitigate these trade-offs in their own way. These trends will be the next section’s subject of discussion, providing input on which approach might work in which situation.

5.3 Trends in subcontractor management

The challenges in subcontractor management of large engineering projects seem to be mainly centred around the blue-sky and performance-based subprojects, where the main contractor can either try to maintain control by adopting an approach that limits the subcontractors freedom, or can adopt an approach in which he does not have direct control, but builds towards a trust relationship and cooperation. The trends presented in this paragraph focus on providing ways to deal with this challenge.

5.3.1 ADVERSARIAL APPROACH

The traditional relationship between main contractor and subcontractor has been mainly transactional with both parties seeking to secure added value at minimum cost, and without much interaction (Miller, Packham, & Brychan, 2002). Selection of tendering here is done purely based on price, after which a contract specifies in detail what is requested, leaving limited room available for the subcontractor to excel. This leads the quality of the end-product to only be as good as is defined in the requirements set by the main contractor. For example, within a so-called guarded adversarial, the main contractor and subcontractor cooperate within the boundaries of the contract (Larson, 1995). The performance here is guided by strict adherence to the contract and major disputes are resolved by the formal interpretation of the contractual obligations. The subcontractor thus has no incentive to deliver extra quality or better technology. Although this approach is called the traditional approach. It remains the most commonly used technique for managing subcontractors still today.

Different reasons are given for the use of this approach. Gadde & Dubois (2010) argue that the majority of large engineering projects are one-off, which often means that no long-term business relationships can be established. However, although these engineering projects are one-off, the main contractor often works with the same parties, because there are only a few contractors that have the capability and capacity to perform the work. This leads to repetitive collaborations, therefore a long-term relationship could be possible here. Another reason for promoting the adversarial approach is that firms normally strive to avoid dependency on specific business partners, because they want to reduce uncertainty in single transactions, avoid having lock-in with the technical solution of a single supplier and encourage competition to stimulate supplier performance (primarily on price) (Gadde & Dubois, 2010). The approach however neglects the influence of certain complexities in the subproject (type of subproject) and the influence of relation indicators on the project performance.

5.3.2 PARTNERING, STRATEGIC ALLIANCING & INTEGRATED PROJECT DELIVERY

Bygballe *et al.* (2010) argue that a fundamental shift away from traditional adversarial relationships between main contractor and subcontractor can be seen in the market. Larson (1995) argues that this shift started to emerge already two decades ago, in response to the general decline of the North American construction industry. Increased international competition forced companies to keep up with the escalating competitive pressure of the globalizing marketplace (Andersen, 1999). This shift is further enhanced by the uncertainties rising from the credit crunch, and has resulted in new approaches to subcontractor relations, such as Partnering, Alliancing and Integrated Project Delivery (IPD).

Partnering has been described as “the most significant development to date as a means of improving project performance” in the pilot study of Wood & Ellis (2005, p. 317), who derived this statement from collected opinions of 48 commercial managers employed by a leading national contractor. Using partnering allows firms to specialize in core activities and rely on external partners for additional technological input (Wood & Ellis, 2005).

A strategic alliance is a *'long-term inter-organizational arrangement for mutual benefit, which is based on equivalence and high complementarity'* (Anvuur & Kumaraswamy, 2007, p. 230). The idea behind strategic alliancing is therefore the same as partnering, but alliancing is per definition long-term and therefore on portfolio level rather than project level.

Integrated Project Delivery is a project delivery system that targets integration of knowledge and expertise in the design and construction stage, and encompasses strong team cooperation, early involvement of subcontractors, risk and benefit sharing models, and joint responsibility to ensure success of a project (Bygballe, Dewulf, & Levitt, 2014; Kent and Becerik-Gerber, 2010).

Lahdenperä (2012) noted that Partnering, Alliancing and IPD are often used interchangeably. Even if they have their differences, *'early involvement of key parties, transparent financials, shared risk and reward, joint decision-making and a collaborative multi-party agreement are some of the features incorporated in all the arrangements to a varying degree'* (Lahdenperä, 2012, p57) (Bygballe, Dewulf, & Levitt, 2014). Such high-involvement relationships are characterized by adaptations between the buyer and supplier, made in order to improve their joint performance (Gadde & Dubois, 2010). These adaptations do not only improve the performance in a relationship, they also lead to interdependencies between the parties. The time aspect also plays a major role. Black *et al.* (2000) differentiate partnering in three types, depending on the respective time-frame; open ended (often called strategic partnering), for a specific project, or for a specific time-period. This relates to the scope of the collaboration (i.e. project level or portfolio level) and is reflected in the model of subcontractor management. This is nicely illustrated by the figure presented by Gadde & Dubois (2010);

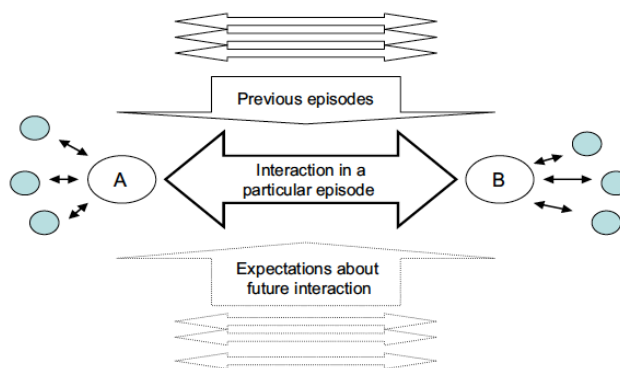


FIGURE 22 INTERACTION EPISODE IN ITS TIME AND SPACE CONTEXT (ADAPTED FROM GADDE & DUBOIS 2010)

The key themes behind partnering are teamwork, collaboration, trust, openness and mutual respect (Larson, 1995). Cicmil and Marshall (2005) however point out that such collaborative procurement methods do not automatically facilitate collaboration and improved project performance. They argue that structural intervention such as special contractual arrangements, is insufficient to deal with the paradox of the relationship between project performance and control on their own on the one hand, and the processes of cooperation, collaboration and learning, on the other.

Relationship Aspect	Findings
Relationship duration	<i>In both the literature and in practice there is a tendency to focus on project partnering more than strategic partnering, even if the latter is often seen as the goal.</i>
Relationship partners	<i>Neither dyadic, nor multi-actor perspectives predominate in the literature. However, not many articles are concerned with joining sub-contractors and suppliers in partnering.</i>
Relationship development	<i>Formal aspects of partnering, such as contracts, tool and techniques, receive a lot of attention. However, many of the articles argue for a mix of formal tools and informal/dynamic/social aspects.</i>

TABLE 3 SUMMARY OF LITERATURE REVIEW BYGBALLE ET AL. (2010)

Kim & Dossick (2011) therefore looked into the key elements that contribute to the integration of project delivery. They identified five elements that contribute to/reinforce the integration of project delivery: (1) Contract type, including an integrated form of agreement, (2) Culture, (3) Organization, (4) Lean principles and (5) Building information modelling (BIM). These elements support the statement that social processes and relationship dynamics play an equally important role as the more formal mechanics (Bygballe, Dewulf, & Levitt, 2014). In their literature review Bygballe *et al.* (2010) find that partnering is related to three aspects of relationships; the duration, the partners and the development (table 4). As the table shows, much attention is given to the formal aspect of partnering, such as contracts. Since the influence of contract is so broadly shared amongst literature it is interesting to have a more in-depth discussion about the role of contracts in subcontractor management. This discussion is presented in subsequent section 5.5. First, attention is given to the general role that the negotiation plays in the collaboration between main contractor and subcontractor and how this affects the project (performance).

5.4 Negotiations with subcontractors

The negotiations a main contractor conducts with subcontractors determine to a large extent how the collaboration will take shape during the project, as the outcome of the negotiations determines the set of preconditions the main contractor and subcontractor will work with. These negotiations can either be held to form an agreement for a project, or for a greater time span on a portfolio level. This relates to the distinction that has been made in the previous section between project partnering and strategic partnering: the relationship duration.

The contract often functions as the umbrella under which the agreements made during the negotiation process are written down. Before diving into the contract, which is subject of the next section, attention is given to some theories that shape this contract.

These theories try to explain the concept of strategic behaviour of stakeholders when entering a negotiation. Contracting parties often work through motivation cultivated by divergent objectives and hidden agendas (Rahman & Kumaraswamy, 2004; De Bruin & Ten Heuvelhof, 2008). Traditionally, the main contractor will try to transfer risk to the subcontractor, which will try to avoid taking these risks at all. Additionally, the subcontractor will try to sell their services for the highest price possible, whilst the main contractor tries to find ways to squeeze the profit margin of the subcontractor. In short, both parties will try to pursue their own interests. Approaches like partnering try to align the interests to improve the collaboration and hence the project.

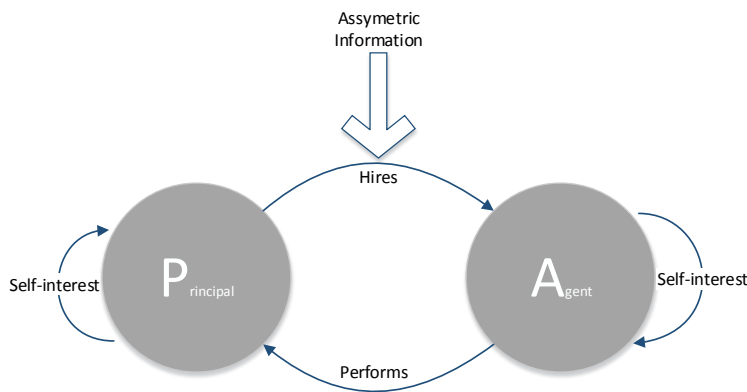


FIGURE 23 PRINCIPAL-AGENT PROBLEM

The negotiation a main contractor conducts with a subcontractor considering a subproject with a high degree of complexity is, next to strategic behaviour, also influenced by the concept of Moral Hazard; the Principal-Agent problem. The Principal-Agent problem is visualized in figure 23. The most famous example of the Principal-Agent problem is the dentist-patient situation in which the dental patient (principal) wonders if the expensive treatment that is recommended by the dentist (agent) is truly necessary for the patients’ dental health, or whether this recommendation is driven by self-interest of the dentist because it generates income. There is a parallel to be drawn between this example and the negotiation a main contractor conducts considering a highly complex subproject, because the main contractor will also not be fully knowledgeable about the specifics of the subproject to be outsourced. Here the subcontractor can misuse its power position due to its knowledge advantage. [REDACTED]

[REDACTED]

[REDACTED] the negotiation process is iterative and consists of multiple rounds of interaction (De Bruin & ten Heuvelhof, 2008).

According to Agency theory that supports the use of performance incentives, the agent will shirk unless their actions contribute directly to their own economic self-interest (Anvuur & Kumaraswamy, 2007). They argue that shirking can therefore only be mitigated by monitoring, supported by contracts that appeal to their self-seeking nature; including penalties and rewards. The search for appropriate incentives will be subject of the next section in which the role of contracts is investigated.

5.5 The role of contracts

Much attention is given to the formal aspects of relationships, such as contracts. Generally, the relationship between main contractors and sub-contractors is reflected in the contract that is concluded (Veen & Korthals Altes, 2011). Traditionally, the approach in construction projects was mainly prescriptive; the sub-contractor was told what to do based on the specifications in the contract (Olander, 2014). The shift towards approaches like partnering has led to a demand for different forms of contracting. The complexity of large construction projects requires more flexibility than the relatively simple fixed price, or lump sum contracts (Nicholas & Steyn, 2012). First, this flexibility is discussed in the next subsection. Subsequently, possible remuneration schemes are discussed.

5.5.1 DEVELOPMENTS IN CONTRACTING

Main contractors are starting to use contracts that are performance-based (Olander, 2014). Performance-based contracts move risk from the main contractor towards the sub-contractor by transcending from focusing on the project construction lifetime to focusing on the facility lifetime. This change of project scope has great consequences for the relationship approach between the parties. Instead of rewarding the subcontractor to a list of assembled parts, the sub-contractor is rewarded to the extent the delivered product or structure meets the user requirements/satisfaction (Gruneberg, Hughes, & Ancell, 2007). Examples of such performance-based contracts are Cost-Plus Incentive Fee Contracts (CPIF) or Design-Build-Operate-Maintain (DBOM) contracts (see next subsection), which steer towards sharing risks and sharing profits (Nicholas & Steyn, 2012).

Relational Contract Theory (RCT) has a somewhat different approach to contracting with the core proposition of 'all contracts are embedded in relations' (Veen & Korthals Altes, 2011 p312). Van der Veen & Korthals Altes (2011) have made an effort to provide guiding principles for the drafting of a development agreement (see table 4). A development agreement differs from a contract in that it is a framework in which the specific agreements are yet to be made. The guiding principles do however give insight in how a more collaborative contract can be drawn (cfr. Relational Contract Theory). The guiding principles are based upon the results of their research into four international large construction projects and account for the ten contract norms defined by Macneil (1980) (also shown in table 4).

GUIDING PRINCIPLE	SHORT DESCRIPTION	COMMON CONTRACT NORMS
1. Focus on relations	<ul style="list-style-type: none"> - Acknowledge that contracts are embedded in relations - Introduce relational norms to accommodate them 	<ul style="list-style-type: none"> 2. Mutuality and reciprocity 8. Creation and restraint of power 10. Harmonisation with the social matrix
2. Focus on the interest of the project	<ul style="list-style-type: none"> - The focus of the agreement must not be on the interest of parties involved. Goals of the parties should be weighed against this rule 	<ul style="list-style-type: none"> 1. Role integrity 6. Contractual Solidarity 9. Propriety of means
3. Specify functions of the agreement	<ul style="list-style-type: none"> - Exchange function: the quid pro quo - Planning function: the planning of the project - Statutory function: the rules that parties must comply with - Instrumental function: the public goals that are pursued by the planning authorities 	<ul style="list-style-type: none"> 3. Implementation of planning
4. Specify the goals of the agreement	<ul style="list-style-type: none"> - What is the aim of the contracting parties - What is the aim of the project - What is the aim of this specific agreement 	
5. Plan for flexibility	<ul style="list-style-type: none"> - Make sure that the contract can accommodate changing circumstances 	

TABLE 4 GUIDING PRINCIPLES FOR DEVELOPMENT AGREEMENTS, ADAPTED FROM VAN DER VEEN & KORTHALS ALTES 2011

The five guiding principles strive to focus on the relation and setting the project interest before company interest. Flexibility in these contracts is key for success. Relational Contract Theory and other similar approaches seem to fit well within the complex context of large engineering projects, because they allow for flexibility and put the relationship at the centre of discussion. Disadvantages here are that ensuring progress is difficult and the scope of the project is not easily manageable.

We can deduce from this literature that the shift in relationship approach from hierarchical towards partnering is reflected in the way contracts are set up. Trust and collaboration are some of the main keywords that show up in literature regarding the demand for new approaches to manage relationships in the large construction projects (Bygballe, Jahre, & Sward, 2010) and are reflected in new approaches to contracts, such as Relational Contract Theory and performance-based contracting. How this influences the remuneration schemes will be discussed in the next sub-section.

5.5.2 TYPES OF CONTRACTS

Naturally there is no single form of contract agreement that will fit in every situation or project (Kerzner, 2013). However, companies following a systems approach to subcontractor management generally work with five types of contracts; Fixed-Price or Lump Sum (FP), Cost-Plus Fixed Fee (CPFF) or Cost-Plus Percentage Fee (CPPF), Guaranteed Maximum-Shared Savings (GMSS), Fixed-Price Incentive Fee (FPIF) and Cost-Plus Incentive Fee (CPIF) (Kerzner, 2013);

Lump Sum – Lump sum remuneration is an agreed single fixed payment for which a subcontractor will perform the work that is outsourced to them. This requires the subcontractor to carefully estimate the target cost of the subproject, as it is required to perform the work at the negotiated contract value. Lump sum remuneration is often seen as a risk evasive approach for the main contractor, as the risk in such a contract is transferred to the subcontractor that agrees to perform the work for a fixed price. This approach may however make the main contractor pay an excessive amount of contingency if the subcontractor does not have a clear view on the risks (which is often the case in complex engineering projects). Besides, in practise the risk is often still at the main contractor, as this contractor still has the ultimate responsibility for the project if the subcontractor does not deliver. This form of contract should only be used when the main contractor can fully specify the work that needs to be done and has clearly identified the potential risks. Change orders often result in additional costs for the main contractor because the purely price-based selection entices tenderers to lower their bids to win a contract, relying on subsequent claims to recover their costs (O'Conner, 2009).

Cost-Plus Fixed Fee – In this form of contract the remuneration scheme for the subcontractor is a fixed fee, regardless of the total costs of engineering, labour, materials and other costs (which the main contractor pays for). This type of contract is mainly used when no accurate pricing is possible. The subcontractor runs limited risk, since the fee is fixed regardless of the quality he delivers. This puts a considerable risk at the level of the main contractor. Additionally, the fixed fee is often a percentage – *Cost-Plus Percentage Fee* – of the total cost, giving the subcontractor a disincentive to work efficiently.

Guaranteed Maximum-Share Savings – The remuneration of this type of contract offers a fixed fee to the subcontractor for his profit and is, up until a negotiated ceiling tariff (guaranteed maximum), reimbursed for all costs made (engineering, material, labour etc.). Additionally the main contractor and subcontractor share the savings that are made below this threshold. This construction creates for both the main contractor and the subcontractor an incentive to realize the project at the lowest cost possible, where the financial risk is shared between both parties.

Fixed-Price Incentive Fee – This contract is similar to the fixed price contracts, but gives the subcontractor an incentive to reduce costs to increase profit via a formula that has been agreed upon beforehand by both the main contractor and the subcontractor. Both parties share in risk and profit in this model.

Cost-Plus Incentive Fee – The cost-plus incentive fee contract is similar to the Cost-Plus Fixed Fee, but differs in the reward scheme; the incentive fee is variable and depends on a formula that is

agreed upon by both main contractor and subcontractor, which considers the planned costs versus total cost, for example. The subcontractor is incentivized to keep the costs down to increase profit and the main contractor therefore runs less risk.

5.5.3 THE CHOICE FOR A CONTRACT

The previous sub-section gives an overview of the types of contracts that are generally used in the construction industry. This section looks into the variables that influence the choice for a type of contract. This choice for a specific contract form depends on a certain amount of variables; Kerzner (2013) suggests the following:

- Overall degree of cost and schedule risk
- Type and complexity of requirement (technical risk)
- Extent of price competition
- Cost/Price analysis
- Urgency of the requirements
- Performance period
- Contractor's responsibility (risk)
- Contractor's accounting system (earned value?)
- Concurrent contracts
- Extent of subcontracting

These factors give a rather comprehensive systems view on the variables influencing choice for a specific type of contract. However, the influence of the negotiation process here is neglected. Naturally the type of contract is dependent on what parties can agree upon, so it is not an one-sided choice.

The way in which these variables precisely influence the choice for a contract form is not discussed by Kerzner (2013). For example, the impact of a high degree of cost and schedule risk on the choice for a contract is not clear. Additionally at least one variable seems to be missing; the time (and therefore cost) required to manage contracts. This variable is relevant as certain contract types require more monitoring and therefore more effort and thus cost than others. This trade-off will influence the choice a main contractor wishes to make. When further analysing these suggested factors it is interesting to see the link with the performance criteria of projects, as discussed in chapter 4. The factors are generally formulated around the criteria of cost, quality, time and scope.

The use of performance incentives in contracts has often been cited as critical success factor for approaches like partnering. However, research also shows that the use of performance incentives in contracts can be problematic and even counterproductive (Bresnen & Marshall, 2000). The problems that may arise are mainly caused by the concept of Moral Hazard, as explained in the previous section. The main lesson to be learned here is that a contract form does not provide a guarantee for a successful project/collaboration. This process needs to be evaluated regularly and adapted when deemed necessary.

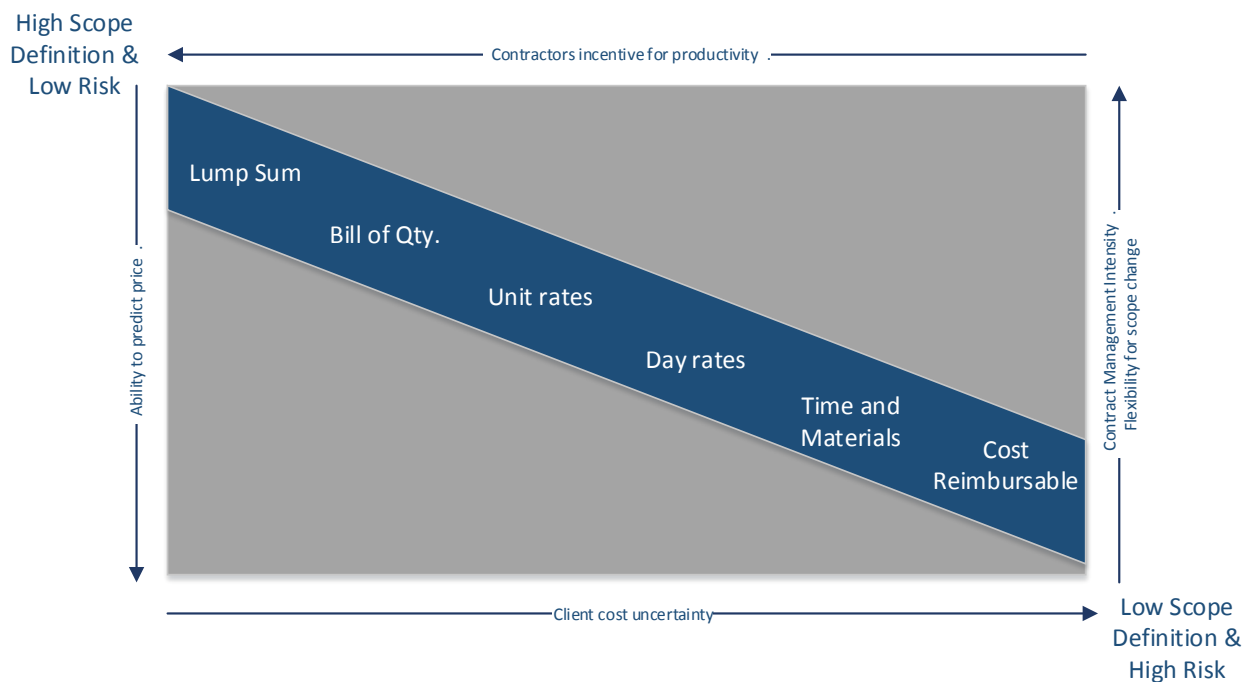


FIGURE 24 REMUNERATION SCHEMES (ADAPTED FROM SHELL PROJECT ACADEMY – ESSENTIALS OF PROJECT DELIVERY)

The Shell Project Academy uses six different remuneration schemes to reward subcontractors in projects, with their choice for a remuneration scheme being dependent on four variables (axes); price prediction capacity, client cost uncertainty, flexibility for scope change and contractors' incentive for productivity. In these four dimensions the performance criteria of cost, scope & risk are clearly present. The different remuneration schemes are presented in figure 24. It is interesting to notice that these remuneration schemes are somewhat traditional; incentive fees or other forms of remuneration that suit with relational contract theory (partnering) and performance-based contracts are not included in this figure. The approach furthermore seems to neglect Moral Hazard challenges and relational aspects in subcontractor management. This could be explained by the power position Shell has in the market, but this is purely speculation, or due to its rich history and therefore entrenched procedures

5.6 Relationship Indicators

Within subcontractor management the relation between a main contractor and subcontractor is assumed to play a large role. This is why the model on subcontractor management includes the relation explicitly. The focus here is on the long term, thereby discussing how a history with a subcontractor affects the choices a main contractor makes, and vice versa. The focus is also on the feedback loop that is included in the model, representing the experiences that both parties take along from the current project into potential new projects in future.

Meng (2012) notes that construction projects often suffer from poor performance creating time delays, cost overruns and quality defects (iron triangle performance indicators). Meng finds few studies that have addressed the influence of the relationship between main contractors and subcontractors on project performance in construction (one of the grounds for this master thesis) (2012). Therefore, the author has performed an extensive questionnaire in the UK construction industry, combined with a series of interviews with industrial experts, in order to explore the specific characteristics of supply chain relationships in construction and to assess how these characteristics impact the project performance (Meng, 2012).

The study uses ten indicators that describe the supply chain relationship, based on common factors in the studies of Chan *et al.* (2004), Hellard (1995), Black *et al.* (2000) and Crane *et al.* (1999); mutual objectives, gain and pain sharing, trust, no-blame culture, joint working, communication, problem solving, risk allocation, performance measurement, continuous improvement.

KEY INDICATOR	DESCRIPTION KEY INDICATOR
MUTUAL OBJECTIVES	The development of mutual objectives ensures that the interests of every party involved will be best served by concentrating on the overall success of the project.
GAIN AND PAIN SHARING	Also known as a risk/reward scheme; an agreement that allows the parties to share profits or cost savings and share losses due to errors or cost increases. Mutual objectives are achieved through gain sharing.
TRUST	To be vulnerable towards another party with the potential for collaboration. Lack of trust is a major barrier for a collaborative relationship.
NO-BLAME CULTURE	Traditionally parties are keener on blaming each other when a problem arises, instead of looking for a solution. The blame culture is equivalent to a risk-adverse culture; in a no-blame culture time is not wasted in trying to allocate blame.
JOINT WORKING	Working together in integrated teams, reflected by; joint decision-making, joint effort for problem solving and joint effort for continuous improvement.
COMMUNICATION	The lack of open communication is identified as a main reason for the failure of construction partnering. Open communication = open exchange of information.
PROBLEM SOLVING	Effectiveness of the problem solving process is an important indicator to describe the relationship between the parties. Solving at lowest possible level.
RISK ALLOCATION	Traditionally risks are passed down the line to the weakest member. Ideally a risk should be anticipated and then assigned to the party who is best able to manage it (shows importance of risk identification).
PERFORMANCE MEASUREMENT	It is important to measure project performance in the agreed areas, at the agreed intervals and to feed back the results to the project team, using benchmarks to review progress and identify opportunities for further improvement.
CONTINUOUS IMPROVEMENT	Without continuous improvement (using results of performance measurement) it is easy for a partnering to drift into a cosy and inefficient way of working.

TABLE 5 KEY INDICATORS INFLUENCING MAIN CONTRACTOR - SUBCONTRACTOR RELATIONSHIP (BASED ON MENG, 2012)

Meng concludes that poor performance is often due to the deterioration of supply chain relationships. The occurrence of time delays can be reduced significantly by encouraging *joint and collaborative working* (2012). Additionally, according to Meng the occurrence of cost overruns can be significantly reduced through *open and effective communication, clear and fair risk allocation, abandonment of the blame culture, regular performance measurement and effective problem solving*; quality defects can

be avoided by establishing an effective solving mechanism (2012). Meng goes as far as stating that poor performance will be reduced by replacing the traditional approach with partnering arrangements, especially strategic partnering. Strategic partnering is partnering that exceeds the project boundaries, so for multiple projects on a longer term (as discussed in section 5.3)

However, he admits that partnering is not a panacea for solving poor project performance (Meng, 2012). Besides, project partnering (i.e. partnering for a single project) will not necessarily lead to better performance as it is bounded to time and therefore to an immature collaborative relationship. It is therefore recommended to adopt long-term strategic partnering. Although not explicitly mentioned, the experiences from previous collaborations thus play a major role in subcontractor management, as it influences indicators like trust, no-blame culture and more.

5.7 Conclusion on subcontractor management

In this chapter subcontractor management is discussed in greater detail. First, subprojects have been segmented into four types: catalogue sub-projects, performance-based sub-projects, exploration-driven sub-projects and blue-sky sub-projects. This segmentation has been made based on whether the goal of the subproject is clearly definable and whether the method to achieve this goal is clear. The segmentation helps in working towards a process design on subcontractor management.

Secondly, different types of subcontractors are presented using an adapted Kraljic model of suppliers (1983). For each of these different types of subcontractor a different sourcing strategy has been suggested, which has led to a combination between the type of subproject and the desired type of subcontractor. This combination determines the input for the process design on subcontractor management in the next chapter.

This chapter furthermore presents the main theories or trends on subcontractor management in large engineering projects according to literature, answering research question 4:

4. What are the main trends in literature on subcontractor management in large engineering projects?

The traditional relationship between main contractor and subcontractor is adversarial, with minimum interaction and risk-averse behaviour. In this relationship the subcontractor does not have a clear incentive to deliver extra quality or better technology, as the performance is guided by strict adherence to the contract.

New trends in subcontractor relationships that are most discussed in literature are partnering, strategic alliancing and integrated project delivery. Although these approaches have some differences, in practise they are often used interchangeably. This is because they all share features such as the early involvement of key parties, transparent financials, shared risk and reward, joint decision-making and a collaborative multi-party agreement. The main lessons learnt from looking into these trends is that the traditional approach towards subcontractor management is challenged by alternative approaches that result in better project performance by putting more emphasis on the relation between the main contract and subcontractor.

This directly relates to the key elements in subcontractor management that are assumed to affect project performance indicators; research question 5:

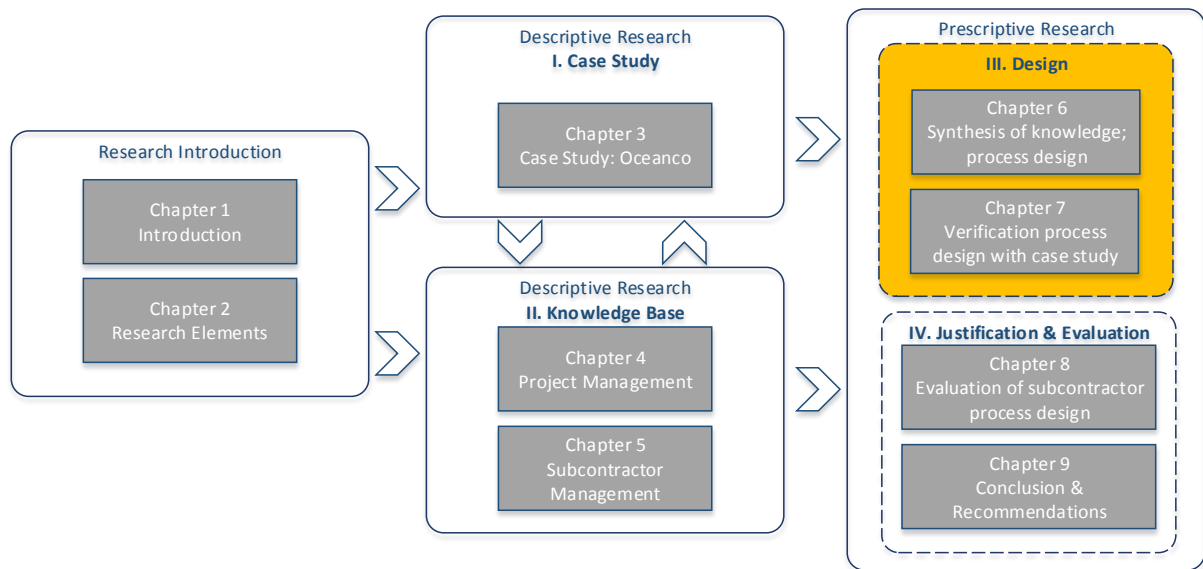
5. Which elements in subcontractor management are assumed to affect the project performance indicators?

Many authors describe the influence that the contract plays in the relationship between the main contractor and the subcontractor, and how this can influence the project performance criteria. The contract type is therefore studied in more detail, as it is assumed to be one of the elements in subcontractor management that influences the project performance indicators. Furthermore the process of negotiation is researched more in-depth.

The literature presents an extensive body of knowledge that discusses different types of contracts and the choice for a contract is brought down to be determined by a certain amount of variables. This neglects the impact strategic behaviour has on the process of negotiation and hence the forming of the contract. Additionally, it still remains unclear how (i.e. what direction etc.) these variables influence the choice for a type of contract: empirical data would be needed to answer this question. This will be covered in the chapters that contrast theory with practice (chapter 7 and 8).

Also assumed to affect project performance indicators is the relation between the main contractor and subcontractor. Section 5.6 presents the key indicators that influence the relationship between the main contractor, and therefore the project performance criteria. A good relationship seems to positively influence the project performance, and thereby as a natural consequent deterioration of the relationship influences the project performance negatively. The key indicators for a good relationship between the main contractor and the subcontractor are mutual objectives, gain and pain sharing, trust, no-blame culture, joint working, communication, problem solving, risk allocation, performance measurement, continuous improvement.

III. Design



With the input from the case study in part I of this research and the theoretical knowledge gained in part II, a process on subcontractor management is designed in this third part of the research. Chapter 6 synthesizes the knowledge gained in the case study and theoretical research into a process design on subcontractor management. This answers research question (6) How can literature on subcontractor management be used to improve the process of subcontractor management at Oceanco? Chapter 7 verifies the process design by means of applying it to the case study of Oceanco. This chapter answers research question (7) How can Oceanco improve their management of subcontractors?

6

Synthesis of knowledge gained; Process Design

This chapter forms the synthesis of the knowledge gained from both the knowledge base and the case study, leading to a process design on subcontractor management. The model on subcontractor management introduced in chapter 3 is used as point of departure for this process design (see figure 25),

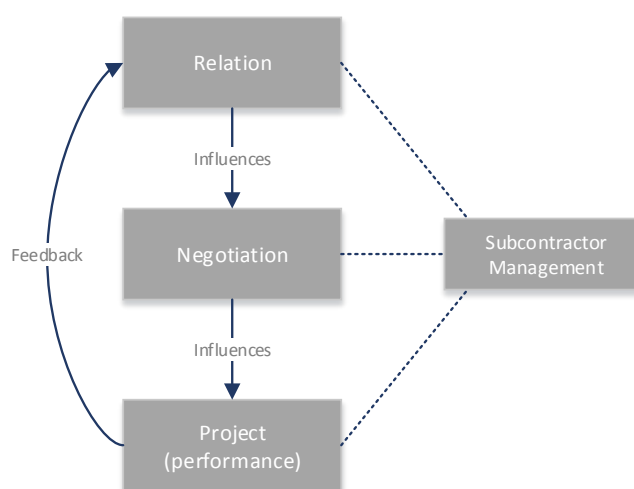


FIGURE 25 MODEL OF SUBCONTRACTOR MANAGEMENT

The first section (6.1) presents the major decision moments in the process of subcontractor management. Section 6.2 provides a more in-depth discussion about the choices in these decision moments on the strategic & relational level of subcontractor management, Section 6.3 covers the negotiation/project level and the operational level is discussed in section 6.4. Section 6.5 brings these decision moments together and presents the process design on subcontractor management, after which section 6.6 concludes the chapter.

When building the process design on subcontractor management in large engineering projects, it is important to reemphasize that, due to the unique character of these projects, this design is not meant as (and cannot possibly provide) a plug and play solution that will work in each situation. The process design is merely meant to challenge current views on subcontractor management and provide guidance in establishing desired subcontractor relationships.

6.1 Decision moments in subcontractor management

Projects can be seen as a planned set of interrelated tasks to be executed over a certain period of time. The management of subcontractors can therefore also be placed on a timeline, as a process with certain decision moments. Reconsidering the project life cycle by Turner (2008) presented in chapter 4, this can be seen as a rough timeline for these decision moments. This segmentation helps in understanding how subcontractor management can be steered. Naturally, this process will not be as linear or clearly identifiable in practise.

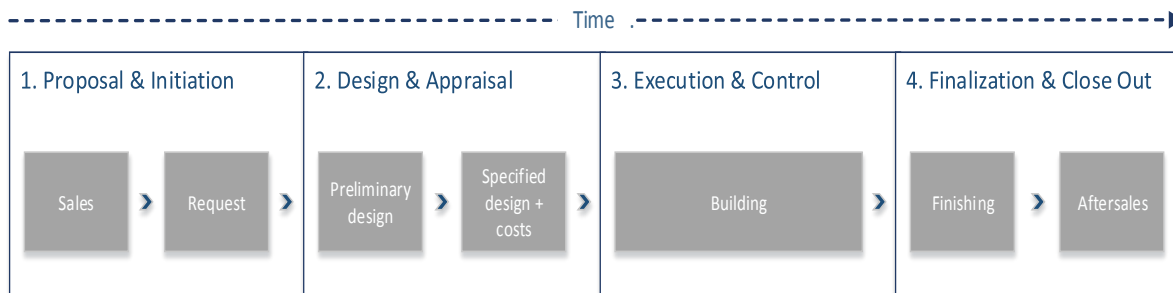


FIGURE 26 PROJECT LIFE CYCLE AS TIMELINE (ADAPTED FROM TURNER 2008)

Identifying the decision moments in subcontractor management helps in understanding and improving these processes. Eriksson & Westerberg (2011) present seven buying stages in their framework on cooperative procurement procedures, as follows;

Stage I	Design: the level of integration between client and contractor in the design stage
Stage II	Tendering: the number of contractors (invited) in a tendering process
Stage III	Bid evaluation: focus on soft/hard parameters
Stage IV	Subcontractor selection: the extent to which the client is involved in subcontractor selection
Stage V	Payment: with or without incentives
Stage VI	Collaborative tools: usage of collaborative tools
Stage VII	Performance evaluation: based on contractors' self-control or by client

These buying stages provide a good basis in defining the major decision moments to be taken in subcontractor management (Eriksson & Westerberg, 2011). However, they do need some adaptation based upon the literature review conducted in the previous chapter before they can be used in the process design. Three reasons justify this claim.

Firstly, a limitation in Eriksson & Westerberg's theory is that it only considers the procurement stages of one project. In reality, the process of subcontractor management does not only entail the project level, but also portfolio (relation) level (2011). This overarching stage should be present in the process design; we call this stage portfolio management. Within this stage a (strategic) decision has to be made whether a long-term agreement is made with the respective subcontractor. The main contractor can decide whether to engage in a framework agreement with a subcontractor (and vice versa) for a longer period of time.

Secondly, the framing of Eriksson & Westerberg (2011)'s stage I 'Design' is too general to define the level of integration between the main contractor and the subcontractor, as the design stage encompasses many interactions and decision moments. The decision on the desired level of integration can be made both before and after the initial or specified design is made, depending on the type of subproject and subcontractor. Regarding the effort to define the decision moments in subcontractor management we have therefore chosen to rephrase this stage into 'when to involve subcontractor'.

Furthermore, stage IV subcontractor selection is assumed to be indirectly included in the decision stage on the bid evaluation. For the process design on subcontractor management this stage is therefore considered to be redundant and removed from the list of decision moments. The list of decision moments in the process of subcontractor management is shown in the following figure.



FIGURE 27 DECISION MOMENTS IN SUBCONTRACTOR MANAGEMENT

Before a more in-depth discussion about the possible choices regarding these stages can be undertaken, it is interesting to look at the sequence in which the decisions are taken and the organisational level at which these are being made. Although the described decision moments seem to follow each other linearly, in practise this is not always the case. Furthermore, literature does not explicitly distinguish subcontractor management in different levels; in project management it is common to distinguish between levels of planning (see for example figure 28). There is also a distinction in levels of subcontractor management that can, and should be made. For example, the decision on whether to engage in a collaboration with a subcontractor using a framework agreement is considered to be a decision beyond the project boundaries, and rather considers the relation between the main contractor and the subcontractor. The distinction of levels is also shown in the model of subcontractor management.

We therefore make use of the levels in the model on subcontractor management to group the decision moments according to the levels on which they interact. The decision of whether or not to engage in a framework agreement is made on a strategic level; the level of portfolio management and relations. The decision stages II-V consider choices made at a project level of negotiation. Finally, the decisions on collaborative tools and performance evaluation are assumed to be heavily influenced by day-to-day operations and therefore take place at the operational level. This is the level of the feedback loop in the model. As a result the distinction is made between three levels of subcontractor management in the process design;

- Strategic & relational level; stage I. framework agreement
- Project & negotiation level: stage II. When to involve subcontractor; III. Which type of tendering; IV. Bid evaluation; V. type of payment
- Performance & operational level: stage VI. Which collaborative tools to use; VII. How is the performance evaluated

The subsequent paragraphs will provide a more in-depth analysis on the choices possible in the process of subcontractor management at these three levels. First, the input variables for the process design are discussed.

6.2 Input variables for the process design

Decision are always based upon information that is given to the decision maker: the input. This is equally applicable to the case of subcontractor management decisions. Three variables have been identified as input variables for the process design. First, the type of subproject, second the type of subcontractor, and third the relation between the main contractor and subcontractor, if any.

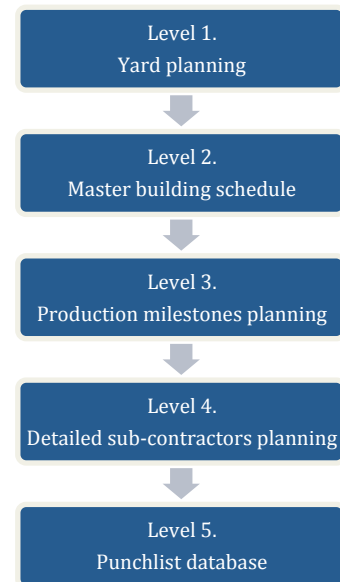


FIGURE 28 OCEANCO LEVELS OF PLANNING, ADAPTED FROM DE LOOFF, 2011

6.2.1 THE TYPE OF SUBPROJECT

The type of subproject is considered to be one of the key input variables for decision-making in subcontractor management, as it determines the complexity of the product/service to be outsourced. In chapter 5 of the knowledge base four types of subprojects have been identified: catalogue, performance-based, exploration-driven and blue-sky subprojects (see figure 29).

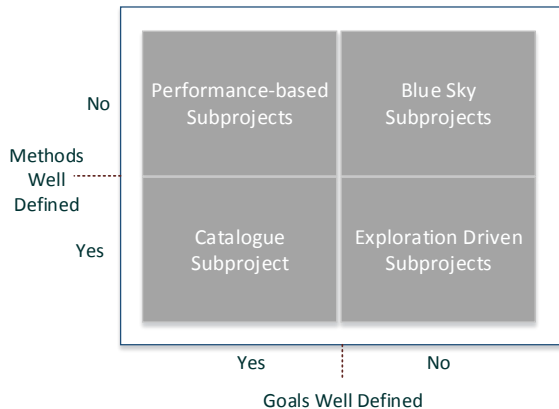


FIGURE 29 TYPE OF SUBPROJECT; INPUT VARIABLE

These types of subprojects are based upon the ability of the main contractor to define the goal of the subproject and define the method to achieve this goal. Not being able to define the goal and/or method of the subproject is associated with a higher risk, because the level of uncertainty for the main contractor rises. Therefore, the main contractor has to rely more on its subcontractor, which is specialised in the respective subproject. Figure 29 shows the type of subprojects, as they were shown in figure 21 of chapter 5. The complexity of the subproject is as a result inherently related to the stage the main contractor wishes to involve the subcontractor. Quite naturally, when the main contractor cannot define the method and/or goal, early involvement in the definition stage of the subproject is desirable.

6.2.2 THE TYPE OF SUBCONTRACTOR

The type of subcontractor is dependent upon the supply market characteristics and is related to the importance of the respective subproject. A highly complex supply market means that there are only a few subcontractors available to execute the subproject, and that subcontractor’s unique expertise grants them a certain power positions that limits the leverage position of the main contractor.

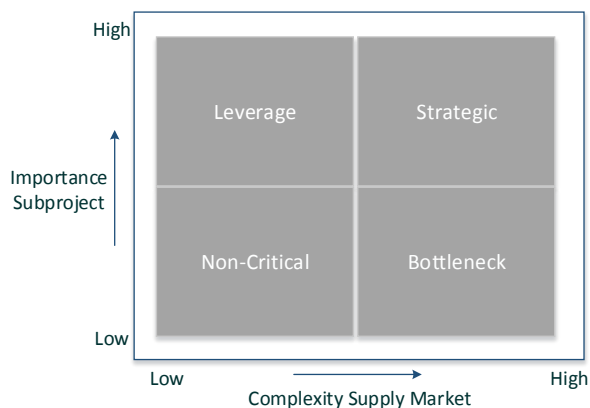


FIGURE 30 TYPE OF SUBCONTRACTOR; INPUT VARIABLE

The importance of the subproject determines whether the main contractor is actually invested in the subproject. Important subprojects therefore require more time and effort from the main contractor. The four types of subcontractors identified in chapter 5 are shown in figure 30 and are used as input variables for the process design: non-critical, bottleneck, leverage and strategic subcontractors.

6.2.3 THE RELATION BETWEEN MAIN CONTRACTOR AND SUBCONTRACTOR

The relation is argued to be of great importance in subcontractor management. Therefore, the relation is the third input variable influencing the subcontractor management approach to be taken. Meng (2012) has researched the influence of key indicators on project performance (see section 5.6), and these indicators are used to assess the relation input in the process design. The indicators are mutual objectives, gain and pain sharing, trust, no-blame culture, joint working, communication, problem solving, risk allocation, performance measurement, continuous improvement.

The relation is used as input for the decision when to involve the subcontractor and subsequently the type of tendering, bid evaluation and payment scheme. The feedback loop in the process design ensures that improvements or other changes in the relation are taken into account in future projects.

6.3 Subcontractor management decisions on a strategic & relational level

Subcontractor management on large engineering projects is a continuous effort for the main contractor. The interaction with subcontractors often exceeds the project boundaries as the main contractor uses the same subcontractor for multiple projects, which was observed during the case study at Oceanco. The process of subcontractor management therefore does not really have a specific beginning or end. This means that an advice on the management of subcontractors should account for the previous interactions that have taken place, as well as possible future interactions, between the main contractor and subcontractor. Subcontractor management is, after all, based on human interaction. Regardless of the strategic decision made at the portfolio level to engage in a framework agreement, previous interactions – the relation – will have an impact on the decisions made in the entire process. The relation with a subcontractor should therefore be considered as an important input the process design.

On the strategic level of portfolio management the planning of the entire company is made. On this level the master building schedule per project is also constructed. The portfolio planning encompasses multiple projects, so decisions here can influence the decisions to be made on the project level. The decision or choice to engage in a framework agreement with a subcontractor is made on this level. This choice can be made before a project has started and can last longer than the timeline of a project.

A framework agreement is normally used if a certain repetition of type of work takes place in the project portfolio of the main contractor, and the main contractor has (relational) reasons to hire this subcontractor repeatedly. For the main contractor there are multiple reasons to engage in a framework agreement with a subcontractor. First of all, it limits the costs that are involved with a tendering trajectory, as the subcontractor is hired for a longer period of time than just one project. Secondly, it enables economies of scale, as certain components in projects will be similar in many projects. Third, and probably most important, it allows the main contractor to collaborate on better terms with the subcontractor, as the subcontractor is ensured continuity over a longer period of time. This creates trust and gives the subcontractor more room to offer flexibility. The main contractor has more leverage in the framework agreement (as a larger contract is created), it is therefore likely to strike better project agreements with the subcontractor.

Literature does not provide a clear model to follow for the content of a framework agreement. This is not surprising, as framework agreements are to be formulated and agreed upon by both the main contractor and subcontractor(s). The parties are thus entirely free to choose how to design this agreement, but mutual agreement is required. This entails that there is no one-size-fits-all solution.

Nevertheless, the guiding principles of Van der Veen & Korthals Altes (2011) presented in section 5.5 seem useful in drafting a framework agreement: (1) focus on relations, (2) focus on the interest of the project, (3) specify functions of the agreement, (4) specify goals of the agreement and (5) plan for flexibility. These guiding principles are based upon the results of their research into four international large construction projects and account for the ten contract norms defined by Macneil (1980). Furthermore, the guiding principles fit well with the thought behind partnering or alliancing collaborations, as they focus on the relation between the actors. This is considered to be essential when engaging in a framework agreement.



FIGURE 31 FRAMEWORK AGREEMENT OPTIONS

A general distinction is made between three types of framework agreements (see figure 31). The types of framework agreements have their own characteristics and therefore unique advantages and disadvantages. The first type is a framework agreement that grants all of the projects that the main contractor receives which are related to the speciality of the subcontractor for a fixed period of time. The advantage is that this type of collaboration allows for full integration between the main contractor and the subcontractor in their way of working in these projects. A disadvantage may be that the subcontractor becomes lazy because they are ensured of getting assignments, regardless of their performance. Another disadvantage is the inflexibility that is inherent to such long-term agreement.

The second type of framework agreement holds for a certain number of specific projects. By knowing which projects the subcontractor will get in advance, the subcontractor will be able to make better preparations, likely to result in better project performance. The disadvantage is that possible additional projects have to be re-negotiated.

The third type of framework agreement holds for a specific amount of projects, for example at least 3 assignments in 5 years, or a minimum amount of hours the subcontractor will be hired. This ensures continuity for the subcontractor, but it is unclear what the exact scope of the work will be. Although this allows the main contractor to be flexible in cooperating with the subcontractor, it limits the potential for economies of scale because the subcontractor does not know what is expected of him.

6.4 Subcontractor management decisions on project & negotiation level

On a project level the process of subcontractor management entails multiple decision moments. The first decision that needs to be made is when to involve a subcontractor (section 6.4.1). Subsequently, the main contractor should decide upon the type of tendering (subsection 6.4.2), the bid evaluation (subsection 6.4.3) and the type of payment (subsection 6.4.4).

6.4.1 WHEN TO INVOLVE SUBCONTRACTOR

As the project life cycle of Turner (2008) and the project scheme of Oceanco show (section 3.4), every project, no matter how unique, has similar processes in development. When to involve the subcontractor is a very relevant, yet very delicate question, because it depends on a multitude of factors. The decision is influenced by the type of subproject, the type of subcontractor and the relation with subcontractor (as explained in section 6.2). Previous interactions with a subcontractor play a major role here, since a main contractor in the private market is not bound to procurement rules (further discussed in section 6.4.2). This decision is also based on what the main contractor wants the subcontractor to do; the type of subproject. Approaches such as partnering and alliancing promote the early involvement of subcontractors, because it generally improves the project performance (see chapter 5). However, it is questionable whether this early involvement is desired in every situation, considering every subproject.

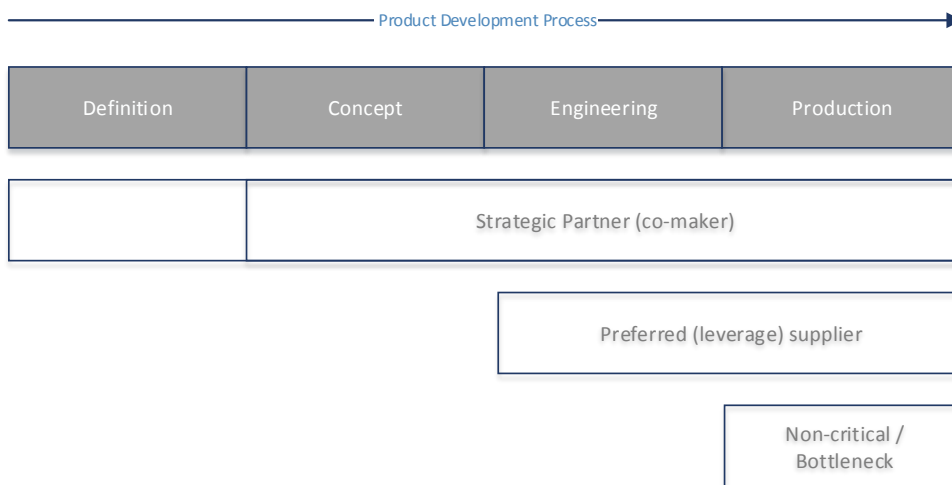


FIGURE 32 STAGES IN WHICH SUBCONTRACTOR CAN BE INVOLVED

For catalogue sub-projects the answer to the question of when to involve the subcontractor is most straightforward. Because the goal and the method of the respective subproject are easy to define for the main contractor, the input/expertise of the subcontractor is not necessary in the early stages of design (non-critical). The type of subcontractor can be non-critical or bottleneck, dependent on the supply market characteristics. In both cases the subcontractor is likely to be involved after the specified design has been made because the main contractor has this knowledge in-house. This enables competitive (open) tendering. Naturally the choice can still be made to involve the subcontractor earlier on in the process, for example if the working capacity of the main contractor for this purpose is limited. Also, the relation between a main contractor and subcontractor can influence this decision.

Performance-based subprojects have a clear goal, but are characterized by a certain degree of complexity which makes it difficult for the main contractor to define the method. For this type of subprojects it may be advantageous for the main contractor to involve the subcontractor earlier to use its knowledge. This can be done after the concept (rough spec) has been made, or even earlier after the definition of the subproject, depending on the capacity/focus of the main contractor and the expertise of, and relation with, the subcontractor. According to the importance of this respective subproject and the supply market characteristics the main contractor should either look for a

leverage or strategic partner as a subcontractor. The relation with the subcontractor also plays an important role here: if the key relational indicators are present, the main contractor is more likely to involve the subcontractor earlier, in order to transfer more risk and responsibility towards the subcontractor.



FIGURE 33 OPTIONS WHEN TO INVOLVE SUBCONTRACTOR

Exploration-driven subprojects are rather unique in the construction industry, as they are characterized by lack of a clear goal, but have a clear method. This type of subproject is common in the ICT sector, where the product (program) can easily be made iteratively, but in construction this proves to be more complicated. If such a subproject is outsourced, the main contractor may want to involve the subcontractor as early as possible (partner/co-maker) in order to avoid extra work. The relation with the subcontractor here is important, as the subcontractor has to guide the main contractor in defining the goal of the subproject.

Blue-Sky subprojects do not have a clear goal and lack a definable method. These subprojects are most challenging, as they are characterized by many uncertainties. It is questionable whether subcontracting can be done with these subprojects or not, as it is basically outsourcing Research & Development. If it is possible, the main contractor should use all of the knowledge the subcontractor has to offer. Therefore the main contractor is advised to involve the subcontractor as early in the process as possible (partner/co-maker) in order to enable the sharing of risks, which is desirable in subprojects with so many uncertainties. The subcontractor should be considered as a partner, as the uncertainties require trust, mutual objectives and other key relation indicators present between the parties.

6.4.2 TYPE OF TENDERING

The type of tendering the main contractor uses is influenced by the type of subproject that is outsourced, the type of subcontractor and relation with the subcontractor, but is mainly driven by the decision the main contractor takes on the moment to involve the subcontractor. We distinguish three options in the type of tendering that can be used when outsourcing a subproject (see figure 34): Open/Closed, Global/Local and Selected. These options are not mutually exclusive, but can be combined.

The first decision that has to be taken by the main contractor is whether the tendering procedure will be open or closed. Open tendering is applicable to any party that is interested and fulfils the criteria set by the main contractor. Closed tendering is based upon invitation by the main contractor. Open tendering for public works above a certain threshold is obliged in the European Union, but our focus is mainly on large engineering projects built in the private sector so this does not have to be taken into account. The advantage of open tendering is that new parties that were not yet known by the main contractor can present themselves and therefore make tendering more competitive. Closed tendering generally takes less time and thus less costs. Using closed tendering the main contractor is pretty sure that all the tenders they receive are serious, because they have already pre-selected the companies.

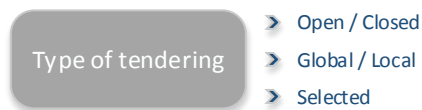


FIGURE 34 OPTIONS FOR TYPE OF TENDERING

The second decision considering the type of tendering is the market in which the main contractor wants to tender: global or local. This choice also depends on some trade-offs. Global tendering has the advantage to potentially get more suitable subcontractors, which allows for a better selection. However, global tendering is also time-consuming and can be undesirable due to cultural or linguistic barriers that make the execution of the subproject more difficult. Local tendering is relatively less time-consuming, but can result in a limited number of available and capable subcontractors, which can in turn influence the power position of the main contractor in the negotiations.

Selected tendering can be used if the main contractor already has a subcontractor in mind to perform the work. This is mainly done when this involves strategic partners, with which the main contract can already be engaged in a framework agreement, or when the subproject is so complex or unique that it is bound to be outsourced at a certain subcontractors, simply because there are no other subcontractors available to perform this task.

6.4.3 BID EVALUATION

The subsequent decision-moment after the type of tendering has been chosen is the bid evaluation. The evaluation criteria are used to select the subcontractor that can best perform the task. The evaluation criterion that is most often used to evaluate the bids is cost. However, as illustrated in chapter 4 of the knowledge base, selecting purely on price might entice parties to lower their bids in order to win the tender, relying on subsequent claims to recover their costs (O'Conner, 2009). Again, this is dependent on the type of subproject that is being outsourced, as relatively simple 'catalogue' sub-projects might be perfectly suitable for a tender evaluation purely based on price.

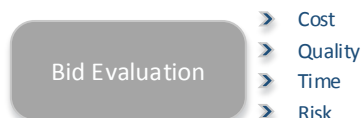


FIGURE 35 BID EVALUATION CRITERIA

The project performance criteria that are used by the main contractor to evaluate project success can also be used to assess the sub-projects and their bid evaluation. As discussed in chapter 4 of the knowledge base, the Iron Triangle of cost, quality and time is most well-known for this purpose. However, these criteria are considered to not fully cover the interest of the main contractor, as client satisfaction for example is only partly covered by the criterion of quality. Kerzner's competing constraints model of project performance (section 4.4.2) has taught that risk is at the centre of project management (Kerzner, 2013). For example, according to the Dutch legislation of 'Wet Keten Aansprakelijkheid', the main contractor carries responsibility for the way the subcontractor performs its work. Risk is therefore considered to be essential in evaluating tender offers of subcontractors.

6.4.4 TYPE OF PAYMENT / CONTRACT

The type of payment is directly related to the contract form that the main contractor uses for the subproject. The formulation of the contract, which includes the payment scheme, is negotiable and needs mutual agreement, and can therefore not solely be determined by the main contractor. However, it is interesting to consider the possibilities for these payment structures from the main

contractor's point of view, as to give insight in the possible strategies and their probable consequences for each type of subproject. These different payment schemes are discussed in section 5.5.2: fixed price (+incentive fee), cost + fixed fee or incentive fee, guaranteed maximum & share savings and reimbursable.



FIGURE 36 TYPE OF PAYMENT / CONTRACT

As previously mentioned, the content of the contract is dependent on the consensus of both the main contractor and the subcontractor, where these parties are likely to have different interests and values. In the formulation of the contract it therefore seems beneficial to use the five guiding principles by van der Veen & Korthals Altes (2011) (explained in section 5.5.2). The five guiding principles are (1) focus on relations, (2) focus on the interest of the project, (3) specify functions of the agreement, (4) specify goals of the agreement and (5) plan for flexibility.

6.5 Subcontractor management decisions on operational & performance level

Subcontractor management on an operational level considers the day-to-day management of the subcontractors and the evaluation of their performance. Although the choices considering collaborative tools and performance evaluation are usually already made on a higher level of subcontractor management, the decision moments are included in the level where they take effect, which is likely to be the operational level. First, collaborative tools are discussed (section 6.5.1), after which the performance evaluation model is presented (section 6.5.2).

6.5.1 COLLABORATIVE TOOLS

Collaborative tools are used to enhance and guide the collaboration between the main contractor and the subcontractor during the project. Generally, these tools are developed because there was a problem or challenge that needed to be solved. Collaborative tools are therefore seen as a result of an empirical research into a problem, where they function as the solution. These tools are designed to adequately deal with obstacles in and around project/subcontractor management. Every tool has its scope; it targets a specific obstacle, or tries to tackle multiple of these.

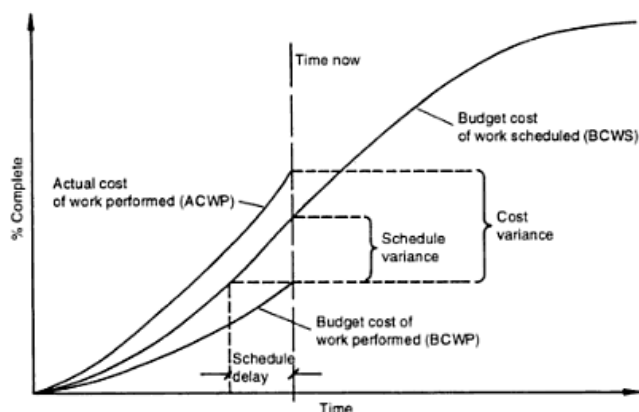
There are plenty of software tools available to enhance collaboration, monitor project development, asses risks etc. Only two collaborative tools are presented in this subsection to give an idea of the diversity of the available tools: one found in literature (Primavera) and one found at Oceanco (Punch list). Within the decision moment of collaborative tools the most important question to be asked is which obstacle(s) should be addressed. Here, the performance evaluation process can be of use (see next subsection), but it is better to think about this in advance. Furthermore, the importance of empirical knowledge is underlined throughout this thesis. Therefore, in chapter 8, where the process design is confronted to project managers from other industries, input on collaborative tools is requested.



FIGURE 37 COLLABORATIVE TOOLS

Primavera

Primavera is a project planning software tool designed to give more control to project managers on the progress of their project through Earned Value Analysis. The use of this method requires the subcontractor to register all hours and material costs that were made. The use of the method of Earned Value Analysis is a typical systems approach to projects, as it breaks the complexity of such a project into measurable components. However, it does have influence on the relationship between the main contractor and the subcontractor, because this method seems to be a response to the problem that subcontractors are not always transparent about their progress. For subcontractors that are partner or co-maker of a main contractor (see previous section), such an approach can harm the trust relationship and collaboration between the parties. Besides, such measurements give an indication about the progress of the project, but do not always represent the actual status of the project since it is only based on cost & time, and not quality for example.



Element	Item	Acronym
Work planned	Budgeted cost for work scheduled	BCWS
Work accomplished/ earned value	Budgeted cost for work performed	BCWP
Cost of work accomplished	Actual cost of work performed	ACWP
Work authorized	Budgeted cost at completion	BAC
Estimate of final cost	Estimated cost at completion	EAC
Cost variance	Cost variance (BCWP minus ACWP)	CV
Schedule variance	Schedule variance (BCWP minus BCWS)	SV
At-completion variance	At-completion variance (BAC minus EAC)	ACV

FIGURE 38 EARNED VALUE ANALYSIS (MORRIS, 1994)

Punch List

A Punch list is a relatively easy tool to implement in subcontractor management. This list is used by the main contractor to communicate the milestones and activities that need to be performed by the subcontractors before payment takes place. The subcontractors have access to this list to keep the list up-to-date by communicating whether the task is completed. This streamlines the process of quality control and gives the main contractor insight in the development of the project.

6.5.2 PERFORMANCE EVALUATION

The last stage is not really a ‘decision moment’ per se, but is given special attention because the presence of an iterative improvement process is considered to be of vital importance for subcontractor management on the long term (exceeding project boundaries). This feedback loop is also present in the model on subcontractor management presented earlier this thesis. The feedback loop should ensure that the process of subcontractor management is subject to continuous improvement at all levels of the organisation.

The so-called Shewhart or Deming Circle allows for an iterative improvement process to subcontractor management. The Deming Circle consists of four steps: Plan, Do, Check and Act. The first step is to establish objectives and output expectations, based on an analysis of the current situation (the collaboration between main contractor and subcontractor) and subsequently design a plan or process to improve the collaboration. The second step is Do; it consists of implementing the plan/process in a controlled environment. The implementation should be measured using different criteria. The third step is Check; it requires the study of the results of the improvement plan or process by comparing them to the original situation. Additionally, completeness of the plan/process can be assessed. In the last stage the plan/process is adjusted according to the findings in this assessment and implemented on a larger scale or longer term. This improvement cycle is to be used continuously.



FIGURE 39 PERFORMANCE EVALUATION (BASED ON DEMING CIRCLE)

Performance evaluation does not necessarily have to be such a formal procedure. The Deming Circle presents one way of how iterative improvement could be formalised into practise, but this is not the only way. However, formalizing the process of evaluation is assumed to help improving subcontractor management, as it enables continuous improvement on all levels; so during the project, but also lessons learnt for future projects. How obvious the process in the Deming circle might seem, often this process is not strictly followed and this can lead to suboptimal practises in which efforts are being wasted.



6.6 Bringing decisions together; process design

The aim of this chapter is to design a process for subcontractor management, based on the knowledge gained from the case study and the knowledge base. In the process of working towards a subcontractor management process design, the earlier discussed decision moments are brought together. The identified levels (strategic & relational, project & negotiation and operational & performance) are used to structure these decision moments in the process. The type of subproject and type of subcontractor are considered as inputs for the model, as well as the possible relation that

the main contractor already conspires with a subcontractor based on previous interaction. The process of subcontractor management is furthermore guided by the master building schedule of the project. Elucidation of the designed process is given per subcontractor management level (figure 40).

Strategic & Relational Level

On the strategic and relational level of subcontractor management the management of the companies' portfolio takes place. Portfolio management entails the selection of projects and the general planning for all projects, accounting for the available resources within the firm. Considering the management of subcontractors, the decision here can be made to engage in a long-term agreement with a subcontractor: a framework agreement. Such a framework agreement holds for a term that transcends a project life cycle. The relation with a subcontractor is therefore considered to be a vital input in this decision. The relation with a subcontractor is naturally quite capricious, but with this concept has been made more tangible through the key relation indicators set by Meng (2012), and presented in section 5.6. The key relation indicators can furthermore be used to assess the collaboration between the main contractor and the subcontractor during and after the project has ended.

The decision for a framework agreement can already be made during previous projects (on a portfolio level), which means the project management team has to work with this agreement, or it can be made based upon feedback delivered by the manager on project level, hence the feedback loop. The guiding principles of Relational Contract Theory are applied in the formulation of a framework agreement (Veen & Korthals Altes, 2011).

Project Level

The subcontractor management process on project level starts with the input of the master building schedule, with which the type of subproject can be defined (see section 6.3). The decomposition of the project into subprojects (in the master building schedule) is very important in the project life cycle, however due to the focus of our research on subcontractor management this input is taken as given. The decision of whether to outsource the subproject also falls outside the scope of this framework, as the focus lies on the question of how subcontractor management takes place, which implies that the choice for outsourcing has already been made. The type of subproject to be outsourced and the type of subcontractor are connected with each other, because the type of subproject relates to the type of subcontractor.

Naturally the choice for the type of subcontractor is constrained by the actual availability of subcontractors, which is represented by the axis of the supply market complexity in the model that segments subcontract types presented earlier. The type of subproject, combined with the type of subcontractor, determines the choice of when to involve the subcontractor, because the type of subproject determines what the main contractor exactly wants from the subcontractor and the type of subcontractor influences the type of collaboration.

For instance: in an outsourced part of a part of a project defined as a 'catalogue' subproject, the type of subcontractor is likely to be 'non-critical' as there will be multiple subcontractors available to perform this part of the project. This means that both the method and the goal are clearly defined, therefore the main contractor would not need to use knowledge from the subcontractor for the completion of the given task. The question of when to involve the subcontractor then becomes straightforward; either after the specified design has been made by the main contractor, or already during the engineering stage, dependent on the availability of resources of the main contractor and the relation with the subcontractor

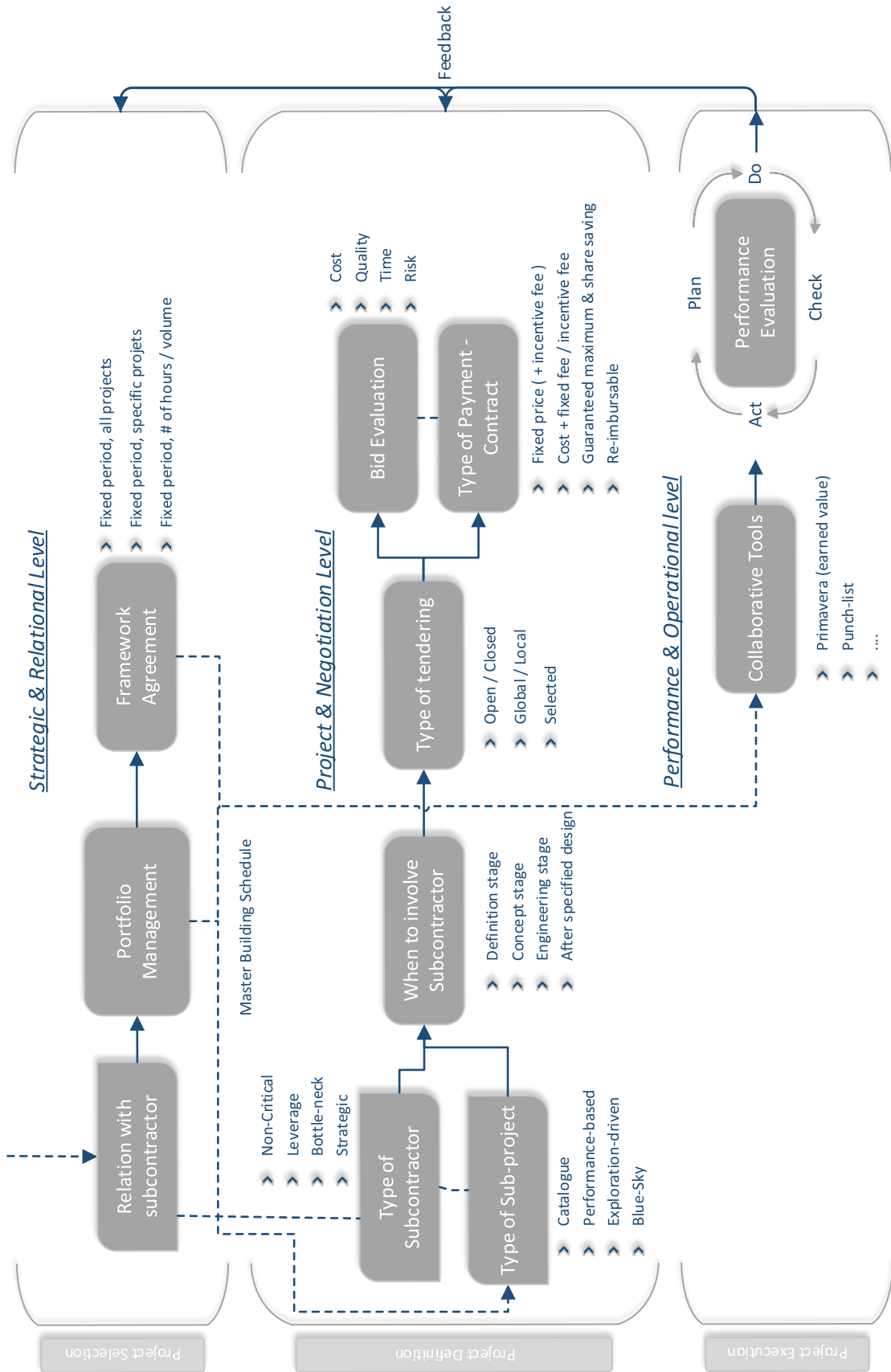


FIGURE 40 PROCESS DESIGN OF SUBCONTRACTOR MANAGEMENT

The stage in which the subcontractor is to be involved influences the choice for type of tendering to be used. To illustrate: if we take the same subproject as previously described, it is likely that there are many available subcontractors to perform this task. The type of tendering could therefore be open and global; open tendering gives the main contractor the chance to discover new subcontractors and global is in this case also possible because only few interactions with the subcontractor are needed with outsourcing after the specified design (as the action mainly involves manufacturing).

The evaluation of the bid can in this case be done mainly on cost, as the quality of the executed catalogue subproject is assumed to be relatively indifferent between subcontractors. However, the quality should be monitored, so this criterion might be taken into account as well. The type of payment for such a relatively easy subproject can be done in a lump sum, because the main contractor is capable of overseeing all risks associated with the subproject. The process design shows the interrelatedness of the decision moments and visualizes the choices that can be made per decision moment. The relation, master building schedule and type of subproject and subcontractor are used as the input of the project level process of subcontractor management.

Operational Level

The choices made on collaborative tools on a strategic level influence the day-to-day operations of the (sub-)project. Although the decisions for collaborative tools are assumed to be made on a higher process level, the input for this decision should come from the operational level. This also explains the performance evaluation stage at this process level; the input for evaluation should be given here to enable improvement of the processes in the entire business model of the company. Additionally the performance of the subcontractor should be evaluated in order to determine how this could be further improved during the project. Furthermore this evaluation model provides input for a list of preferred suppliers and potentially a 'black-list' of suppliers that for example have not met the quality standards and are not willing to improve their way of working. The feedback loop back to the project and strategic level is considered to be vital for improvement of the subcontractor management processes, and therefore the project performance in general.

6.7 Conclusion on the process design

Analysing the challenges of subcontractor management at Oceanco a model on subcontractor management has been constructed in chapter 3. This has subsequently steered the search for academic literature in the knowledge base of chapter 4 and 5. This chapter forms the synthesis of the knowledge gained on subcontractor management. A process design of subcontractor management has been developed, to enable improvement of the subcontractor management approach at Oceanco. This chapter therefore answers research question 6:

6. How can the literature on subcontractor management be used to improve the process of subcontractor management at Oceanco?

The literature on subcontractor management is used to construct a process design. The process of subcontractor management has been described in this chapter as a set of interrelated decision moments. It has proven to be difficult to put these decision moments on a timeline. The decision moments and their order are adapted from Eriksson & Westerberg's (2011) buying stages, in their framework on cooperative procurement procedures. The decision moments provide structure and insight in the capricious process of subcontractor management. The model of subcontractor management was used to distinguish three levels in the process of subcontractor management: strategic & relational level, project & negotiation level and operational & performance level. Each decision moment was subsequently related to a specific level.

Within each decision moment the main contractor has several choices. These choices are driven by their respective input. The first decision on the strategic & portfolio level is driven by the previous interactions with a subcontractor. The decision on the project & negotiation level when to involve a subcontractor is driven by the relation, but also by the type of project and the type of subcontractor. The choice for type of tendering, bid evaluation and type of payment is driven by prior decisions, which shows the interdependency of these stages. On the operational & performance level of the process the choice for collaborative tools is driven by the master building schedule, constructed on the strategic level of subcontractor management. The performance evaluation was found to be an iterative process in itself (Deming Circle), as opposed to a clear choice.

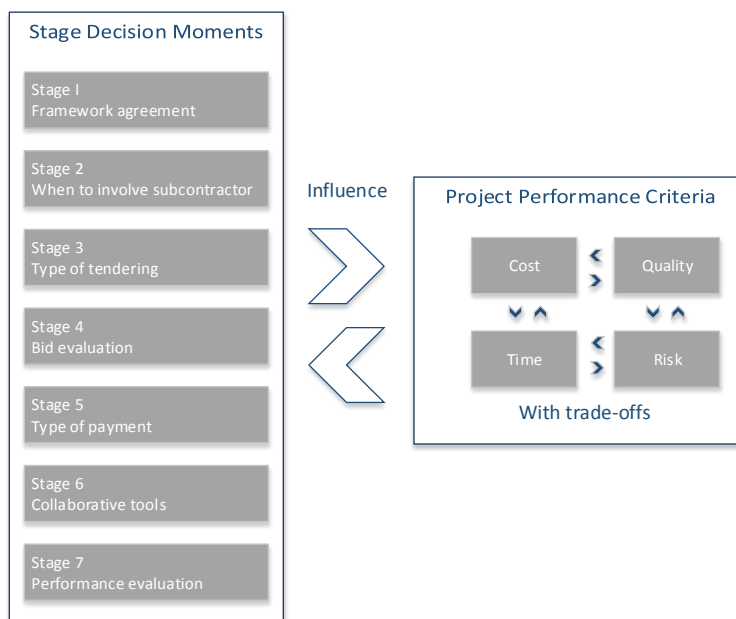


FIGURE 41 RELATION BETWEEN DECISION MOMENTS AND PROJECT PERFORMANCE CRITERIA

The decision moments in the process of subcontractor management influence the project performance of the project, as was already suggested by the model presented in chapter 3; the negotiation level influences the project performance level. Figure 41 shows this interaction between the decisions made in the subcontractor management process and the project performance criteria. The notion of trade-offs in the project performance criteria has been made because the relative importance of a project performance criterion may change during the project. The focus may for example shift from purely on cost towards time and quality.

The interaction between the decision moments and the project performance criteria also reveals a relationship that is not directly visible in the process design: the influence of the determined project performance criteria on the decision moments. For example, if the focus of performance in a project is entirely centred on time, the choice for the type of tendering may be predetermined as selected tendering because this would save time, even if this means the costs would increase considerably.

The next chapter applies the process design of subcontractor management on the case study of Oceanco. Applying the process design allows for evaluation on the applicability and validity for the single case study. The potential of this process design for other main contractors managing large engineering projects will be investigated in part IV of this thesis: the justification & evaluation.

7

Applying the process design for Oceanco

In this chapter the validity of the process design introduced in chapter 6 is investigated using the case study of Oceanco. Oceanco works with several subcontractors to build their yachts (see case study chapter 3 and appendix III). Each subcontractor is responsible for a specific subproject, which in turn has its own specifications and complexities. Oceanco uses three different types of subcontractors: co-makers, preferred suppliers and non-critical suppliers. To see how the process design can help with the subcontractor approach for different subprojects, one of each type of subproject is selected. This selection is based upon an interview with [REDACTED] and is elaborated upon in the respective section¹⁰.

Section 7.1 discusses the current subcontractor management approach of co-maker [REDACTED], [REDACTED], and the recommended approach using the process design presented in previous chapter. Section 7.2 and 7.3 are structured the same way and respectively discuss the preferred suppliers of the interior and the non-critical suppliers responsible for the glass.

During the case study the challenge of implementing new procedures at Oceanco came to light. It was argued that the proposed design should account for the organisational characteristics at Oceanco and be adapted to this context to ensure the design would be effective in the organisation. Therefore, a workshop has been organised in which an adapted process design was presented to several project managers and other executives at Oceanco. The setup and conclusions of this workshop are presented in section 7.4. Section 7.5 evaluates the validation of the process design with the workshop and the three 'scenario' studies.

7.1 Process design for the co-maker [REDACTED]

[REDACTED]

7.1.1 CURRENT APPROACH [REDACTED]

[REDACTED]

¹⁰ Interview confidential

[REDACTED]

[REDACTED]

[REDACTED]

7.1.2 PROCESS DESIGN [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

¹¹ Interview confidential

[REDACTED]

[REDACTED]

CONFIDENTIAL

TABLE 6 [REDACTED]

[REDACTED]

[Redacted text block]

[Redacted text block]

Process design on strategic & relational level

[Redacted text block]

[Redacted text block]

Process design on project & negotiation level

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

Process design on operational & performance level

[Redacted text block]

[REDACTED]

[REDACTED]

7.1.3 EVALUATION OF THE PROCESS DESIGN [REDACTED]

The process design challenges the current approach Oceanco uses [REDACTED] and offers relatively easy methods to implement measures that can be used to improve the collaboration, and therefore also the relation, between Oceanco [REDACTED]. Using early involvement [REDACTED], performance evaluation targeted at time, quality and risk, payment with cost + incentive fee and use of a collaborative tool like Primavera that improves the transparency will encourage the development of a co-maker philosophy of cooperative collaboration.

[REDACTED]

The recommendations given based on the process design aim at improving the collaboration and relation between Oceanco [REDACTED]. More specifically, the recommendations are assumed to positively influence the key indicators of mutual objectives, pain-and-gain sharing, risk allocation, performance measurement, and trust. Finally, the proposed measures should put a process in motion that will increase the no-blame culture, joint working, communication, problem solving and continuous improvement.

7.2 Process design for the preferred interior suppliers

[REDACTED]

7.2.1 CURRENT APPROACH TO MANAGE PREFERRED INTERIOR SUPPLIERS

[REDACTED]



7.2.2 PROCESS DESIGN FOR MANAGING PREFERRED INTERIOR SUPPLIERS

The process design (see figure 40, of the previous chapter) is used in this subsection to explore the possibilities of improving the subcontractor management approach that Oceanco uses for managing the preferred suppliers building the interior of their superyachts.

Input variables

Oceanco qualifies a subcontractor as preferred supplier when it has had previous positive experience with this subcontractor. The relation is therefore also considered to be a very important input for the subcontractor management of preferred suppliers. Negative experiences with a current project can result in Oceanco not hiring this builder in the next project that it undertakes.

The goal of the interior subproject to be built is clearly definable, as Oceanco has already made a builder's estimate on the work that needs to be done before outsourcing. However, the defined method of making and installing the interior is rarely as clear and straightforward as one may expect. The uniqueness of each of the interior sub-projects, caused by the client's different interior decorating requests, further complicates this step. Dependent on the complexity in defining the method to achieve the goal of the subproject, the type of subproject is either performance-based or catalogue according to its complexity.

The type of subcontractor is easier to define. The building of the interior is considered to be an important subproject, as it determines to a large extent the appearance of the yacht, which is directly associated with the client's satisfaction. The supply market is not very complex, as Oceanco has a multitude of interior builders available for the execution of this subproject. This means that the type of subcontractor can be classified as a leverage supplier, corresponding to the classification that Oceanco currently employs.

Process design on strategic & relational level

There is only a small interface between the preferred suppliers and the strategic & relational level of subcontractor management. On this level the master building schedule is constructed, including the builder's estimate on the interior subproject. Portfolio management considering the interior subproject is however difficult. This is because the choice for the interior architect, who designs the interior, is based on the personal preferences of the client. The wishes of the client can result in a rendering that is so specific that it narrows down the possibilities for the preferred suppliers. This basically means that, regardless of the relation between the preferred supplier and Oceanco, a framework agreement is not beneficial: Oceanco simply does not control this process to a sufficient extent to make such a decision. The relation does however impact the decision moments on the project and negotiations level, discussed hereafter.

Process design on project & negotiation level

The interior of a yacht differs per yacht build. As previously discussed, this can have great influence on the complexity of the subproject. However, the choice when to involve the interior builder is a little more straightforward, as in all cases he will be involved once the design of the interior has been made. This is because the interior architect is leading in the choices to be made with regards to the interior and the builder is required realize anything that is drawn. The type of subcontractor, defined as a leverage supplier, only draws attention to the management of risk, as it is an important subproject.

Considering the input of a performance-based subproject and a leverage supplier its is recommended to involve the subcontractor after the concept (render in this case) has been made. Oceanco is advised to outsource (a part of) the engineering work that needs to be done in orde to translate the render into a builder's estimate and specified design, as the interior builder knows exactly how to realize and therefore draw this specific design. This would entail early involvement of the subcontractor after the architect has made the concept.

The type of tendering for the interior is recommended to be open and global. Open tendering ensures that Oceanco keeps all of its options on the table, also for suppliers that have not yet proven their value. This ensures continuity in the availability of interior suppliers, and accounts for the projected growth of Oceanco. Another argument to keep the tendering open is to stimulate the preferred suppliers to keep innovating with design building. The trade-off with the time investment it takes to organise and evaluate an open tender should be taken into account, but is considered to be worth the effort for the long-term subcontractor management strategy. Besides being open, the tendering should also be global, as the origin of the builder does not make a difference for Oceanco as long as they perform well (see bid evaluation). Additionally, the construction and outfitting of the interior is done on site at Oceanco's shipyard, so global tendering should not necessarily imply communication barriers. However, cultural barriers may be implied with global tendering. Therefore Oceanco's purchasing department needs to perform extensive due diligence and make solid agreements with its new suppliers.

The bid evaluation for the interior is based upon cost and quality. This often results in time delays, which in effect can cost Oceanco a significant share of their profit. Besides, as mentioned in this research's case study, the reputation of Oceanco is vital for their continuity. This may imply that the cost should be used more as trade-off, with setting the focus rather on time and quality. Contract incentives can be used to incentivize the subcontractors in delivering the right quality for the right cost and on time. It is important that the purchasing department's performance is also not evaluated purely on price. Finally, emphasizing the importance of risk in the bid evaluation, by for example identifying the risks together with the subcontractor, ensures that both parties know what they are up too. Oceanco already reduces the risk by dividing the work between multiple subcontractors, which is smart, provided that the interfaces between the different parts of the interior are relatively easy to manage.

The current contract form for any preferred supplier working for Oceanco is based on a lump sum reward with all risks transferred to the subcontractor. This contract form does not include any incentives for the subcontractor to deliver added value on the terms that have been agreed upon. It is furthermore quite inflexible, as all scope changes require an official change order procedure before they can be put into practise. Considering the interior subproject this inflexibility is undesirable, because the client always requests multiple changes to the interior throughout the project. Finally, the same argument against the use of lump sum contracts as with the co-maker ██████████ holds here:

it remains questionable whether the risks are actually completely transferred to the subcontractor. The process design provides alternative payment schemes that are likely to result in better project performance and collaboration with the interior builders. As a significant share of the cost associated with the interior are in the costs of the material (as compared to for example the painter, because only the most exclusive materials are used for the interior), a payment scheme covering the cost for labour and material with an incentive fee may be more beneficial for Oceanco and the subcontractor. This incentive fee can be based on the planned costs versus the total cost, for example. The interior builder is incentivized to keep the costs down to increase profit and Oceanco therefore runs less risk. The method Oceanco uses comparing the tender offers with previous projects also reduces the risk for Oceanco to get trumped by the subcontractor.

Process design on operational & performance level

If the decision is made to change the payment scheme based on cost, a tool is desired in which Oceanco can see how the labour and material costs develop during the project. For this purpose a tool like Primavera can be used. Otherwise, any tool in which Earned Value Analysis can be applied in an easy way would serve for this purpose. The process design does not offer many possible tools, but merely suggests that the main contractor thinks of the aspects of the collaboration improvement that might be ensured and stimulated with use of tools.

The decision moment on collaborative tools provides input for performance evaluation and vice versa. For the preferred interior builders this performance evaluation can help them in getting new projects. Also, for non-familiar suppliers to Oceanco the performance evaluation is the means to get on the preferred suppliers' list. It must be noted that the effectiveness of the Deming Circle depends on whether Oceanco will use the supplier in future, because on top of the improvements made during the project, this method also helps to iteratively improve the collaboration on the long term. This requires future interaction.

7.2.3 EVALUATION OF THE PROCESS DESIGN FOR PREFERRED INTERIOR SUPPLIERS

The process design offers some interesting insights comparing the advice with the current approach for the management of the preferred suppliers such as the interior builders. Although the relation here is not the main driver for the subcontractor management approach, some measures that are easy to implement can improve the collaboration with and performance of these subcontractors. The project performance can be improved by early involvement, bid evaluation on mainly time, quality and risk, and a cost + incentive fee contract.

When dealing with the preferred suppliers, more emphasis in the process design is put on the decision moments considering the type of tendering and bid evaluation, as Oceanco has numerous subcontractors available to execute these subprojects. In this case the advantages of open and global tendering seem to outweigh the disadvantages, but this consideration that has to be made for each subproject that is executed by preferred suppliers. The process design guides in this consideration.

One limitation was found when applying the process design for preferred interior suppliers: the step involving the definition of the type of subproject using the segmentation model into the four types seemed somewhat insufficient. Determining whether the method is definable was found to be especially difficult, as the truth considering the interior subproject is not so black and white. This means that the subproject is classified as being between performance-based and catalogue. However, fortunately this does not strongly impact the functioning of the rest of the process design and the advice following from it.

7.3 Process design for non-critical glass suppliers

[REDACTED]

7.3.1 CURRENT APPROACH TO MANAGE NON-CRITICAL SUPPLIERS (OF GLASS)

[REDACTED]

7.3.2 PROCESS DESIGN FOR MANAGING NON-CRITICAL (GLASS) SUPPLIERS

The same structure as the previous subsection to discuss the process design is followed to explore the possibilities for improving the subcontractor management approach that Oceanco uses for managing their glass suppliers. In the title ‘glass’ is put between brackets, because the suggested approach also holds for other non-critical suppliers.

Input variables

The glass supplier is considered to be non-critical. This is because the subproject is of less importance when weighed against the whole project and the supply market is not complex; there are plenty of subcontractors that can deliver and install the glass. The type of subproject is defined as catalogue, as the goal of the subproject as well as the method for achieving this goal can be clearly defined. Except from unusual shapes and sizes, the ordering of glass can literally be done by browsing through a catalogue. [REDACTED]

[REDACTED] browsing a catalogue is unfortunately not enough. The relation between the main contractor and subcontractor delivering the glass is considered to be of less importance, as Oceanco is not dependent on the knowledge of the subcontractor, nor on its availability. The key indicators are therefore not specifically analysed here.

Process design for non-critical suppliers on strategic & relational level

Naturally, it is beneficial for a main contractor like Oceanco to have a good relationship with a supplier, even if it is a non-critical one. A good relationship is likely to result in fewer problems and creates a commitment of the supplier to honour its agreement (Meng, 2012). A framework agreement is however not really necessary with a non-critical supplier like the glass supplier, since every project (client) may require different glass and the flexibility of using the open market is attractive for Oceanco in getting the lowest price.

Process design for non-critical suppliers on project & negotiation level

Since the glass is a catalogue subproject and the supply market characteristics make the type of subcontractor non-critical, the question of when to involve the subcontractor depends on what the main contractor exactly wants (as opposed to driven by his needs). The main contractor has the knowledge to fully specify the products that it requires. Oceanco has to determine the size (length, width, and height), material and, if necessary, make a 3D model of the flexion for the glass supplier. This can easily be done by the engineering department of Oceanco. However, Oceanco may decide to let the supplier do this calculations and therefore involve him earlier in the engineering stage.

The type of tendering is recommended to be open, as this ensures a competitive offer for the glass. Considering the breakable nature of the glass, Oceanco may decide to keep the tendering local. This is also related to the risk allocation, which should therefore be included in the bid evaluation. Except from these preconditions the tendering can be done based on price, as the quality is already ensured in certain certificates that a glass manufacturer must have and is assumed to be relatively indifferent in simple catalogue subprojects. Payment can be done in a lump sum form, as the risks of the subproject are incalculable. This implies that Oceanco must perform risk identification and mitigation beforehand.

Process design for non-critical suppliers on performance & operational level

Collaboration tools are considered to not be necessary with this relatively easy subproject. The progress can be easily analysed by counting the number of windows that are placed. Using a collaborative tool here could result in sluggish procedures that do not really help the collaboration and/or performance of the project. While the use of collaboration tools might not be necessary in such a relatively easy subproject, the performance evaluation is. Oceanco should make a habit of conducting a performance evaluation of non-critical suppliers after they have finished their subproject. If the performance delivered by the supplier meets or exceeds the expectations of Oceanco it may decide to put him on the preferred supplier list. This stimulates the subcontractor in performing well, as an incentive for more work means continuity for the firm. Additionally, for Oceanco it avoids making a mistake with a subcontractor multiple times and makes future projects easier to outsource.

7.3.3 EVALUATION OF THE PROCESS DESIGN FOR NON-CRITICAL SUPPLIERS

There does not seem to be a large difference when comparing the current approach of Oceanco towards their non-critical suppliers with the advice following from the process design. This is mainly because both the type of subproject, with easily defined goal and method, as the supply market, is non-complex. This means that the main contractor has a lot of freedom to steer the subcontractor management approach, as opposed to being steered by project, supply market or relational characteristics. The process design does however add value in providing a clear structure on the subcontractor approach that can be followed.

For these type of subprojects and subcontractors it might even be possible to design a standard procedure, like the one Oceanco now has. However, this is considered to not be desirable, as questioning the input of the process design, as well as the decision moments, ensures an informed decision from the main contractor. Besides, non-complex subprojects such as the previously discussed glass one, can vary in complexity, according to the project at hand.

7.4 Implementing the process design at Oceanco

The process design, as shown in chapter 6, was presented to Oceanco to see whether this could be used as a tool to improve subcontractor management¹². Although [REDACTED] found the process design to be comprehensive and clear on the working of subcontractor management in practise, the process design missed some guidance in what subcontractor management approach to choose in which situation. Furthermore the process for implementation was discussed, as they argued that an ordinary consultancy advise would probably not be adopted by the organisation.

This paragraph firstly presents the steps that were taken to address the point on guidance and usability. Secondly, the setup of the workshop is discussed. Finally, the results of the workshop that was organised at Oceanco are presented.

7.4.1 GIVING THE PROCESS DESIGN MORE GUIDANCE

Throughout this chapter the applicability of the process design has already been analysed by testing the design with three different examples of subprojects and subcontractors at Oceanco. The most important aspect of the process design is however that in future it will be used by the employees of Oceanco themselves, which means that the design should be easy to use. Although already early on in this research the aim of designing a one-size-fits-all solution was recognized to be impossible, the process design could have more guidance considering which subcontractor approach would fit with what input. Therefore the process design has been transformed into a ‘Subcontractor Management Canvas’: a canvas that, just like the Business Model Canvas does for startups searching for their best business plan strategy (Osterwalder & Pigneur, 2009), guides the main contractor into making an informed decision on the subcontractor management approach to follow.

The canvas is made with the same ingredients as the process design: using the three input variables (type of subcontractor, type of subproject and relation) and the decision moments defined in chapter 6. As the canvas is aiming to be used as a stand alone tool, the choices made with regards to the input variables are included in the canvas. Additionally, in order to provide guidance in the subcontractor management approach, for each input variable an icon is created that can be found throughout the canvas. For each input variable the question was asked: What would be the output of this decision moment considering this input variable? For example: When would I involve the subcontractor if I consider a Blue-Sky project? The answer to this example is in the definition stage, as both goal and method are unclear, for which one has to rely on the expertise of the subcontractor. For the relation input the question was asked for each decision: would I need a good relationship with the subcontractor considering this choice, or is the relationship not important? With regards to the decision to involve the subcontractor in the definition stage the relation is argued to be very important, as the main contractor is dependent on the expertise of the subcontractor.

The result of filling in the canvas is shown in figure 42. The main added value of this canvas compared to the original process design it that the user can identify which general strategy fits best with which situation. Considering the decision to involve the subcontractor at the definition stage one can see that this should only be used with exploration-driven and blue sky subprojects, where you need a strategic subcontractor with which to maintain a good relationship. On the other hand, involving the subcontractor after the specified design has been made is only useful if you can define both the method and goal of the subproject. Here the type of subcontractor is likely to be non-critical and the relationship is of less importance.

¹² Interview confidential

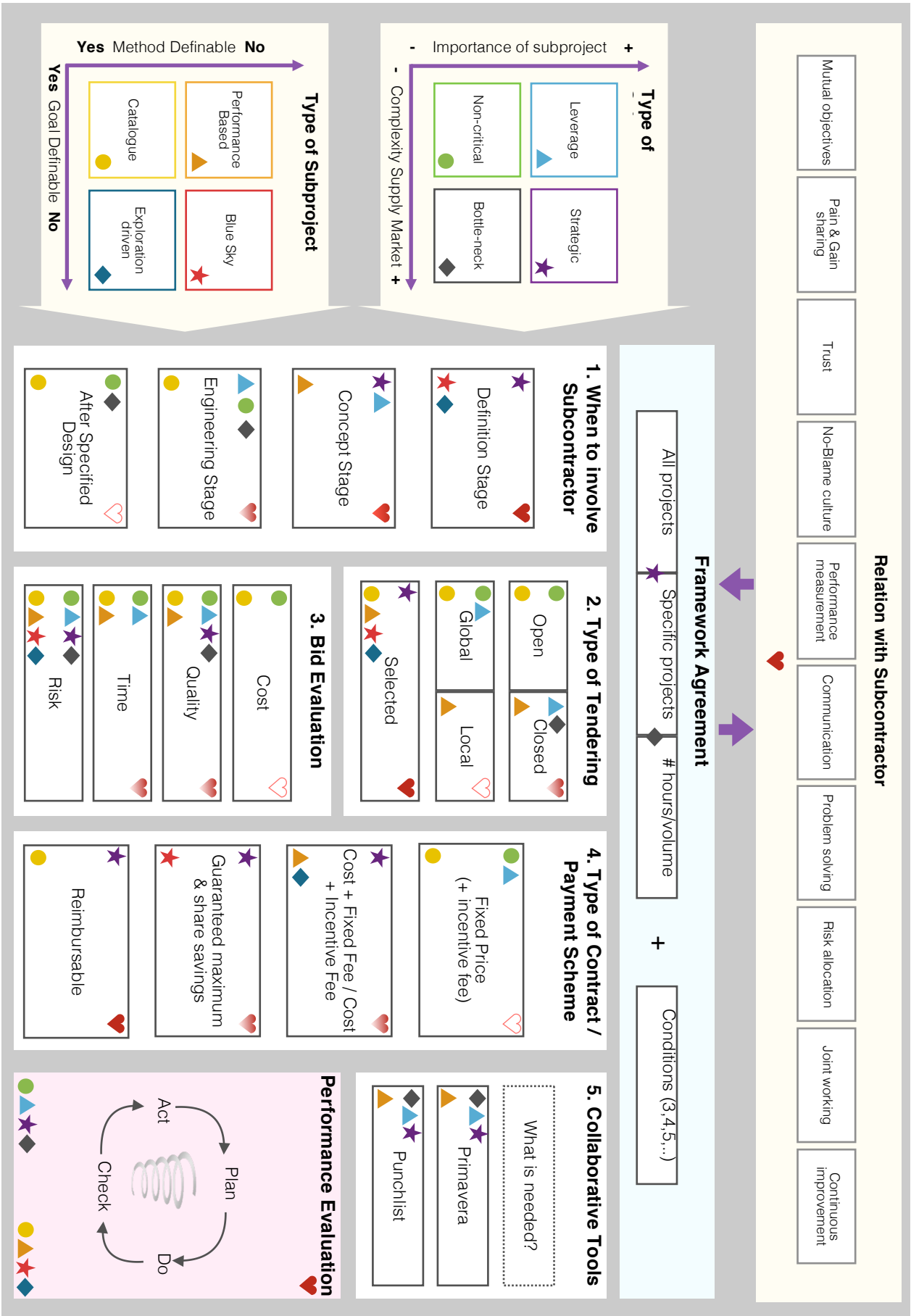


FIGURE 42 SUBCONTRACTOR MANAGEMENT CANVAS

7.4.2 SETTING UP A WORKSHOP FOR THE SUBCONTRACTOR MANAGEMENT CANVAS

Instead of imposing changes in Oceanco's subcontractor management strategy by presenting the created solution to the management of Oceanco, a workshop has been created. This workshop aims to activate the employees at Oceanco who often interact with subcontractors (on a strategic level), such as the project managers and purchase managers, to consider revisions in their subcontractor management strategy. The workshop therefore aims to establish an awareness of the necessity to change.

The workshop makes use of the canvas presented in previous subsection, but is presented empty to the participants. Stickers are used to represent the icons of the different input variables, where the participants are, in pairs, asked to go through each decision moment in the canvas considering the input variables and position the stickers according to their interpretation of what the subcontractor strategy should look like. This is done in pairs to make the participants more comfortable and allow for discussion before putting the stickers into place.

After the participants have gone through every decision moment with each of the input variables they are asked to present their canvas. The participants are presenting their own version of the canvas that is likely to differ from the canvas in figure 42. With this input the discussion is started on how the subcontractor management approach can be adjusted to each single subproject & subcontractor. By making their own canvas, they are actively

7.4.3 RESULTS OF THE WORKSHOP AT OCEANCO

Three project managers, two purchase managers and the operations manager participated in the workshop held at Oceanco. After a short presentation about the purpose of the research, the main findings were shared, in which both the process design, as well as the subcontractor management canvas were discussed. In pairs the participants completed the canvas, after which they were asked to give a presentation of their conception of the canvas to the rest of their colleagues. An impression of the workshop is shown in figure 43.

When comparing the results of the completed canvasses it is interesting to see that all participants have recognized the need to distinguish the characteristics of the subproject to be outsourced within the management approach. Additionally, the type of subcontractor and relation with these actors were recognised to influence the decision moments of subcontractor management.

Individually considering each input variable individually during the workshop, as opposed to considering the combination of the type of subproject, subcontractor and relation, was very effective, as it postponed the discussion on the suggested approaches to the moment that the canvas was completed. It also emphasized the combination of the input variables, as this was part of presenting the conclusions.

There were some differences in interpretation and choices made in filling the canvas. This is only natural as subcontractor management is largely based upon personal preferences and tacit knowledge due to previous experiences. Moreover, the differences led to discussion between the participants about which approach to follow would be best to follow. This is considered as an ideal output of the workshop. The discussion had the effect of making the participants actively think about ways to improve their current approach, instead of thinking about why a presented solution would work or not work.

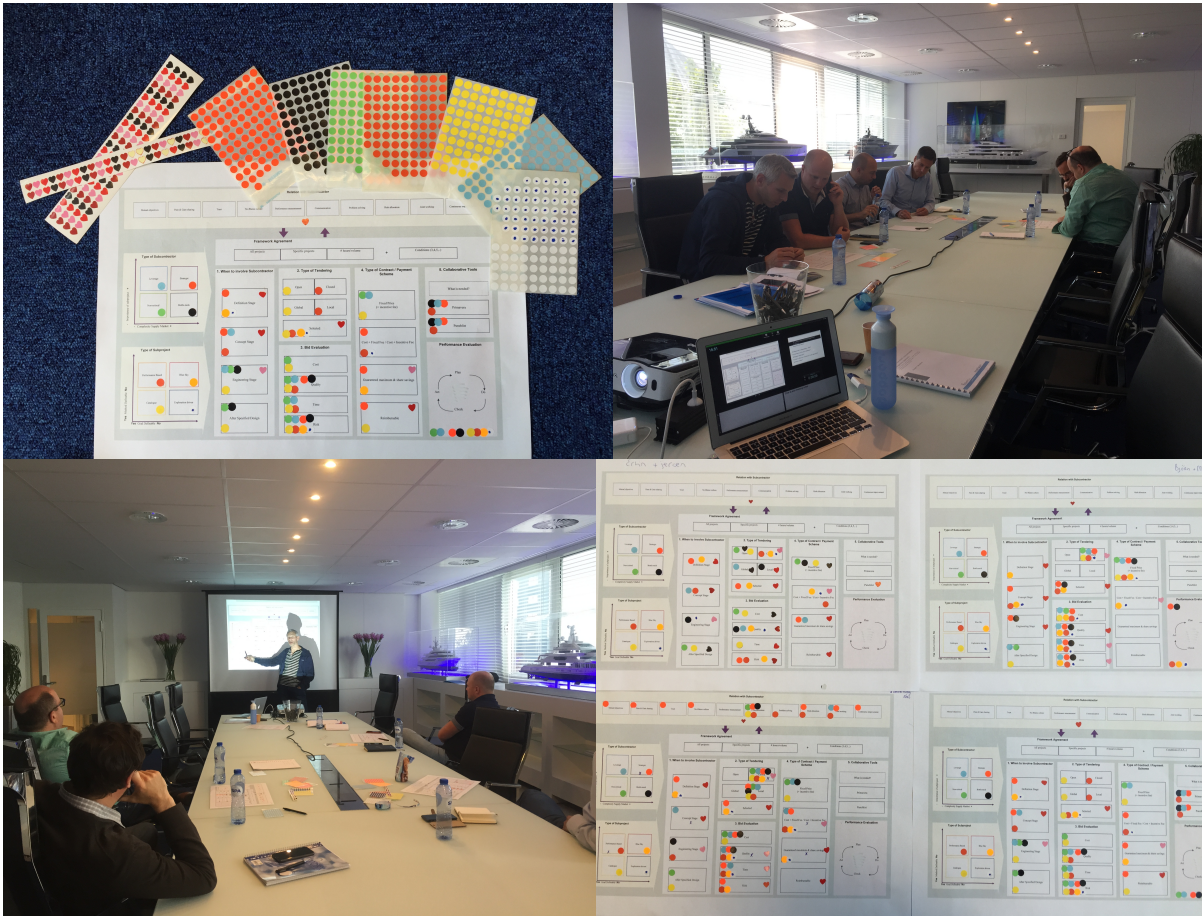


FIGURE 43 WORKSHOP SUBCONTRACTOR MANAGEMENT AT OCEANCO

Additionally, there were not so many discrepancies between the different views on how to improve the subcontractor approach based on the input variables. The discussion mainly focused on the next step, regarding how to implement in practice the suggestions made by the canvas. The value of the workshop was recognized by the participants, who also suggested ways for a follow-up on this workshop.

7.5 Conclusion & discussion on applicability of the process design at Oceanco

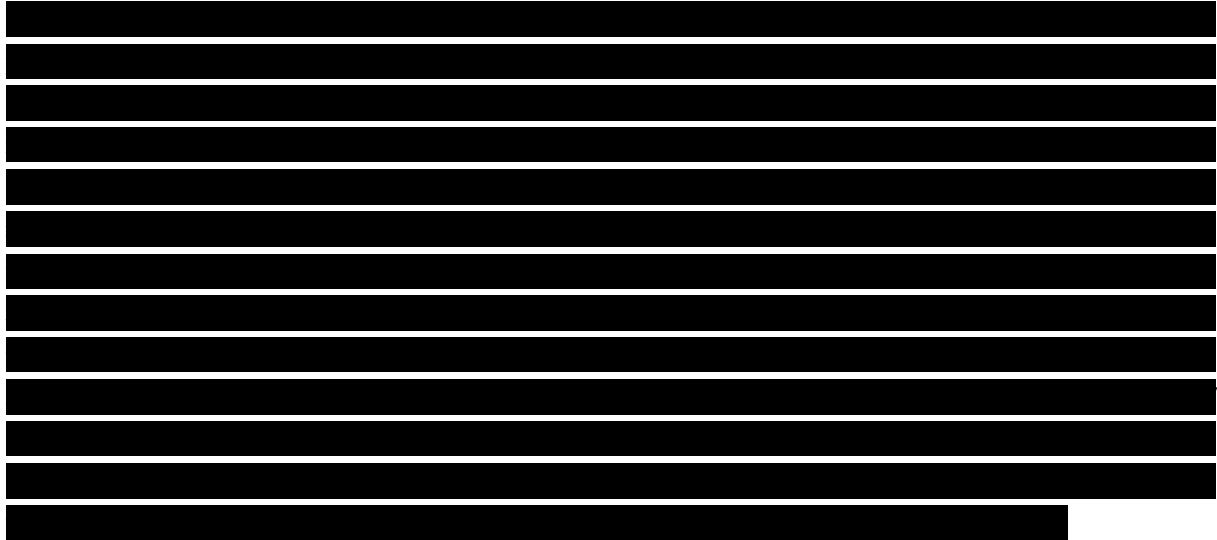
In this chapter the process design, constructed in chapter 6, is applied to the case study of Oceanco. Validation of its working is done firstly by working through the process design for three different subprojects at Oceanco and secondly by means of a workshop with Oceanco executives.

Evaluation of the applicability of the process design at Oceanco: three subprojects

The process design does not prescribe a certain specific approach. This was never the intention, as subcontractor management was found to be too context dependent. The process design merely allows the main contractor to make an informed decision on each situation. The process design thereby also functions as a means for communicating and substantiating certain choices. This was done for three subprojects of Oceanco.

The three subprojects vary from catalogue project to performance-based project and are performed by three different subcontractors; one co-maker, one preferred supplier and one non-critical supplier.

The ambiguity in the process design proves to be larger for the more complex subprojects that are outsourced in a complex supply market compared to the catalogue subprojects executed by non-critical suppliers. This is considered to be natural, as the input variables of the type of project and the type of subcontractor play a role throughout the entire project and negotiation level of the process design. Additionally, the relationship between the main contractor and subcontractor is perhaps even more important in subcontractor management than what is logically following from the process design.



The process design for preferred suppliers also challenges Oceanco's current subcontractor management approach though the relation with the subcontractor plays a smaller role here, as there are no long-term agreements to be made. This is because the type of subcontractor is not critical, as the supply market offers enough alternative suppliers. The type of subproject changes of characteristics per project (i.e. the interior differs per yacht) and is generally somewhere between catalogue and performance-based. Consciously thinking about the decision moment of when to involve the subcontractor on project and negotiation level is argued to be very useful for the preferred suppliers. The builder of the interior could for example already be involved during the engineering stage, which could improve the efficiency, as this builder is better (specialized) than Oceanco can possibly be. Furthermore, the bid evaluation and type of contract in the process design are useful. Instead of evaluating purely on price and pushing all risks towards contractors who cannot carry this risk, incentives can help improve the quality of the collaboration and hence the project performance.

Applying the process design for catalogue projects that are performed by non-critical suppliers, it is noticed that the results correspond to a relatively great extent with Oceanco's current purchasing procedure. This is not surprising, as these subprojects and subcontractors are considered to be easier to manage due to their limited complexity. The lesson learnt from the process design is that for these type of projects/subcontractors Oceanco is not as dependent, and can make the decisions based on their own needs. To illustrate: Oceanco might have limited working capacity to engineer a solution for a catalogue project and therefore involve the subcontractor in an earlier stage. This is a deliberate choice, as opposed to when Oceanco is actually dependent on the expertise of the subcontractor.

Implementing the process design at Oceanco

Oceanco has some specific organisational characteristics. Firstly, many activities considering subcontractor management are carried out based on the tacit knowledge of the employees and not written down in procedures. [REDACTED]

[REDACTED] the implementation process at Oceanco has received special attention in this chapter.

First, feedback was obtained from [REDACTED] Oceanco by discussing the process design with them. The main point for improvement was identified as providing more guidance in the choices to be made in the design. Based on this feedback an adapted process design, a so-called subcontractor management canvas, was created, in which suggested choices were included based upon the specific input variables.

[REDACTED] a workshop was organised for a number of executives at Oceanco who regularly have contact with subcontractors. The purpose of this workshop was to create awareness amongst these professionals that Oceanco's current subcontractor management approach might need improvement. The workshop was considered a success, as it evoked discussion amongst the participants: not only on the specific approach to be followed, but also on the follow-up steps needed to put the new ideas on subcontractor management into practise.

The process design is therefore validated for Oceanco. Not only is its working verified by the application of the design to three different subprojects of Oceanco, but it was also validated by means of interviews and a workshop. The process design has proved its use during this workshop and will possibly be implemented in the purchasing process of Oceanco in the near future.

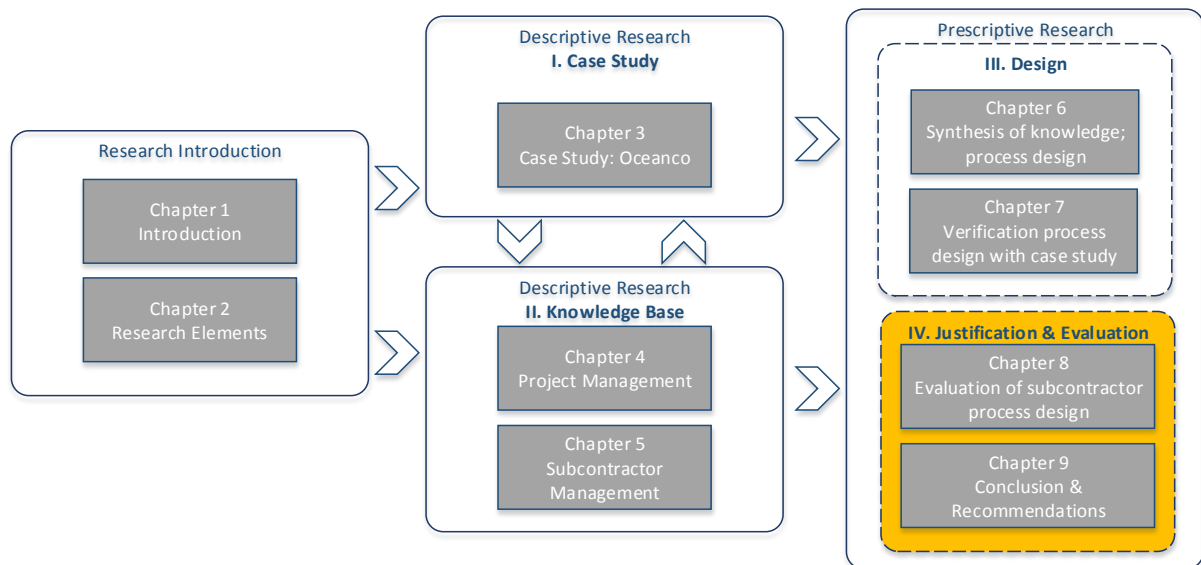
Research question 7 is thereby also answered in this chapter:

7. How can Oceanco improve their management of subcontractors.

The first part of the chapter gives concrete advice on ways of improving the subcontractor management strategy for three subprojects of Oceanco. Following this advice Oceanco can improve the management of their subcontractors. However more importantly, the second part of this chapter discusses the way of implementing the process design in Oceanco's organisation, so the improvement of their management comes from within the organisation.

The final part of this research will research whether the process design can also be used for other main contractors facing similar challenges as Oceanco, but operating in different industries, by means of a number of interviews with project management professionals. This part also discusses the conclusion and recommendations of this research.

IV. Justification & Evaluation



The final part of this research consists of the justification and evaluation of the process design on subcontractor management and the conclusions and recommendations of this research. The justification & evaluation of the process design in chapter 8 is done by means of interviews with experienced project management professionals and confrontation with academic literature. This chapter answers research question (8) Which elements of the process design on subcontractor management are representative for other main contractors managing large engineering projects and which elements are specific to Oceanco? Chapter 9, the final chapter of this research, contains the conclusion and recommendations. In this chapter the main research question is answered and recommendations are given for future research.

8

Evaluation of the subcontractor process design

Chapter 6, in part III of the research, presents a process design for subcontractor management based on the case study at Oceanco, a number of assumptions, and study of relevant academic literature. Subsequently, the applicability is verified using the case study in chapter 7 of part III.

Empirical data from other main contractors in the market, needed for proper validation of the scientific contribution of this process design, is lacking so far in this research. Therefore this chapter firstly investigates whether the process design needs improvements in its functioning according to project management professionals from other industries. Secondly this chapter questions whether the presented process design is also usable outside the organisation of Oceanco (by main contractors managing complex large engineering projects in other industries). This is done by means of semi-structured interviews, of which the method and format is explained in Appendix V. The reports of the interviews are included in Appendix VI.

The final step in evaluating the process design is to contrast the results with the relevant scientific literature on this topic. The conclusion on the validity of the process design is based upon both the results of the interviews as well as the reflection with literature.

Section 8.1 presents the lessons learnt on the functioning of the process design from the interviews with the project managers. Section 8.2 elaborates on the applicability of the process design outside the organisation of Oceanco for other main contractor managing large engineering projects. Section 8.3 reflects the process design to the relevant academic literature on this topic. Finally, section 8.4 concludes this chapter by answering research question (8) *Which elements of the process design on subcontractor management are representative for other main contractors managing large engineering projects and which elements are specific to Oceanco?*

8.1 Verifying the functionality of the process design

Multiple professionals experienced with subcontractor management have been interviewed to contrast the suggestions of the process design presented in the previous part of this research with their experiences. This is done as means of verifying the functionality of the process design. The interviewed project managers are selected based upon the characteristics of the projects of interest presented in chapter 2 of this research. Project managers at ASML (H. Mooi), RHDHV (R. Bakker & S. Vorselman), Philips Healthcare (S. van Opstal & P. America), Royal IHC (W. Zevenbergen & R. van Arkel) and OVG (Robert van Alphen) were interviewed for this purpose. The reports of the interviews are included in appendix VI.

To structure the lessons learnt on the process design during the interviews the three levels of the process design are used. Section 8.1.1 presents the lessons learnt on a strategic & relational level, section 8.1.2 on project & negotiation level and 8.1.3 on performance & operational level. The summary of these lessons learnt is displayed throughout these sections by means of highlighted textboxes.

8.1.1 LESSONS LEARNT ON STRATEGIC & RELATIONAL LEVEL PROCESS DESIGN

The lessons learnt on strategic level are mainly focused at the elaboration & improvement of possibilities within the choice for a framework agreement. However also some general remarks and comments on the input on this level process design were also made.

General remarks & comments about the input

Mooi (ASML) thinks it is hard to make a process design for such a complex, tacit knowledge based, issue. Van Alphen (OVG) agrees with this statement, but thinks that the distinctions made in the process design are very relevant. He believes that the impact of the type of subproject and the importance of the relation in the choices made in subcontractor management are especially good.

Mooi comments that the desired relationship with the subcontractor is dependent on the type of subproject. Furthermore Mooi thinks that the influence of risk on subcontractor management is insufficiently emphasized in the process design. The ownership of risk is essential for subcontractor management, as replacing the ownership of the risk to the subcontractor or insurance company increases cost. Every risk has an expected value, for which the main contractor will be charged.

Lesson 1 – “The ownership of risk is essential for subcontractor management. This entails the need for an analysis and a division of the risk to the party that can best handle this risk”.

H. Mooi – ASML

Regardless of the penalty, in the end the main contractor owns the risk because of their responsibilities towards the client. Besides, the main contractor does not benefit from bankrupting their subcontractors because this will cause delays and might result in higher cost. These aspects mentioned are also brought forward by Meng (2012) as influencers of the relation. Van Alphen (OVG) argues that subcontractor management is mainly based on trust and human interaction.

On the completeness of this level Bakker of RHDHV made the point that it is very relevant to consider the jurisdiction that applies between the client and main contractor. The Rhineland model of law works with the principle of reasonableness and fairness (*redelijkheid en billijkheid*), where the Anglo-Saxon model of law does not elaborate such a clause. This has a significant impact on the risk-reserves one has to make and therefore impacts the contract that the main contractor signs with the client. Furthermore, Zevenbergen & America (Philips Healthcare) note that outsourcing everything as a dogma might not always be beneficial, as it may lead to reactive management instead of proactive management and it can easily lead to a Lock-In with subcontractors.

Framework agreements

Framework agreements add value for both the main contractor and the subcontractor according to Vorselman of RHDHV. Firstly, because of the pace in which the process of assigning projects goes after the framework agreement is signed. Payment conditions, delivery conditions, change order procedures and more are included in the framework agreement, making the negotiations on the project level much quicker and easier. Back to back contracting should be used here to ensure the conditions agreed upon with the client also hold for the agreement with the subcontractor. Moreover, this comment is also valid for the contracts made on the project level.

In a framework agreement RHDHV often includes a discount for the main contractor of which the height is dependent on the total value of contracts given to the subcontractor on a yearly basis. This discount gives the main contractor the incentive to hire the subcontractor more often, as the discount will become larger. Hiring the subcontractor more often means that more work is given to that subcontractor, which meets the subcontractor's interest of continuity and growth. This discount therefore is considered to be a win-win situation.

Lesson II – “A framework agreement should include incentives for collaboration between the main contractor and subcontractor.”

S. Vorselman – RHDHV

However, Bakker of RHDHV commented that for the subcontractor a framework agreement does not necessarily mean that the subcontractor has continuity, as this depends on the main contractor's sales team. Therefore, the subcontractor needs to decide whether they want to be dependent on the main contractor for the work. It must be noted here that a subcontractor can engage in framework agreements with multiple main contractors, which could cover this risk.

The framework agreement should be seen as a strategic alliance according to Mooi (ASML). Mooi draws upon the experience ASML has with Zeiss, their single supplier for the lenses in their machines. The awareness of their mutual dependency, combined with their own responsibilities and scope work really well. According to Mooi the communication lines should be short in such an alliance, both on strategic and operational level. These comments directly relate to the relation indicators by Meng, used as input for the process design on this level.

Lesson III – “The communication lines between main contractor and subcontractor should be short at both strategic as well as operational level.”

H. Mooi – ASML

8.1.2 LESSONS LEARNT ON PROJECT & NEGOTIATION LEVEL PROCESS DESIGN

The feedback on the functionality of the project & negotiation level process design is structured by the respective decision moment that the feedback was intended for. First, some general remarks on the project & negotiation level process design and comments about the inputs are given, after which the feedback on the several decision moments is presented.

General remarks project & negotiation level & comments about the input

Bakker and Vorselman (RHDHV) emphasize the importance of the management of risks and the need to analyse these beforehand. Modern tendering is all about management and the distribution of risk. RHDHV uses the RISMAN method for the management of risks in their projects. In groups (also together with the subcontractors) they identify risks, assess the change of occurrence, the impact on time, quality and cost, and the remaining risk. It is important to note the reference to the Iron Triangle of project performance here. Multiplying the chance of occurrence with the consequence determines the contingency reserve one has to take. The challenge is to think of a mitigation strategy that is SMART. Subcontractor management is all about the game of who takes which risk.

Zevenbergen (Royal IHC) notes that the decision moment of when to involve the subcontractor is indeed dependent on the type of subproject and the type of subcontractor. According to him this can also be seen as a matrix, because the relations are relatively predictable. To illustrate: the scaffold builder does not need to be involved early on in the project, as the subproject to be performed has a clear goal and method. In the process design this relationship could be emphasized more. At Philips Healthcare the type of subcontractor is also related to the type of subproject and stage that the subcontractor is involved. The comments of Zevenbergen & van Opstal about this relationship are valid, though the interplay between the type of project and type of subcontractor is not always this clear. Furthermore, the desired type of subcontractor might not always be available. To transform this into a matrix therefore does not seem appropriate.

Lesson IV – “When considering the type of subproject one wants to put up for tender, one should decide to specify the subproject either solution-driven or output-driven.”

S. Vorselman – RHDHV

Vorselman (RHDHV) commented on the input of the subproject that one should specify the subproject not only on complexity, but also decide whether it is a solution-driven or output-driven subproject. This determines whether the subproject is steered based on performance, or on adherence to the specified design. This formulation therefore basically determines what type of subcontractor one should choose (however, what you want is not always available). Additionally, this formulation seems closely related to the method used in the process design to determine the type of subproject, as this is done based on goal- and method definition. When the goal can be defined, but the method cannot, this naturally becomes a solution-driven subproject. Subprojects with a clear goal and method are often output-driven, as they can easily be fully specified.

When to involve the subcontractor

The decision moment of when to involve the subcontractor depends on the type of subproject and the type of subcontractor according to Zevenbergen (Royal IHC), which complies with how the process design is constructed. This is also influenced by the “80-80” moment, which is used at Royal IHC to define the start of the project. This is the moment that the sales department is 80% certain that the project will actually be built and 80% certain that IHC will be awarded the contract. This is the moment that project management gets involved. Before this moment contact is already established with the core subcontractors to get offers on the work to be performed, in order to ensure IHC has a jump start when the project is awarded to them.

Lesson V – “The type of subproject, the type of subcontractor and the ‘80-80’ moment determine when to involve the subcontractor”.

W. Zevenbergen – Royal IHC

Vorselman (RHDHV) argues that early involvement of subcontractors creates commitment because it is based on the principle of co-creation (and interaction). Transparency and trust are key to this form of collaboration; for example opening the books (financials) at both the sub- as well as the main contractor. The early involvement is likely to reduce the amount of change orders, because the

design is co-created with other sub-contractors. Besides, it will also positively influence the handling of change orders, as it increases the sense of responsibility of the subcontractor. RHDHV uses Virtual Design & Construct for this purpose, which is discussed in subsection 8.1.3 about the collaborative tools. Noticeable is the correlation the comments by Vorselman have with the key relation indicators used as input for the process design.

Bakker (RHDHV) agrees that early involvement of the subcontractor is beneficial. This requires an investment in the beginning, but will result in better project performance throughout the project, because it is less likely to be necessary to go back to the drawing table and enables just-in-time delivery of goods for example (which results in a cleaner construction site, and therefore less accidents, etc.). Van Alphen (OVG) does not want the main contractor to be involved too soon, because then the risk that the main contractor deviates too much from the project goals is created.

Bakker (RHDHV) notices that deciding to involve the subcontractor after the specification has been made enables better tendering on price. However, this requires much preparatory work (cost) from the main contractor, so there is a trade-off to be made here. It should be considered how many employees are available for specification, and whether the subcontractor should be given more freedom to do what he does best. Given that the subcontractor is specialised in this task, the main contractor should not intervene just for keeping control.

Type of tendering

Bakker (RHDHV) thinks the best tendering strategy for a main contractor is to have a shortlist of subcontractors for selected tendering. This opinion is shared by van Opstal (Philips Healthcare), Mooi (ASML) and Zevenbergen (Royal IHC). Philips Healthcare has a formal procedure for this preferred supplier list, corresponding to ASML that uses a list of preferred suppliers who first have to prequalify to prove that they are able to provide the product or service that is inquired. Royal IHC involves most of its subcontractors (also internal parties) in such an early stage that this tendering can also be considered to be selected.

Lesson VI – “Make a shortlist of preferred suppliers for selected tendering, possibly based on a formal procedure similar to Philips’ Umbrella Purchase Agreements.”

S.van Opstal – Philips Healthcare

Bakker and Vorselman (RHDHV) point out that commercial companies like Oceanco do not have to obey to the European rules on procurement. However, apart from this defined procedure being a bit sluggish, it does provide a clear and transparent approach towards tendering, which can also be useful for commercial companies.

Bid evaluation criteria

ASML uses Quality, Logistics, Technology and Cost (QLTC) as criteria to evaluate suppliers. The subcontractors ASML works with are thus not evaluated purely of price, but also on the quality of the delivered product/service and the logistics (timing). ASML considers time to be the most important performance indicator in the Iron Triangle of project performance for their business model, with trade-offs being made on cost and quality. This also holds for the subcontractors that ASML works with, hence the logistics aspect in the QLTC evaluation.

At OVG they follow the principle of “live and let live”. The best projects are those in which all stakeholders are satisfied, meaning that all parties get their share of the cake. In such projects, many conflicts are resolved with a closed purse. If subcontractors have to start with a loss (lowest tendering price), they will do everything to compensate this, thereby creating an entirely different environment.

Bakker (RHDHV) points out that the quality insurance can be ensured with the use of a preferred supplier list. Therefore, Bakker thinks that the tender should be evaluated on criteria other than just price and quality. Amongst these, he believes that the tender should be evaluated upon how well the subcontractor is compatible to the main contractor’s processes in terms of the software, for example. The main contractor should evaluate the subcontractor’s competences and willingness to improve its performance to work with the main contractor. This relates to the evaluation moment in the process design. Vorselman shares the opinion that RHDVH mainly steers on risk instead of cost in their construction projects. This is already taken into the process design.

Lesson VII – “Evaluate the tender offers on the competences of the subcontractor to perform according to the main contractor’s way of working and their willingness to improve in performance.”

R. Bakker – RHDHV

At Philips, it is the commodity manager who usually sets the bid criteria. For this purpose Philips has a template with a list of bid evaluation criteria. Typically, the cost price is a determining criterion, but the logistical criteria are also important. For Example, the question of whether the supplier allows for SMOI (supplier managed own inventory) or the development location to play a role. SMOI uses the principle of paying upon delivery, where the supplier builds a stock inventory at the site of the main contractor, but the main contractor only pays the moment the product/component is off the shelf.

Type of payment

Bakker (RHDHV) argues that if a main contractor is constantly busy with trying to transfer all of the risks towards a subcontractor who cannot carry these risks, they will still find themselves in an equally insecure situation when something goes wrong as a result of the project’s end-responsibility being placed on the main contractor. Generally it works better to reward than to punish. The rewarding can only be decided once the scope is entirely clear. If one tries to bargain a price before the scope is clear, they are likely to pay a risk-premium that the subcontractor puts in place as contingency. If one wants to make quality and timing their focus, they should involve the subcontractor at an earlier stage and define the budget by mutual agreement. RHDHV does not put a price on anything before the scope of the task is entirely specified.

Lesson VIII – “Continuously squeezing the profit margin of the subcontractor works counterproductive. A durable collaboration is transparent and thus based on honesty and an absence of double agendas.”

R. van Alphen – OVG

OVG adds an incentive to take responsibility by means of an expenditure in the budget for 'Nadere Plan Uitwerking' (NPU), which translates into further development of the plans. OVG adds NPU as extra expenditure to the budget, to ensure a 'geen gezeur garantie' (no nagging warranty) for small changes that fit within the defined scope of the project. This varies from 1 to 2% of its entire budget, which operationally varies from 500.000 to more than 1 million euro, without a clearly defined product in return. OVG puts this front-end incentive in the budget to reduce the risk of additional costs; "You win some, you lose some".

The type of payment used at ASML depends on the type of subproject and collaboration that is being conducted. Black-box suppliers are often just given a certain budget and time within which they are given the freedom to develop the subproject. This is a form of a reimbursable payment scheme. Philips also uses a form of reimbursable payment called 'open book calculation'. Here, the main contractor and subcontractor agree on a price for the material, labour costs, overhead, and a profit margin beforehand. The subcontractor in return keeps a transparent administration of the costs that were made, so the main contractor knows exactly what he is paying for.

8.1.3 LESSONS LEARNT ON PERFORMANCE & OPERATIONAL LEVEL PROCESS DESIGN

The process design on the performance & evaluation level centres around the use of tools and the way to evaluate performance.

Collaborative tools

RHDHV uses Virtual Design & Construction (VDC) for the co-creation in the design phase of the project. Originally, the principle behind this method comes from NASA. Based on the functional design they construct a virtual design together with the subcontractors. All the important builders and suppliers are brought together in a room to improve the design. In this way all parties are directly confronted with the consequences of their choices. It enables direct insight in possible clashes in design and the division of the responsibilities. For example, if a pipe scheme runs through a wall where a door should be placed, the main contractor (Oceanco) can decide who should adapt this flaw, and the respective subcontractor can make a financial estimate of what it would cost to arrange this. The advantage in this approach is the speed at which decision-making can be done, as at separate locations solving such conflicts will take longer and often lead to suboptimal solutions.

A Building Information (BIM) Model is an overarching term for software that is aimed at integrating information in a project by means of a digital model of a planned construction. BIM is currently mainly used in the building construction industry, where important savings are being made through this approach due to the reduction in engineering faults. OVG also works with BIM. The objects in the 3D model are intelligent, which means that they 'communicate' with each other so that, amongst other advantages, clashes are automatically detected.

Performance Evaluation

"As main contractor you should focus on your core strengths" says Bakker (RHDHV). For Oceanco this is the selling of yachts. A main contractor should not desire to be doing everything. The main contractor should therefore focus on process control, instead of checking every detail of the subcontractors' work. This system-based model of contract control fits the model of functional design, in which a supervisor is no longer continuously present on the construction site to check the work that is being done, but rather checks at random occasions in order to assure the quality. Through using random checks the subcontractor can be evaluated and punished with a penalty if deemed necessary.

Mooi (ASML) thinks the amount of control a main contractor desires depends on the type of relationship one wishes to have with their subcontractor. In a black box collaboration the degree of freedom is very important, therefore one should not wish to be updated constantly. Constant monitoring also requires large financial costs, there is therefore also a trade-off to be made here. Trust is of vital importance in such collaborations; If one has a good working relationship with a subcontractor on all levels, control becomes less important. It is crucial to maintain a strategic alliance between a main contractor and subcontractor on an executive level.

8.2 Applicability of the process design for the market

Next to the feedback on the functioning and completeness of the process design, the interviewees were therefore also asked whether the process design could be useful to their own organisation. This paragraph discusses the applicability of the process design for the market and gives insight in the elements of the process design on subcontractor management that are representative for other main contractors managing large engineering projects and the elements that are specific to Oceanco.

First, the interviewees generally recognized the distinction made in the process design between the strategic and project level, as the respective companies also have made this distinction themselves with regards to their organisational structure. This was considered to be important, as it makes the difference between project and portfolio, or short-term and long-term planning, clear.

Van Opstal (Philips Healthcare) was supportive of the presence of the strategic decision moment in a framework agreement, as Philips works with a similar model. They only outsource subprojects to preferred suppliers, who have all signed an Umbrella Purchase Agreement (UPA). The UPA forms the overarching framework agreement that contains, amongst other, the payment conditions, delivery conditions and liability clauses. Within this umbrella agreement Philips and the subcontractors engage in a SPA (Supplier Project Agreement) for each individual project. New sub-contractors have to be added to this list before they are allowed to work with Philips, regardless of the type of project or collaboration. This is done via an assessment.

The interviewees were also positive about the input of the type of subproject and subcontractor that determines the choice for when to involve the subcontractor. Even though the respective organisations for which they work all have their own procedures and processes in place to assess these inputs and making the decision, they all follow a similar line of thought. Vorselman acknowledged that the process design developed in this thesis could, although their business is different from Oceanco's, fit with their business.

To further illustrate: ASML works with build-to-print suppliers and black-box suppliers, where these two extremes form the extremes of the spectrum of the subcontractors that ASML uses. ASML uses Black Box suppliers if they need a product of which they only know the requirements and not the specifics. They are given a budget and a timeline, but within these constraints they are free. A form of requirement can be that the product has to have certain dimensions, so it can fit as an attribute in the total system. This type of subcontractor strongly relates to both blue-sky sub-projects and performance-based sub-project defined in the process design. Mooi calls this form of subcontracting performance-based. On the other side of the spectrum they have Build-to-Print suppliers, which ASML uses for the production of attributes that are completely specified, known as the catalogue sub-projects in the conceptual framework.

Philips also uses a similar model to the process design for making the decision when to involve the subcontractor (figure 44).

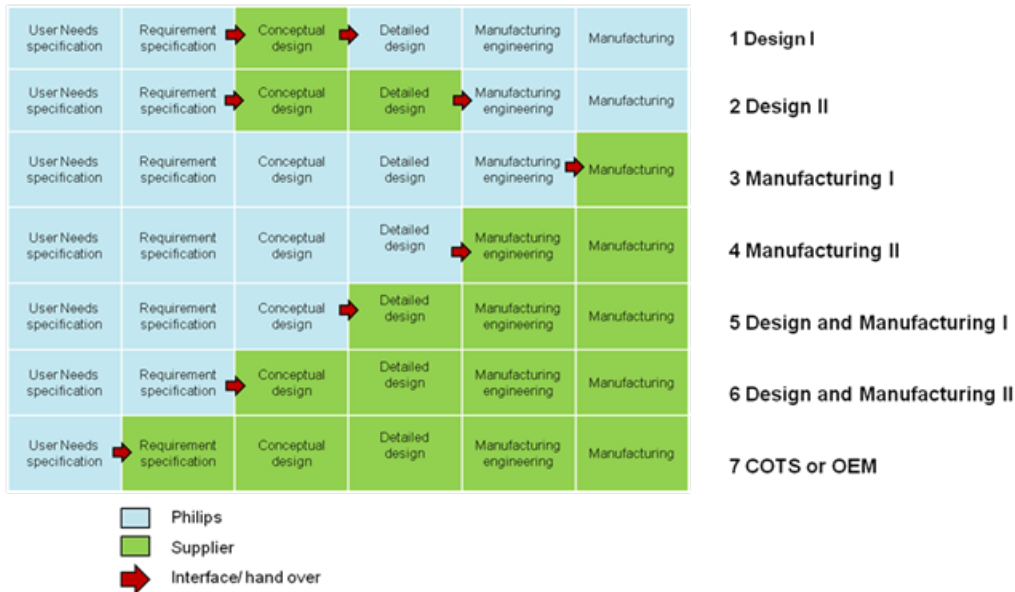


FIGURE 44 MODEL USED BY PHILIPS TO DECIDE WHEN TO INVOLVE SUBCONTRACTOR

When the decision to make a buy has been taken, Philips Healthcare works with different levels of out-sourcing, based on the project life cycle stages. Whereas this research’s process design considers 4 stages in which the subcontractor can be involved, Philips has decided to work with 6 stages. This can be explained by the fact Philips mainly works with manufacturers, and therefore lays more emphasis and detail into the different designs that are made during a project. The process design takes a slightly more general view, as the process design is also meant for subcontractors delivering services. For example, the interior builder not only manufactures the interior, but also installs it. The model of Philips that is shown is complementary to the process design. It nevertheless is important to not that the influence of the type of subproject on the involvement of the subcontractor in Philips’ model is not included.

The interviewees had some critique with regards to the advisory role of the process design, arguing that the process design generally left a lot of room for variations in the process. They argued that they missed some steering/advisory aspect in the process design, which could give them a concrete advice on how to approach a subcontractor. This guidance was also found in the feedback from Oceanco, for which the subcontractor canvas was created. Unfortunately, due to time constraint of this research, this canvas could not be shown to the interviewees.

Furthermore, although currently not yet applied at Royal IHC, van Arkel suggested that it might be beneficial to include contracts like Design & Build and Design, Build & Maintain in the process design as these have proven to be beneficial in the construction industry. Through these processes the payment scheme is more performance-based than traditional lump sum rewarding. These models were only implicitly included in the process design by the relation between the decision moment of when to involve the subcontractor and the payment scheme to choose.

Bakker (RHDHV) argues that he would lay the focus in the process design more on the competences and willingness of the subcontractor to work with the main contractor. Thereby, he claims that it is important to take into consideration how close the collaboration between the two parties can be, whether the software used by the subcontractor is compatible, whether the subcontractor is willing to cooperate in an improvement process like the Deming Circle etc. Nevertheless, Bakker believes the process design is helpful in making informed decisions with regards to the choices made in subcontractor management.

8.3 Contrasting process design with literature

Now that the process design has been verified on its functioning by application to the case study and feedback of professionals in the market has been gathered, it is interesting to contrast the process design with the literature presented throughout this thesis, in order to analyse whether the process design differs from current academic views.

It is interesting to look back at the spectrum of literature on subcontractor management presented in chapter 5 of this thesis. The process design puts considerable emphasis on the relation between the main contractor and the subcontractor, by considering it as one of the three input variables for the choices to be made in the management approach. The process design therefore tends to follow the ideas behind approaches like partnering, strategic alliancing, and integrated project delivery, as opposed to the traditional adversarial approach (Bygballe, Jahre, & Sward, 2010; Miller, Packham, & Brychan, 2002; Anvuur & Kumaraswamy, 2007).

The process design does however provide possibilities for more control with collaborative tools, but trust is considered to be an important influencer in this choice. Furthermore it defines a relationship between the characteristics of the subproject and subcontractor and the approach to be followed. As such, it favours a more adversarial approach when the subprojects are simple and the supply market not complex, and a more participative softer approach when considering complex subprojects in supply markets with limited or only one subcontractor.

The process design does not really contradict literature, it merely brings literature together. This can be explained through the process design's goal: enabling the main contractor to make an informed decision on how to manage its subcontractor. It therefore does not strongly steer the subcontractor approach to follow. The argument behind this choice in approaching the process design does however show resemblance with the academic theory of process management that there is no unambiguous substantive solution that holds for every situation (De Bruijn, ten Heuvelhof, & in 't Veld, 2010).

The process design furthermore tries to show possible means to deal with the problem of Moral Hazard, derived from Agency Theory (Rahman & Kumaraswamy, 2004), by following the principles of Relational Contract Theory (Veen & Korthals Altes, 2011). The process design also seeks to provide the main contractor with clear contract forms that can be used as a starting point for better cooperation. The process design does not provide a contract agreement that will fit in every situation, as this is not possible (Kerzner, 2013).

Finally, the process design follows the main thought behind a strong body of literature that argues that project management should be made contingent upon the project's context or environment (Bosch-Rekvelde, 2010; Engwall, 2003; Howel, Windahl & Seidel 2010; Sauser et al 2009; Shenhar, 2001; Smyth & Morris, 2007; Williams, 2005). More emphasis is put on the behavioural aspects, but it is still complemented by traditional tools and techniques of project management presented in PMBoK and other project management bodies of knowledge, so the process design is finding the middle ground, or presenting the best of both worlds considering subcontractor management.

The subcontractor management canvas follows the line of thought behind the business model canvas, by providing the user with the right questions and decisions to be made (Osterwalder & Pigneur, 2009). Further scientific value of this canvas needs to be researched and could be subject of future research.

8.4 Conclusion on evaluating the process design

This chapter explores the usability of the process design outside of the organisation of Oceanco, for other main contractors managing large engineering projects that are dealing with similar challenges considering in the management of their subcontractors. For this purpose project managers from several industries were asked about the functionality of the process design and whether it would be of use in their own organisation. Additionally the process design was confronted with literature on subcontractor management to see how the findings in this research correspond with findings in literature.

Although the process design was constructed using the data from a single case study, combined with all relevant academic literature found, the process design seems to also be applicable in other markets, for other main contractors.

The interviewees were generally satisfied with the completeness of the process design. As mentioned in section 8.2, the interviewees had some critique on the process design for being too abstract, as they were missing an advisory function in the design. In reality the choice for this abstractness in the process design was deliberate, because the process design's goal is to allow main contractors to make an informed decision themselves. In subcontractor management some discretionary room is needed to adequately deal with the complexities of specific subprojects and characteristics of specific subcontractors, instead of being mauled by a predefined procedure.

The process design should allow for flexibility, as there is no single ideal procedure to approach a particular problem (De Bruijn, ten Heuvelhof, & in 't Veld, 2010). The process design shows that there are multiple ways to manage a subcontractor successfully. It follows the thought that project management should be made contingent based upon its content (Bosch-Rekvelde, 2011). However, it is recognized that the process design could be made more detailed, according to the context of the market in which the main contractor operates. The subcontractor management canvas could have been the right tool that included this advisory function, but could not be presented to the interviewees due to the time constraints of this research. This could be interesting for further research, which is elaborated upon in the final chapter of this thesis.

Additionally, some interviewees gave feedback on the process design, arguing that the influence of risk was not emphasized enough. Mooi argued that the influence of risk on subcontractor management was insufficiently emphasized in the process design. Vorselman and Bakker also underlined the importance of risk in subcontractor management. The ownership of risk is essential for subcontractor management, as it steers the allocation of cost.

Indeed, subcontractor management is recognized to be about the replacement or transfer of risk. The influence of risk is taken into account in the process design via the input of relation, as risk allocation is specifically mentioned as being one of the ten key indicators for the relationship. Besides risk is inherently coupled to the typology of both the subproject and the subcontractor. This is because the goal and method specification that determines the typology of a subproject includes risk, and the complexity of the supply market also considers risk in defining the type of subcontractor. Finally, risk is one of the criteria to be taken into account in the process design's bid evaluation. This encompasses both the risk transfer, as well as the potential risk premium to be paid by the main contractor. In the subcontractor management canvas risk is purposefully strongly emphasized as a bid evaluation criterion that should be taken into account for each outsourced project, regardless of its specifics.

In literature the influence of risk on projects is also widely recognized. However, the importance of these risks on the subcontractor management approach is underexposed in literature. Furthermore, risk is in the PMBoK recognized as one of the key areas of interest, while the underlying relation between these areas, and thus their interdependency, is not defined. The process design does acknowledge the broad influence that risk has on the choices to be made in subcontractor management and thus project management as a whole. Nevertheless, it is recognised that the process design could have emphasized more the influence of risk. Risk is implicitly present in the entire model, but could have been mentioned explicitly more often. Risk analysis could for example also be used as an input for the model. The conclusion and recommendations chapter further elaborates on potential improvements of this research.

9

Conclusion & Recommendations

Main contractors managing subcontractors in large engineering projects face numerous challenges. As projects are becoming more complex due to their increasing size and usage of state-of-the-art technologies, main contractors increasingly rely on the subcontractor's expertise to realize their projects. This dependency has consequences for main contractor's position, but also creates new opportunities for collaboration. This study was initiated to provide main contractors managing large engineering projects with insight on how to best manage their subcontractors.

By performing a single case study, an extensive literature review and numerous interviews with project managers managing these complex projects, a process design was created to help main contractors make an informed decision on their subcontractor management approach. The aim of this study was to elucidate the following problem statement:

It is unclear how main contractors in complex large engineering projects should shape their management approach towards subcontractors to improve both the relationship with the subcontractor, as well as project performance

This chapter first presents the conclusions of this study in section 9.1. Subsequently section 9.2 provides answer to the main research question in this thesis. Finally section 9.3 discusses the findings in this study and gives recommendations for further research.

9.1 Conclusions

Central to the research problem of this thesis are the challenges that main contractors face in managing their subcontractors in complex large engineering projects. After considering the problem statement in the research's problem exploration phase, the following main question was formulated:

Which approaches to subcontractor management are effective in large scale, complex, engineering projects that are characterized by a high amount of change orders and uncertainties, and under which circumstances?

The main research question was divided into a number of sub-questions to provide structure in the research and develop the knowledge needed to answer this question adequately. The chosen methodology to scientifically address the research question consisted of three main phases: a case study, a literature study and a process design.

The conclusions on the case study are presented in section 9.1.1. Section 9.1.2 presents the conclusions of the literature study; the knowledge base of the research. Together they have formed the input for the construction of the process design, of which the conclusions are presented in 9.1.3. Finally, 9.1.4 discusses the justification and presents the conclusions of the confrontation of the process design against the case study of Oceanco as well as other large engineering projects present on the market.

9.1.1 CASE STUDY

The subcontractor management practises of Oceanco were used as a case study and subjected to an in-depth analysis with the aim of finding the challenges and barriers that this company encounters. The environment in which Oceanco operates was found to be challenged by the presence of multiple barriers. Firstly, their projects are becoming increasingly complex, [REDACTED]. Secondly, due to the market characteristics, such as the limited availability of expert subcontractors, a number of subcontractors have a very strong bargaining position. Furthermore, Oceanco works directly for the client, who is likely to change its mind during the project life, thereby making the management of these change orders very important. Additionally, Oceanco is growing its building capacity, as it has recently opened a new facility that can host the building of yachts with a length up to 140 meters. The company therefore also faces the challenge to find the subcontractors that can facilitate this growth. [REDACTED]

The case study brought to light that subcontractor management takes place at multiple levels of the organisation and exceeds the project boundaries. The relationship that is or has been conserved with the subcontractor influences the choices that the purchasing department and the project manager take in the project. It also influences how the negotiations between the main contractor and subcontractor take place, and therefore influences the project and its performance as a whole. The model on subcontractor management was constructed to capture the findings of the case study on subcontractor management at Oceanco (see figure 45).

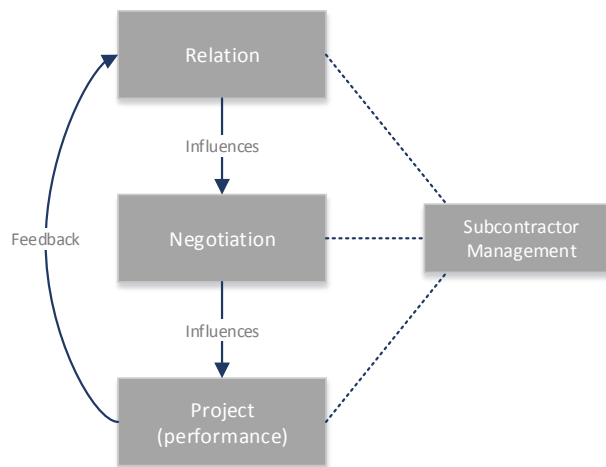


FIGURE 45 MODEL OF SUBCONTRACTOR MANAGEMENT

The model on subcontractor management furthermore uncovered the major interactions that steer subcontractor management. It raised a number of questions considering the concepts of relation, negotiation and project (performance), and the interactions between these concepts. These questions steered the literature research.

9.1.2 LITERATURE

The model on subcontractor management raised a number of questions that guided the search for literature. The knowledge base, as this part of the research is called, is divided into two parts: one part focussing on project (performance) and another focused on the relation and negotiation within the subcontractor management model.

The research on project (performance) has led to some important insights with regards to subcontractor management. Defining the concept of a project as a *'temporary effort undertaken to create a product, service or result'* (adapted from PMI, 2008) has given way for determining the major decision moments that take place in subcontractor management, as it uncovered the 'timeline' of subcontractor management. The schools of thought on project management (Söderlund, 2011) show the pluralism in project management research and have steered the efforts of creating the process design into a model that embraces this pluralism. The process design is strongly affiliated with the behaviour school, relationship school, decision school and optimization school. There is no 'plug and play' approach for project and subcontractor management; the management approach should be made contingent on its context. Finally this part of the literature study reveals that the management approach of a project largely determines the freedom that is given to the subcontractor and is often based upon the performance indicators of cost, quality, and time. Literature often fails to recognise the relation as a driver behind successful project performance.

The second part of the literature study is focused on negotiation and relation. As input for this level of subcontractor management, a typology of subprojects and subcontractors has been created. Furthermore, the main trends in subcontractor management have been researched in more detail. The traditional adversarial approach towards subcontractors was found to be challenged by approaches like partnering, alliancing, and integrated project delivery. These approaches are founded on features such as early involvement of key parties, transparent financials, shared risk and reward, joint decision-making and a collaborative multi-party agreement, thereby putting more emphasis on the relation between the main contractor and subcontractor. The relation is analysed by key relationship indicators. Following the guiding principles of Relational Contract Theory ensures that this relation is taken into account in the negotiation.

9.1.3 DESIGN

The information gathered from the case study and literature is used for the development of a subcontractor management process design. The process design on subcontractor management is founded on the created model of subcontractor management. The process of subcontractor management on the respective levels of strategic & relational, project & negotiation and operational & performance is decomposed using seven decision moments, in which the main contractor is presented with multiple choices per decision moment.

On the strategic & relational level of subcontractor management, portfolio management of projects take place. The relationship, decomposed in ten key indicators (Meng, 2012), is used as input in determining whether to engage in a framework agreement with the subcontractor. This relationship also influences the decisions made on the project & negotiation level, together with the type of subproject and subcontractor. The decisions of when to involve the subcontractor, which type of tendering to use, the bid evaluation criteria and the type of payment are made on this level. The decision moments are interrelated and thus influence each other. The operational & performance level contain the collaborative tools and the performance evaluation that ensures feedback to all levels of the organisation. Finally, the decisions made in the process design will impact the relation with the subcontractor during the project and for future projects.

The choices made in these decision moments affect the project performance criteria. The project performance will influence the relationship with the subcontractor by means of a feedback loop, as experiences and interactions shape the relationship between the main contractor and subcontractor. The interrelatedness between the decision moments and the project performance criteria reveals that the performance criteria can also influence the choices made in the decision moments. The focus on

for example time can result in trade-offs considering the cost and quality of the subproject. The process design does not actively steer the subcontractor approach of a main contractor, but enables the main contractor to make an informed decision by providing a comprehensive overview with the needed discretionary room to tailor the management approach to its specific context.

9.1.4 JUSTIFICATION

Justification of the process design was based on empirical data: by applying the process design for Oceanco, interviews with project management professionals and by contrasting the design with the relevant literature.

The process design challenges the current approach that Oceanco uses for its subcontractors. [REDACTED] the process design distinguishes the approach based on the complexity of the subproject, the typology of subcontractor and the relation with the subcontractor. For the strategic co-makers of Oceanco this approach is most flexible and contingent upon its context, as the projects that these subcontractors execute are the most complex. Many challenges that Oceanco currently faces with the management of these co-makers can be traced back to the relation between the parties. The process design emphasizes the importance of the relation and suggests an approach that incentivises Oceanco and the subcontractor to collaborate more intensively, in which flexibility for change orders is taken into account and risks are allocated towards the party that can best handle these risks.

Based upon feedback from Oceanco on the process design, stating that it lacks some guidance in the decisions to be made in the subcontractor management strategy, a subcontractor management canvas has been created. This canvas gives clear suggestions on the approach to follow based upon the input variables. To account for the organisational context of Oceanco, [REDACTED] a workshop was organised to activate the executives of Oceanco themselves, instead of presenting them a solution. In this workshop the participants created the requested guidance themselves, after which a discussion ensued on the differences with the canvas presented in chapter 7. Currently, a follow-up of this meeting is being discussed at the executive level of Oceanco in order to give the subcontractor management canvas a formal place in Oceanco's purchasing process.

The project management professionals operating in other industries were generally positive about the completeness and insights offered by the process design. The process design was considered to be more useful for the subprojects that are complex (the performance-base and blue-sky projects). This can naturally be explained by the fact that subprojects with a high complexity also have a high degree of uncertainty, which makes the management of the subproject more difficult. The professionals' criticism on the process design mainly concentrated on its level of steering. They would have liked to have more concrete steering suggestions on how to manage their subcontractors. The subcontractor management canvas offers such concrete support, but due to time constraints this canvas could not be presented to the interviewees. Validation for this canvas is therefore lacking and could be subject for future research (see discussion & recommendation).

Although the process design was constructed based on the data from a single case study and relevant academic literature, the process design was found to be applicable in other markets. The process design does not contrast literature, but merely integrates different schools of thought, without disregarding the pluralism inherently bound to this topic. The process design is believed to be flexible and adaptable to allow for context-specific subcontractor management. More specifically, it enables the main contractor to make an informed decision on how to approach a subcontractor in a

complex large engineering project, leaving enough discretionary room to adapt the strategy to the specific context of each subproject and subcontractor.

9.2 Answering the research question

This research's central question has been stated as follows: Which approaches to subcontractor management are effective in large scale, complex engineering projects, that are characterized by a high amount of change orders, and under which circumstances? By means of the formulated sub-questions relevant knowledge was gained from both theory and practise to answer this research question.

Effective subcontractor management approaches are highly circumstantial. The most important indicator in determining the subcontractor management approach is the complexity of the subproject. This complexity can effectively be determined by assessing the goal of the subproject and the method used to achieve this goal. The largest gains are to be made in the complex subprojects that either have an undefined goal, or method, or both. For these subprojects two aspects are of the essence: the relation with the subcontractor and the allocation of risk. The main contractor wants to use the expertise of the subcontractor in these projects (determining the goal/method), and leave room for the subcontractor to excel. The main contractor will only allow for this flexibility if there is trust between both parties. The key relationship indicators can form the starting point in assessing and improving this relationship. Risks in a subproject should be assessed together with the subcontractor beforehand and transferred to the party that could best handle this risk. Performance-based contracts can be used to give the subcontractor the right incentive to excel in its performance and allocate this risk to the right party.

The subcontractor management canvas provides more guidance in the management approach to be chosen upon the context of the subproject and subcontractor. Although this canvas was only presented to Oceanco, it can be argued to also have its effect for other main contractors, as the interviewed professionals gave similar feedback as Oceanco on the process design, which was later integrated into the subcontractor management canvas. The set-up of the workshop that was organised to communicate the findings of this study in the canvas activated the executives at Oceanco to rethink their strategy. Regardless of the specific content of this canvas, it is considered to be a useful tool to start and structure the discussion on subcontractor management within the organisation. It activates the user to think about the most important aspects of subcontractor management and how to shape these according to the specific content of the subproject and subcontractor. Additionally it provides the user of the canvas with an advice that is based on an extensive case study, literature review, interviews and a workshop with six professionals from Oceanco.

The influence of change orders on the subcontractor management approach was found to be mainly related to the complexity of the respective subproject, as this influence is only present in subprojects that either have an undefined method or goal (or both). Complex subprojects require a certain degree of flexibility in the agreement between the main contractor and subcontractor. Furthermore, the crux of handling the change orders lies in a systematic way of handling these change orders, in which the impact of the respective change order is identified before it is put into practise. This relates back to the identification and allocation of risk.

Finally, subcontractor management takes place at multiple levels of the organisation of the main contractor; it exceeds the project boundaries and is largely influenced by previous interactions, as well as potential future interactions. The relation with the subcontractor influences the negotiation,

which will subsequently influence the project (performance). Subcontractor management therefore requires an integrated approach, in which the feedback from the operational to the strategic level of the organisation a precondition is for improvement.

9.3 Discussion & Recommendations

The process design constructed in this master thesis naturally generalizes and/or simplifies the process of subcontractor management. This is done to make this capricious process understandable and workable. The complexity in developing such a process design lies in the challenge to include enough to make the content applicable to real life situations, while keeping the design understandable and workable for companies operating in the complex projects described in this research. Therefore, this section discusses the limitations of the process designed and constructed in this research, and provides recommendations for further research.

Literature, but mainly practise, has taught that much of subcontractor management is actually done based on instinct and gut feeling, as opposed to being guided by several formal procedures. The remarks and observations of many authors contributing to this field of research rightfully state that every project is different. This is especially valid for subcontractor management, as it is the management of human beings; the management of interactions. This makes subcontractor management so context-dependent that it is hard to provide a process design that is considered useful in practise. This was also the general feedback given by the interviewed professionals, before showing them the process design.

An important remark made by several professionals interviewed in this research was that the process design did not actively enough steer the approach to be followed. Ideally this research would provide the answer to all of the problems related to subcontractor management, but this is simply considered not to be possible as subcontractor management is too context-dependent. The goal for this research was therefore to provide a tool, a process design, that could help main contractors make an informed decision about their subcontractor management approach. In subcontractor management some discretionary room is arguably needed to adequately deal with the complexities and characteristics of each specific subcontractor, instead of being mauled by a predefined procedure. The process design therefore allows for this flexibility to adjust the approach based according to the context. It is nevertheless recognised that it could be possible to detail the process design further based on a specific market in which a main contractor operates. However, this was outside of the reach of this research. The arguably needed flexibility has therefore resulted in a relatively abstract process design. As a consequence, the process design does not provide the solution for all of the challenges at Oceanco or other main contractors. For example, the process design has failed to adequately address the influence of Oceanco's expansion desire to subcontractor management. Further in-depth research into Oceanco and its supply market would be necessary to give an advice on this matter.

As illustrated throughout this research, the relationship between a main contractor and subcontractor can make or break a project. The process design underlines this and tries to grasp the measurable decision moments in the interactions that take place in this process and present different choices that are likely to influence the project performance criteria and the relationship with the subcontractor. The process design does not, and cannot, account for specific variables in this relationship that are context-dependent. For example, if the project manager of the subcontractor is depressed and does not hold on to the agreements made with the main contractor, this is likely to influence the relationship with the main contractor. However, such intangible situations fall outside the scope of this research.

The effort to transform the process design into a canvas was taken as a response to the feedback provided by Oceanco and the interviewees upon presenting the process design. This canvas is considered to steer the management approach to be chosen more actively, while still leaving the necessary discretionary room to adjust the management approach upon its context. Alternatively, the canvas can also be used 'empty', as the well-known Business Model Canvas is used. Although the canvas was well received by Oceanco, the applicability for other main contractors could not be validated. This could be interesting for future research.

For future research it would furthermore be interesting to investigate whether the canvas could be validated and iteratively improved by a study containing multiple case studies. Additionally further research into the influence of the allocation of risk on the subcontractor management approach is recommended, because even though the impact of risk is broadly shared amongst scholars writing on project and subcontractor management, empirical data would benefit the process design and canvas, and help main contractors managing subcontractors in the complex large engineering projects.

Epilogue

The process design made in this research has proven its scientific value through empirical research. However, when presenting the design to Oceanco this scientific piece of engineering appeared not to be exactly what they were searching for: the process design was lacking clear guidance and was too abstract to use within the organisation. Therefore the effort was taken to develop the process design further according to Oceanco's context and create a more easy-to-use tool for subcontractor management: the subcontractor management canvas.

The subcontractor management canvas does not differ much from the process design made in this research. It is based upon the same input variables and it considers the same decision moments as used in the process design. Two major differences are included in the canvas, making it more easy to use: the input variables are specified and included throughout the canvas. The methodology to define the typology is included to ensure the canvas can be used as a stand-alone tool, without supplementary reading. Additionally, the input variables were assigned a colourful icon, and included throughout the canvas, in order to provide guidance in the subcontractor approach to be chosen. This creates a relatively simple canvas, that shows the most clear directions on subcontractor management. For example, if one considers the choice of when to involve the subcontractor, it is immediately clear that early involvement requires a good relationship with the subcontractor and is mainly (if not only) used for project with a high level of uncertainty outsourced to strategic partners when looking at the canvas.

After the creation of the subcontractor management canvas the barrier of implementation was considered. [REDACTED]

[REDACTED] the idea of a workshop came to light. The workshop was organised in order to let the participants experience how one can strategically think about subcontractor management, and which choices could be made. Instead of presenting them with the filled canvas, the participants were asked to fill the canvas in according to their view. The discussion this workshop evoked was exactly what was needed to create awareness and to show the opportunities of working methods that are usually not followed at Oceanco.

The next step in the improvement of subcontractor management at Oceanco involves the actual implementation of this subcontractor management canvas in Oceanco's purchasing. In order to realize this, an additional number of workshops should first be organised, in order to make every employee concerned with subcontractor management at Oceanco comfortable with the use of the canvas. These workshops can also be used to further improve the content/advice in the canvas. Secondly, the canvas should be assigned a formal place in the purchasing process. The purchasers at Oceanco have a number of steps to follow when outsourcing a specific subproject. Filling in the canvas as a prerequisite before starting this process could benefit the project in its entirety. Furthermore, the canvas can be used as a communication tool between the purchasers, project managers and others concerned. The way to improvement of subcontractor management is, due to specific relational characteristics, generally long, but worth the effort.

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Appendix I Detailed production process at Oceanco

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Appendix II Change Order Request Form

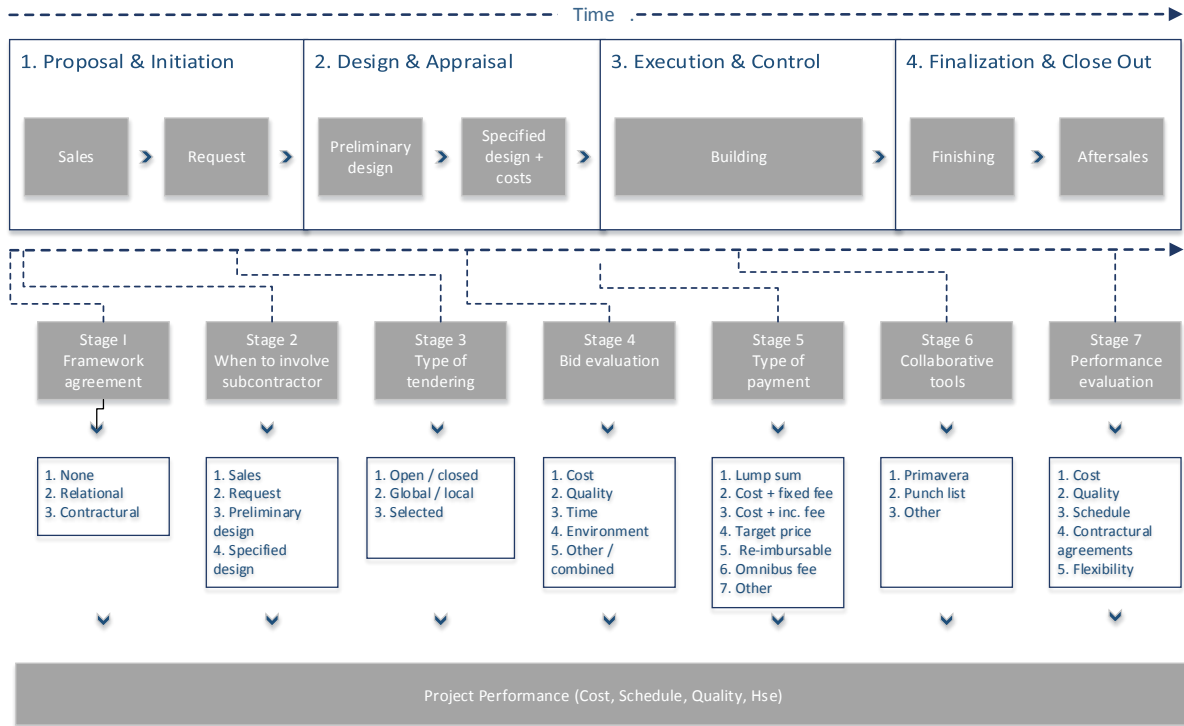
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Appendix III Oceanco Subcontractors

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Appendix IV Process design development

First sketch used to discuss subcontractor management at Oceanco.



Appendix V Semi-structured interviews

The empirical data in this research is gathered by means of interviews with experienced project managers of large engineering projects in other industries than the luxurious yacht-building. This is done to see if the process design of subcontractor management presented in chapter 6 can also be useful for them.

As these project managers have a lot of experience and will share more information when talking freely, the interviews are semi-structured. This means that the interview is not a questionnaire, but more a discussion. To make sure that relevant data is collected, a list of questions is kept by the interviewer, which will be used if the conversation stagnates and used before closing the interview as a check.

The list below shows the questions that were prepared for the interview sessions.

Part I Introduction

1. General information about my research, study background and goal of the interview
2. General information interviewee
 - a. Company description
 - i. What are the core values of your company?
 - ii. What is your companies' signature?
 - b. Function
 - c. Past experience
 - d. Daily occupation

Part II Project Selection

1. Explain the interview/research method
2. Can you tell me more about the business cycle at your company?
 - a. How does the process generally proceed from first contact to delivery?
 - b. Please elaborate on your part in this value chain
3. Is subcontractor management mainly done at project level, or at portfolio level?
 - a. Why?
4. Are there two projects in your portfolio that were similar in characteristics, but of which the outcome differed (greatly)?
 - a. Budget between 100-200 million
 - b. Working directly for end-consumer; regular change orders
 - c. Complex; state-of-the-art technologies
 - d. Highly dependent on subcontractors
5. When is a project successful according to your company? Focus on quality, cost, time or other performance indicators?

Part III Project Differences

1. Can you tell me some characteristics / background of two projects that differed?
 - a. Who initiated it?
 - b. What was the timeline / scope of the project?
 - c. Number of subcontractors

2. How many subcontractors were involved with each project?
 - a. Did you make a distinction between type of subcontractors
 - b. If yes, what distinction (categories)

3. How were change orders generally processed?

4. What were the key differences between the two projects resulting in this difference in project performance (focus on subcontractor management)?
 - a. Use of different subs?
 - b. **Stage model options** / decision moments
 - i. When does your company generally involve a subcontractor?
 1. Before or after tendering / design stage
 2. Or is this totally dependent on the type of contract?

5. What are the most important factors influencing subcontractor relationships?
 - a. Contract / trust / long term perspective
 - b. If possible, in what sequence of importance?
 - c. What do you think are good incentives for subcontractors to keep agreements?
 - i. Incentives, like what?

6. Do you see difference between subcontractors?
 - a. Why/how are these differences?
 - b. What kind of subcontractors is difficult to manage, what kind is easy?
 - c. What are co-makers/partners to you? Preferred suppliers?
 - d. How do you think subcontractors should best be managed?
 - i. Dependent on / differentiate between type?

7. How is risk managed at your company, considering subcontractors?
 - a. Use of multiple subcontractors for example
 - b. Or use of lump sum / risk evasive strategies
 - c. Risk profile per subcontractor?

8. Do you think software or other tools could be beneficial for management of subcontractors?
 - a. Any tips/tricks you want to share?
 - b. For example 'kruisjeslijsten', primavera?
 - c. What would you like to see changed?

Appendix VI Interviews

I. Interview with Herman Mooi - Future Mode Operations at ASML

Program Manager Office Future Mode Operations at ASML

Interviewer: Ruud Brockhus

Interviewee: Herman Mooi

Date: 13/03/15

Subject: Subcontractor management

1. General Information

ASML is a multinational with over 13.000 employees worldwide. They make use of over 600 subcontractors to get their products to the market, which accounts for 86% of the total product value of ASML. ASML makes machines that can etch lines varying from 10 to 15 Nano-metres on the photosensitive layer of the silicon plates that are used in the electronic industry. They can do this with an accuracy of 0.1 Nano-metres. They control almost 90% of the market due to their technological advances; for example on UEV technology they not yet even have a competitor. ASML operates in a highly complex environment; subcontractors are asked to produce a product that is accurate on the level of nanometres.

ASML does not make one-off products, but produces their technologies in small series. However, nearly none of these product are exactly the same, because they are customized according to the client's needs and wishes. Suppliers do have to be able to make the attributes in small series.

Herman Mooi is no specialist in the field of subcontractor management, nor has direct experience with the management of these subcontractors, but does have a rich background in project management. He has been teaching at the Shell project academy for over 8 years and was director of the Delft Centre for Project Management.

2. Type of Subcontractors at ASML

ASML uses Black Box suppliers if they need a product of which they do not know the specifics, but only the requirements. The subcontractors must comply with these requirements, but except from these requirements they are given all freedom. A form of requirement can be that the product has to have certain dimensions, so it can fit as a attribute in the total system. The Black Box suppliers are given a certain budget and amount of time to develop this product. This form of subcontracting is performance-based.

On the other side of the spectrum they have Build-to-Print suppliers, which ASML uses for the production of attributes that are completely specified.

ASML uses Quality, Logistics, Technology & Cost (QLTC) as criteria to evaluate suppliers. The subcontractors ASML works with are thus not evaluated purely of price, but also on the quality of the delivered product/service and the logistics (timing). Subcontractors have to pre-qualify in order to participate in a tender, to prove that they can deliver the product or service that ASML inquires. The QLTC principle needs to be embraced by the subcontractors.

3. *Performance indicators*

A number of important clients of ASML are also shareholder of the company, which complicates the client – main contractor relationship. Considering the Iron Triangle of project performance, for ASML time is always the most important performance indicator. With cost and quality trade-offs are being made, but time is always of the essence. This also holds for the subcontractors that works with ASML, hence the logistics aspect in the QLTC evaluation. Consequently it happens that ASML delivers products that are not yet fully complying with the specifications of the agreement, but this is accepted by the market. For the first shipment of a product series time is always the driving force.

Much freedom is given to the black box suppliers of ASML. They are given a budget and a timeline, but within these constraints they are given all freedom. In concert they may decide to increase the budget or extend the timeline.

4. *Risk*

Replacing the ownership of the risk to the subcontractor or insurance company increases cost. Every risk has an expected value, for which the main contractor will be charged.

ASML may require investments made by the subcontractor, for example when a product they inquire can only be made with a special machine. The risk here is taken by the subcontractor, as they are dependent on the sales of ASML to ensure profit on this investment. ASML may also use penalties if a subcontractor does not meet a deadline or other aspect of their agreement.

However, regardless of the penalty, in the end the main contractor owns the risk because of their responsibilities towards the client. Besides, the main contractor does not benefit from bankrupting their subcontractors because this will cause delays and might result in higher cost. To ensure the flexibility of ASML and its subcontractors ASML uses a % rule which states the subcontractor cannot be dependent on ASML as client for more than a certain percentage of their entire turnover.

The partnership between Zeiss and ASML is different and rather unique. Zeiss is largely dependent on ASML and vice versa. Zeiss is the only subcontractor of ASML for the lenses they use. This partnership is a strategic alliance, which is working rather well for both parties. Exact criteria for this successful relationship are hard to give, but the awareness of their mutual dependency and their scope with enough freedom works really well. The communication lines between Zeiss and ASML are really short, both on operational level as well as on executive level. This ensures that the products are fully aligned.

5. *Conceptual Framework*

The timeline in the conceptual framework is not clearly enough to be interpreted correctly. Herman thinks it is hard to make a framework for such a complex, tacit knowledge based, issue. The relationship is dependent on the type of sub-project. He thinks the subcontractor cannot already be involved at the request stage, because the main contractor first has to know what he is up to. The timeline is thus a point for attention when improving the conceptual framework.

The amount of control one wants depends on the type of relationship you wish to have with your subcontractor. In a black box collaboration the degree of freedom is very important so you should not wish to be updated constantly. Constant monitoring also requires large financial costs, so there is a trade-off to be made there. Trust is of the essence. If you have a good working relationship with a subcontractor on all levels, control becomes less important. It's crucial to have strategic alliance on executive level between main contractor and subcontractor.

II. Interview with Rien Bakker – Business development at RHDHV

Business Development Manager at Royal Haskoning DHV

Interviewer: Ruud Brockhus

Interviewee: Rien Bakker

Date: 24/03/15

Subject: Subcontractor management

1. *General information*

Rien Bakker finished his studies in Utrecht and started his working career at the municipality of Amsterdam, working as supervisor for the department of Public Works, responsible for the roads in the city centre. His responsibility was mainly the planning and coordination of all the roadwork that needed to take place in the city centre. Amongst others, he coordinated the projects of renovating the infrastructure at De Munt and Rembrandtsplein, two of the busiest squares in Amsterdam. These were complex projects, because all the shops and restaurants needed to stay accessible during the renovation.

He left the municipality of Amsterdam to go work for the Province of Zuid-Holland in Sliedrecht. After reforms in the Province organisational structure he moved to Den Haag to work for the Transport department. He first did multiple projects as assistant-project manager, later he coordinated the Province's largest project; the construction of the N470. He spend 12 years on this 200 million euro project.

He coordinated this project from the initial adaptation of the structural visions until the placement of artworks alongside the road. He gained lots of experience with this project because he was given the freedom by the Province. After this project the department with engineers was divested from the Province and became self-sustaining under the name of IBZH (Ingenieursbureau Zuid-Holland) and was subsequently taken over by DHV. That is how he ended up working at Royal Haskoning DHV. He has run an engineering department for some years and is now focused on business development, often working with (sub)contractors in works at national level.

2. *Way of working*

Rien Bakker evaluates the large works that need to be put up for tender by ProRail, Rijkswaterstaat and other large provincial/national projects to see if RHDHV can add public value, after which they often team up with a builder. Sometimes they make arrangements for teaming up two years before the project is put up for tender. They hardly ever wait until the actual tender is placed on 'tendernet'. This makes them better prepared, also in benefit of the client. Depending on the size of the project they also work in consortia, largely dependent on the amount of risk that the builder can take or is willing to take. Projects like the A15 MaVa are hard to calculate and bring large risks with them in execution.

3. *RHDHV's role in projects*

The government as client mainly uses its contracting/engineering entity to lead the project. They make use of an integral project management team, in which RHDHV is often hired to complement this team. In other cases RHDHV is hired by this project management team as one of the subcontractors.

In case they are part of the integral project management team they help with gaining political support, budgeting, establishing a timeline, scope, functional design etc. In this case RHDHV delivers engineers on secondment, who therefore have the same interest as the project, rather than being in the role of subcontractor. RHDHV thus brings knowledge to the project management team. This approach is seen more and more in the builders' market as well, because of the Design & Construct trend in the construction industry in which the builder is responsible for both the design and construction, often complemented with the maintenance as well. This shift has gone quite fast (about 10 years), but parties are accustomed to this now.

Systems engineering assures an integral approach in this context. What are the main goals, what are sub-goals? You can make a goaltree and a list of requirements using this approach. Systems engineering focuses on analysing and decomposing the projects, and enables making a functional design. Constructing a functional design is challenging, because you need to determine the degree of freedom. Old RAW contracts are specified in full, but this does not work with current complex projects. Also the award criteria for tendering play a role here, because tenders are no longer evaluated purely on price, but also other criteria.

4. How do you align the interest of subcontractors with the project?

The most important aspect is common interest. Rien assumes Oceanco's interest is mainly to deliver high quality on time, where cost is somewhat less important. The interest of the subcontractor is to make a living; a healthy profit. At RHDHV they use the principle of virtual design & construct to align interests. Based on the functional design they construct a virtual design together with the subcontractors. All the important builders and suppliers are brought together in a room to improve the design. In this way all parties are directly confronted with the consequences of their choices. It enables direct insight in possible clashes in design and division of the responsibilities if for example a pipe scheme runs through a wall where a door should be placed. The main contractor (Oceanco) can subsequently decide who should adapt and the respective subcontractor can make a financial estimate. The advantage in this approach is the speed at which decision making can be done; at separate locations solving such conflicts will take longer and often lead to suboptimal solutions.

Additionally the purchasing process should be started earlier in the project life cycle. The contractor should be involved earlier on, and the tender evaluated on criteria other than just price. For example on (software) compatibility. That you have to adapt your purchasing process to improve the relationship with your subcontractor is often underexposed. It requires an investment in the beginning, but will result in better project performance throughout the project, because it is less likely that you have to go back to the drawing table and enables just-in-time delivery of goods for example (which results in a cleaner construction site, and therefore less accidents).

5. How to deal with changes of scope during the project?

The department of RHDHV that manages construction of Hospitals, ER rooms and such have lots of experience in this. Change orders are common practise here because these projects have a great timeline and new innovations need to be implemented continuously.

But generally the relationship with the client is very important, so as main contractor you want to please the client as much as possible. The secret in handling change orders properly lies in the systematic structure of your requirements. A change order is a change in the scope and therefore the requirements of your project. You have to analyse how the change order exactly impacts your projects. RHDHV has learned the hard way that it is vital to only accept a change order after the exact consequences for the time, quality and cost of the project have been mapped. Cross-project

aspects like the planning of the yard also need to be included in this analysis. This mapping requires time and therefore money, but it is worth it.

6. Risks

The management of risks is very important and needs to be analysed beforehand. Modern tendering is all about management and distribution of risk. RHDHV uses the RISMAN method for the management of risks in projects. In groups they identify risks, assess the change of occurrence, the impact on time, quality and cost and the remaining risk. Multiplying the chance of occurrence with the consequence determines the contingency reserve one has to take. The challenge is to think of a mitigation strategy that is SMART. Risk management is all about the game of who takes which risk.

7. What if the number of available subcontractor is limited?

Rien Bakker does not have experience in the yacht-building industry, but does have a lot of experience in the road and railway market, that differ to quite a great extent from each other. The playfield of subcontractors within the road market is very diverse, while the railway market is rather limited. In the railway market only four engineering firms and four builders are capable of executing the projects, because ProRail has a very strict approval system that has to ensure railway safety at all times. The four engineering firms and builders often team up to make the best offer. ProRail keeps the power by regularly switching between these consortia.

8. Jurisdiction system

Rien pointed out that it is very relevant to consider the jurisdiction that applies between the client and main contractor. The Rhineland model of law knows the principle of reasonableness and fairness (*redelijkheid en billijkheid*), where the Anglo-Saxon model of law does not have such a clause. This has a large impact on the risk-reserves one has to make.

9. Conceptual Framework

Stage I Framework agreement

RHDHV uses framework agreements as well. RHDHV uses three models for their framework agreements; the first option is to agree with the subcontractor that you will award all the contracts to them for a certain period of time. The second option is that you will award them a specified projects over a period of time. The third option is to award a certain amount of projects over a period of time, but it is not yet clear which ones. For the first option holds that full integration is possible and desirable. When you specify for certain projects you enable the subcontractor to prepare for the projects and economies of scale are possible. The last option ensures work for the subcontractor, but leaves the subcontractor in the dark on what exactly will be the work. These approaches all have different dynamics with regards to subcontractor relationships. The main contractor needs to decide/think about what type of partnership he wants with his subcontractor. The subcontractor needs to decide/think about whether he wants to be dependent on the main contractor, because the main contractor does the sales.

Stage II When to involve the subcontractor

If you decide to involve the subcontractor after the specification has been made then you can tender on price. This does require much preparatory work from the main contractor, so there is a trade-off to be made here. How many employees do you have available for specification? Considering the career of your employees; is it interesting enough for them to just be busy with specifying the work that

needs to be done? Or should you give the subcontractor more freedom to do what he does best? In the end the subcontractor is specialized in this and the main contractor should not intervene just for keeping control. The main contractor should focus on its strengths; in this case selling yachts. As main contractor you should not be doing everything.

A quite radical view on this is to just sell knowledge, become a knowledge broker. Focus the capacity of the company to coordinate the work and let the actual work be done by subcontractors that are specialized in this. A precondition for this model to work is that you can trust your subcontractor. This list of subcontractors will therefore probably be short. As main contractor you focus on process control, you do not check every detail of the sub's work. With random checks you evaluate the subcontractor and if necessary give him penalties. This system-based model of contract control fits with the model of functional design; no longer a supervisor that is always on the construction site to check the work that is done, but random checks as quality control.

Stage III Type of tendering

Open or closed tendering; Rien thinks the best strategy for a main contractor is to have a shortlist of subcontractors for tendering.

Stage IV Bid evaluation

The quality assurance is largely already defined by the selection of subcontractors for the shortlist. Still the question remains whether you should evaluate tender on more aspects than just the price. Rien would focus on the competences of the subcontractor to work with the main contractor; how close can collaboration be? Software compatible with each other? Circle of improvement; Demingcircle; plan/do/check/act. Is the subcontractor willing to cooperate in such a process? How far is the subcontractor willing to go to align its way of working with the main contractor? Is this related to the collaborative tools.

Stage V Type of payment

In the infrastructure projects that Rien has coordinated the main contract used is based on the UAV-GC guidelines (Uniforme Administratieve Voorwaarden – Geïntegreerde Contracten). The legal basis has to comply with the way of working. If you are constantly busy with trying to transfer all risks towards the subcontractor, who cannot carry these risks, you are still in trouble as main contractor. Principle of reasonableness & fairness.

Generally it works better to reward than to punish. Payment can only be decided once the scope is entirely clear. If you try to bargain a price before the scope is clear you are likely to pay a risk-fee that the subcontractor puts in place as contingency. If you want to make quality and timing your focus, you should involve the subcontractor in an earlier stage. Define the budget by mutual agreement. RHDHV does not price anymore before the scope is completely specified. After specification (if this is done by the main contractor) you can use lump sum to tender for lowest price.

10. Closing remarks

How do you motivate your employees? After all the projects stand or fall with the human labour that is required to complete them. Do you motivate them by paying them for their billables, lump sum, letting them work at the subcontractor or at your own office? Everyone needs a different stimulation. Yachts are constructed by the mental effort, the human factor. How to fully use ones potential?

III. Interview with Sander van Opstal – Philips Healthcare

Department Manager Mechanics, Mechatronics Development Cluster at Philips Healthcare iXR

Interviewer: Ruud Brockhus

Interviewee: Sander van Opstal

Attendee: Pierre America – Principal Scientist at Philips Research

Date: 03/04/15

Subject: Subcontractor management

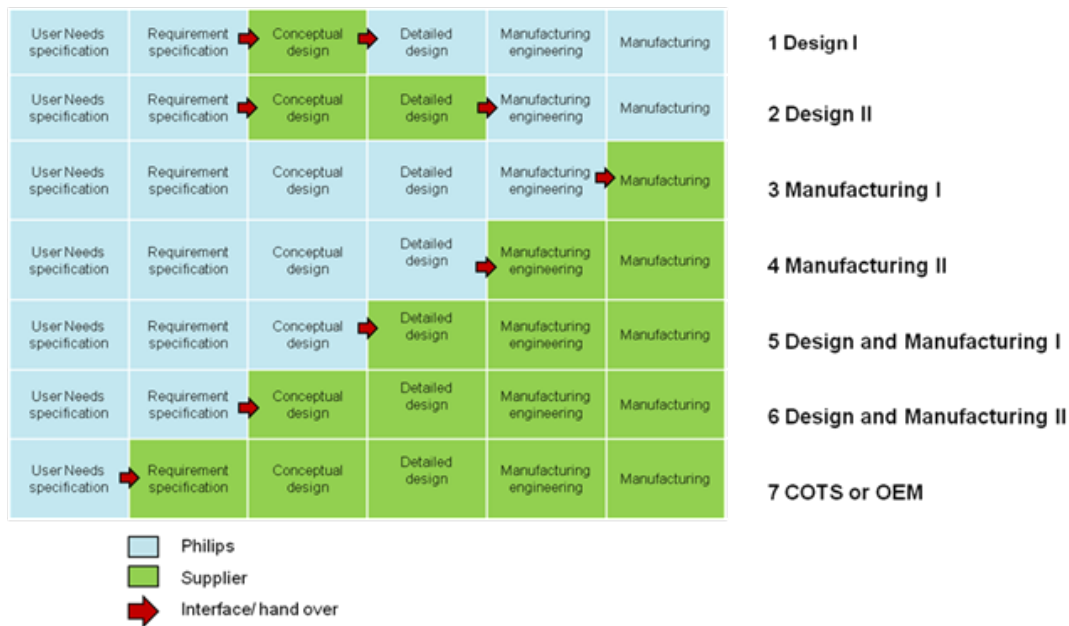
1. *General Information*

The R&D organization of Philips Healthcare considering the iXR systems is structured by several development clusters; the system design cluster (architecture), image chain cluster & the mechatronics development cluster. Sander van Opstal is department manager Mechanics within the Mechatronics Development Cluster at Philips Healthcare iXR (interventional X-Ray). With his team of about 25 they focus on the Mechanics of the interventional X-Ray systems that are developed at Philips Healthcare. Although the iXR systems seem similar, as they all have the same characteristics like a table, bow, monitor & X-ray tube, within all these intersections of the systems variations are possible. Consequently not a single system of the roughly 1000 systems produced yearly is exactly the same; only one-off systems are produced. However, the variations are constrained by the catalogue options Philips provides to their clients. This means roughly 500 variations are possible. The sales price of an iXR system varies between the 500.000 and 1.000.000 euro, dependent on the specifications that are chosen.

2. *Subcontracting approach*

Within Philips Healthcare the projects are decomposed into sub-projects (components) that are identified as being Core, Key or Base to the business model. Core components are developed in-house. For example the AlluraClarity system, which ensures leading image quality at a fraction of the dose it would normally take to generate such a picture, is considered to be a Core component in the iXR systems and is therefore developed in-house. Key components are important for the functioning of the iXR system, but might be suitable for out-sourcing. Base components can always be out-sourced. Dependent on this decomposition system it is decided whether the component should be a make or buy.

When the decision has been taken to buy, Philips works with different levels of out-sourcing, as shown in the figure. The level of outsourcing varies from only the conceptual design to the complete design & manufacturing. As soon as the specifications of the sub-project are clear, the process of outsourcing can start. A development partner can do the design and construction, but also only the design of a part of the engineering development. Development partners require high level of integration between Philips and the subcontractor. Philips also uses the manufacturing model where they only outsource the manufacturing and keep the process of making the design in-house. Different variants are possible within these two extremes.



As you go lower in the model, and hand over more activities towards the supplier, it gets more difficult to manage the supplier. The dilemma of high-level (high level of integration) outsourcing is that you place knowledge outside the boundaries of your organisation, which can create Lock-In. Lock-in makes the main contractor dependent on the subcontractor for products or services, because the main contractor cannot change subcontractor without substantial transition costs. The subcontractor has such specific knowledge vital to the business model that the main contractor becomes dependent and cannot outsource this anywhere else. This influences the power position (negatively) of the main contractor substantially. Philips sometimes also struggles with its power position, as the production of 1.000 systems is of no comparison to the car industry.

3. *How to deal with Lock-in?*

Naturally getting out of a lock-in situation that is already present because of agreements / decisions made in the past is hard. Therefore at Philips new technology trends, both internally as externally, are continuously monitored to account for potential lock-in. In the supplier selection process the consideration of lock-in play a role. To illustrate; if you have three suppliers available, with one being financially weak, one not properly handling life cycle management and one that uses an unconventional production method (risk of lock-in), the latter can is likely not be chosen because of the risk of lock-in in future. Preventing lock-in therefore requires investment.

With the production of the Interventional X-Ray system Philips also has some components that are quite complex and can only be produced by one subcontractor. Therefore Philips continuously searches for other technologies that can be used to produce these components, to not be fully dependent on the single subcontractor. This is not easy. Therefore one focus is on the supplier-relationship, but other is also on looking for other technologies that can replace this technology on the long term

4. *Purchasing process*

The process of purchasing at Philips Healthcare is not encrypted in procedures, but is merely an implicit way of working. Generally the following decisions are being made; first the sub-project or component is analysed for being Core, Key or Base. If it is Key or Base, the sub-project can be outsourced. The next step is determining the level of outsourcing, as discussed earlier. Subsequently

the project manager asks the commodity manager which firms are available to perform this task. Philips works with a system of preferred suppliers; to be allowed as subcontractor they have to successfully pass an assessment by the commodity manager. The commodity manager gives the project manager a list with available subcontractors. Using the technical concept the project manager subsequently starts a RFQ (Request for Quote) process with these subcontractors.

Parallel to the RFQ process the project manager sets the bid criteria. For this purpose Philips has a list with template bid evaluation criteria. Typically cost price is considered as important criterion, but also criteria considering logistics, like SMOI (supplier managed own inventory). SMOI uses a model where the supplier builds a stock inventory at the site of the main contractor, and the main contractor does not pay until the component is actually used). Additionally the development location of the supplier can be used as criterion, as for example a development site in China scores low on communication because of the different time zones.

Once this round of evaluation is over there is a small list, or a small number of contractors left who are invited for an interview. It can also be the case that from the evaluation round none of the subcontractors is deemed adequate. In that case the project manager goes back to the commodity manager for other subcontractors, or back to the drawing board to see whether it can be done in-house, or for example other material can be used.

In front-end development process there is special attention to prevent lock-in. Some technologies are deliberately not used because they would impose dependency on one supplier. The costs that this decision implies are taken for granted. Strategically it's important to analyse where you lock-in may arise. Solution may be due use dual-sourcing; also good from risk-perspective.

5. Process from the selection of suppliers onwards

The subcontractors that are on the approved supplier list of Philips all have signed an Umbrella Purchase Agreement (UPA). This UPA is an overarching framework agreement that contains the payment conditions, but also liability to ensure it is clear who is responsible when for example a supplier makes a mistake in the design. New sub-contractors first have to be added to the approved supplier list before they can be contracted for a sub-project.

The UPA is the umbrella agreement under which Philips and the subcontractor engage in a SPA (Supplier Project Agreement) for each project, with a fixed end-date.

The content of this agreement depends on the level of subcontracting that is used. Sometimes Philips agrees with the subcontractor to reimburse the expenses made on the research to fix the price for the component (usually for 10 years). Once you are in business with Philips it is likely they will use you again. For Philips this is also dangerous, because with repetitive collaboration it is relatively easy to create lock-in. This is prevented by starting a RFQ process, even though a familiar subcontractor is known to be capable of performing the task. This ensures that this firm keeps competitive and gives other subcontractor the opportunity to win a tender.

6. R&D structure

System architecture structure. The clusters are mainly focused on one component of the iXR system, for example the table, monitor, user interface etc. Within these units there are product owners that know everything about the component. These product owners are annually asked to provide a road map of the component they are responsible for, not only for the characteristics of the product itself,

but also for the suppliers of the component. Via the programming division this information is transferred to the projects.

7. Ideas on dealing with the challenges of subcontractor management

Components that are of high value for the end-product and therefore considered to be essential for the performance of the product are managed throughout the entire supply chain of Philips. The subcontractors of Philips are regularly checked on their management of Seconders, to ensure these vital components are made properly (and to ensure they obey the rules on 'Keten Aansprakelijkheid')

[REDACTED]

Another method Philips uses is 'open boek calculatie'. Here the main contractor and subcontractor agree on a price for the material, labour costs, overhead etc. including a profit margin. The subcontractor keeps its finances transparent so that the main contractor exactly knows what he is paying for.

Assigning a manager purely for the relationships with the subcontractors could also be beneficial. This person coordinates the contacts transcending the different projects and is not operationally involved with the projects. Business review meetings; to discuss the quality, time of delivery and pricing, but also to discuss the collaboration. The relation manager can chair this meeting, which allows the supplier to give direct feedback to the comments made by the main contractor. This is also the right setting for improvement of the pricing model for example.

Final remark is that outsourcing everything might not always be beneficial. Philips has done this in the past, but had to pay a high price for this. Furthermore it often leads to reactive management instead of proactive management. Outsourcing everything is not convenient to use as a dogma, since it can easily lead to Lock-in. Philips therefore now works with the Core, Key & Base principle.

IV. Interview with Wouter Zevenbergen & Rens van Arkel – Royal IHC

Manager Central Planning & Project Management Office at Royal IHC

Interviewer: Ruud Brockhus

Interviewees: Wouter Zevenbergen & Rens van Arkel

Date: 22/04/15

Subject: Subcontractor management

1. *Short introduction*

Wouter Zevenbergen is manager of the central planning at Royal IHC. The central planning department consists of three levels of planning; corporate planning, project planning & operational planning. Operational planning is mainly done at subcontractors, because it considers modular sub-projects. Corporate planning is the highest level of planning, which looks at the planning/capacities company-wide, transcending the project boundaries. Also the preconditions for projects are determined at this level, after which this is handed over to the project level central planning, that guards the interfaces between the different parties/subcontractors. The most important difference with Oceanco is that a large part of their subcontractors are actually in-house departments.

IHC is currently in a transformation phase to integrate all their processes and procedures; one IHC. The decentred organisational model in which multiple (35) subsidiaries work autonomously is abandoned and makes room for an integrated cooperation model. One IHC is started to guide Royal IHC in the transition towards a centralized, coherent and transparent undertaking. This means that the practise of 'internal subcontracting' is slowly fading away and that project management offices are formed consisting of all these specialized members to make a horizontal integration in the company.

Rens van Arkel works at the project management office, which started in January. The goal of the Project Management Office is to help project implement the new method of One IHC, which in the early development phase consists of multiple documents like a risk analysis, communication plan etc. Next to this an evaluation process is implemented to make sure that lessons learnt are taken from finished projects into the next projects.

2. *Purchasing*

80-80 is the moment which the project starts. This is the moment that the sales department is for 80% certain that the project will actually be executed, and for 80% sure that IHC will be awarded this project. Before this moment contact is already established with multiple subcontractors, or internal department, to get offers for the work that needs to be performed. Internally calculations are made and after evaluation a certain amount of parties are selected. The moment the project manager is assigned to the project, most of the time the decisions considering the subcontractor selection have already been made.

Project execution begins with basic engineering. From 80-80 the project is handed over from the sales department to project management. This is the moment to align the subcontractors, so that the moment the contract is signed this is already clear. Between 80-80 and 100-100, when project management is on board of the project, the engineering & purchasing works on the 'catalogue' subprojects, but the big subproject contractors are already aligned then. This is mainly possible

because IHC has the largest 'subcontractors' in-house; for the mission equipment. The mission equipment is the reason the client contracts IHC; dredging installation, diving installation, piping tower etc. These are all IHC parties.

External parties like HVAC are involved in the engineering stage, often working on the design of the installation between IHC engineers on-site, based on the requirements. They are already involved earlier to give a rough estimate on the expected cost, used for the tender offer IHC presents to the client.

IHC uses a list of companies per project, for example when a client wants a specific engine because the entire fleet of ships of this client uses these engines and this is easier for maintenance. Within IHC they are now also constructing a list for suppliers that can be used in the long term. This is done within the supply department, which works with different category suppliers within which long-term agreements can be made with external parties. The supply chain director falls under the IHC holding, so this is done company-wide, throughout all the 'internal subcontractors'.

3. Feedback on conceptual framework

For IHC the framework is only slightly applicable, because they have made the strategic decision to engineer/produce the vital components of the projects themselves, or to acquire the companies that make these vital components. They therefore mainly rely on their own resources in the management of their projects, which is different from Oceanco that outsources everything. The interests of these internal organisations of IHC are easier to align, because they all work towards the growth of IHC as a whole.

Incentives for cooperation should also take place at the strategic level, which is currently not logically following from the conceptual framework. It might be useful to include collaborations as Design & Build, and Design, Build & Maintain in the conceptual framework, because they are often used in the construction industry and proven to be beneficial for the main contractor.

The decision moment of when to involve the subcontractor depends on the type of subproject and the type of subcontractor. This can also be seen as a matrix, because the relations are relatively predictable. For example the scaffold-builder does not need to be involved early on in the project, as the subproject he performs has a clear goal and method. This comment relates to the scenarios that are described in chapter 6.

V. Interview with Sander Vorselman – Royal IHC

Director Business Development Buildings at Royal HaskoningDHV

Interviewer: Ruud Brockhus

Interviewee: Sander Vorselman

Date: 24/04/15

Subject: Subcontractor management

1. General Information

Sander Vorselman finished his studies of Construction Management & Real Estate Management at the Delft University of Technology in 1999. He worked as project developer at Van de Griff for nearly 3 years and has worked for DHV (later merged with Royal Haskoning) ever since, working on a number of national and international one-off projects. Since 2012 he works as director business development and is no longer directly involved as project manager of projects.

2. RHDHV's role in projects

Royal HaskoningDHV as independent design and engineering consultancy firm can perform a number of roles in large engineering projects. Generally a distinction can be made between 3 roles:

- RHDHV is hired to take care of the project management on behalf of the client (delegated project management)
- RHDHV is hired as engineering & design firm
- RHDHV is hired as sub-consultant of the contractor, as part of a consortium for example

In the first role, as project management office, RHDHV manages the complete project on behalf of the client, including the tendering of architects, constructors, engineers and a main contractor. Management on time, cost, organisation & quality. They perform this role not only for the building of hospitals, but also for construction of museums, offices, governments, but also companies like Shell

In their role as design & engineering firm RHDHV is very well equipped, since it has specialists from all disciplines within its own organisation (varying from architects, to construction engineers, to soil experts). This multidisciplinary workforce makes the entire design of a construction. RHDHV can manage this entire process from beginning to end in-house, but RHDHV also works with for example an external architect if a client desires this.

RHDHV can also be hired as sub-consultant of the contractor that has the agreement with the client. This is not a large part of their turnover. RHDHV mainly focusses on the first two described roles, as they believe they can deliver best value in these roles.

RHDHV is growing internationally. This means that operating as engineering & design firm or project management is more complex, as the local network and resources are not as extensive as in the Netherlands. For example in India they do not have the entire knowledge base available in-house. Internationally RHDHV therefore has to rely more on knowledge of other parties. These parties can also be unknown to RHDHV, which makes making clear agreements not only desirable, but necessary to properly manage risks. This is a challenging environment.

Sander distinguishes between buying and subcontracting (mainly distinction from financial point of view). In their project management role they only buy, as they act on behalf on the client. If a client wants a project or product, this is called a buy (from a supplier). The supplier shall, in its turn, outsource parts of this project or product to subcontractors (so subcontracting). In the situation that RHDHV performs the role of project manager they will arrange the contracts/tenders, but the financial flow will still go directly for client to main contractor, as RHDHV is an independent advisory firm. In this role they therefore only 'buy' (or advice on buying) and not subcontracting.

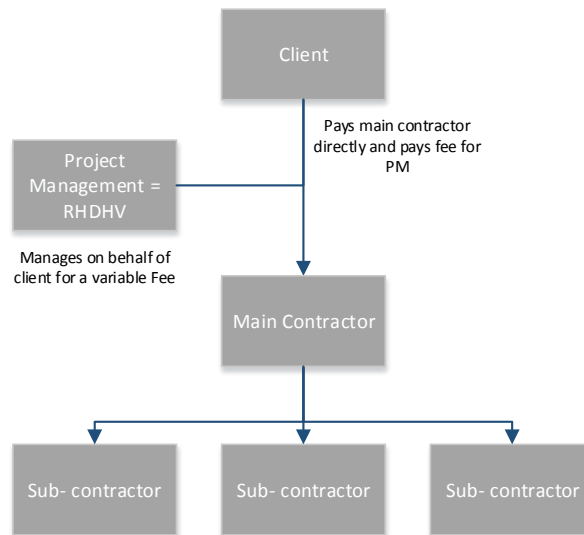


FIGURE 46 CLIENT - MAIN CONTRACTOR - SUBCONTRACTOR RELATIONSHIP IF SUBCONTRACTING IS USED

This is compared to the business model Oceanco uses, which is visualized in the figure below. Here the client directly pays the main contractor for the total product/project. The main contractor subsequently uses subcontractors to deliver the product/project. The main contractor actually acts as a project developer, such as for example OVG does in the construction industry.

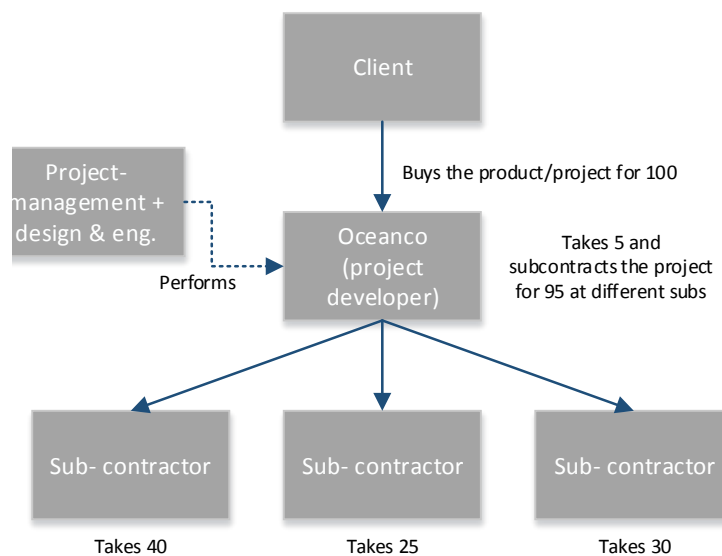


FIGURE 47 BUSINESS MODEL OF PROJECT DEVELOPER

In their role as design & engineering firm RHDHV delivers the design does the engineering for the work to be performed by the main contractor and subcontractors. This looks like the following figure:

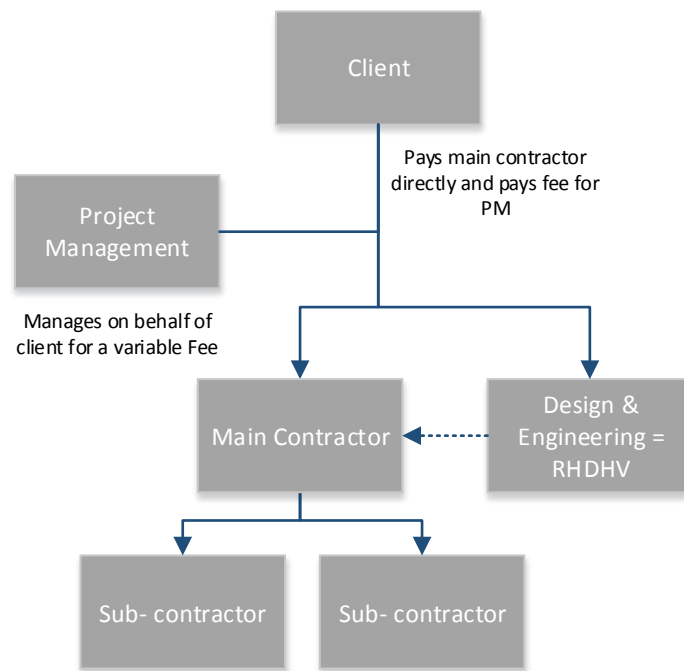


FIGURE 48 RHDHV AS D&E FIRM

RHDHV can also perform the role of EPCM (engineering, procurement, construction & management) contractor, in which RHDVH is in the role of both project manager and design & engineering. In this case the organisational structure follows that Oceanco as project developer, except from the fact that RHDHV never does the execution of the project (main contractor can), because it needs to stay independent (no financial flow through RHDHV, except from some consultants that are hired for specific advice).

In the construction industry usually variants on the DBFMO (Design Build Finance Maintain Operate) contracts are used.



FIGURE 49 TIMELINE PROJECTS

The timeline of a project roughly looks like the figure above. On this timeline RHDHV can offer multiple services. During the initiation phase RHDHV can do a feasibility study. During the definition phase a program of requirements is made. The design/engineering phase consists of multiple designs, starting with the draft design until the specified design. This is normally the moment that the contractor would be contracted to take care of the execution. With use of the specified design the tendering is done. Depending on the party they work for (private/public) they use European legislation for tendering. Contracting is done using the guidelines of the UAV (GC). A relatively new trend is that the contractor also performs part of the design trajectory; Design & Build contracts.

During the building phase RHDHV can offer construction management services, and finally can help with the exploitation via asset management. On the same timeline this looks like the following:

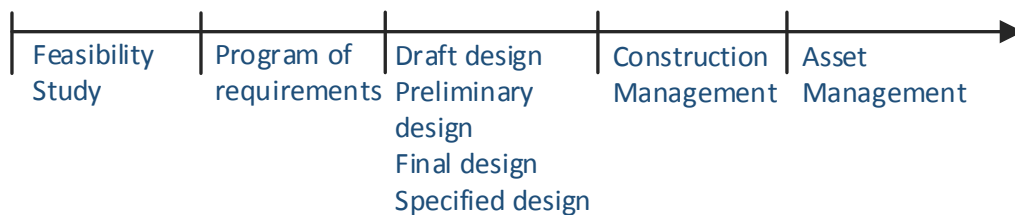


FIGURE 50 DELIVERABLES ON PROJECT TIMELINE

Oceanco does the whole timeline of services, but uses subcontractors in the construction phase (and some in the design phase) to execute the work. In practise this is actually not that different from the role RHDHV takes upon. The main difference between the roles that Oceanco and RHDHV play is that Oceanco operates more as a project developer, which takes upon the full project and subcontracts the parts it does not want to do. RHDHV works as an advisory firm for the client. The execution of the project contractually runs directly between the client and the main contractor here. In the advisory and Design & Engineering role RHDHV plays the role of main contractor.

3. *Back to back contracting*

Back to back contracting is important if you use subcontractors, to make sure that the agreements you make with the client about payments also hold for the agreements you make with the subcontractors. If your client delays the payment for your services, you have to make sure that you can also stall the payments for the subcontractor, without consequences for the progress of the work. Else the subcontractor can refuse to continue working and you as main contractor either have to pay or no work is performed and the whole project is delayed. This is thus important to put in a contract; back to back contracting (pre- financing of the project).

4. *Feedback on framework*

Considering the type of subproject you want to put up for tender you have to decide whether you want to specify the subproject solution-driven, or output-driven. Is the subproject steered based on performance, or on adherence to the specified design? In the construction market still often the specified design is used, which limits the subcontractor in delivering added value to the project, as they are bound to the specification of the design. So catalogue subprojects are generally solution-driven, where performance-based subprojects are output-driven. If the subproject is output-driven, this can be combined with a payment incentive structure; working towards co-makship.

RHDHV uses the tool of Virtual Design & Construction (VDC) for the co-creation in the design phase of the project. Originally the principle behind this method comes from NASA. NASA had the problem of aligning parties in this complex innovative environment. Stanford University has translated this for the building industry. RHDHV has trained employees to use VDC in the construction industry.

The early involvement of the subcontractors also creates commitment because it is based on co-creation (and interaction). Transparency and trust here are key. Open the (financial) books (also at main contractor's side). The early involvement of the subcontractor is likely to reduce the amount of change orders, as it co-creates the design with other subcontractors. Besides, it will also positively influence the handling of change orders, as the subcontractor will become more responsible for its part in the project.

The co-makers in such projects can also be committed for a longer period of time with use of a framework agreement. RHDHV structures the construction of framework agreements as follows: they create the general conditions for the collaboration like the organisation of financials (hourly fee), payment conditions, delivery conditions, change order procedures etc. Within this framework agreement simple project agreements are made. Additionally the framework agreement offers possibilities for economies of scale (incentives); for example a discount provided by the subcontractor based on the yearly amount of the hired hours (for example $>500.000 - 1.000.000 = 5\%$, $>1.000.000 = 7\%$). This gives an incentive for the main contractor to use the subcontractor, as the discount increases with the amount of work he assigns to the subcontractor. Additionally it creates continuity for the subcontractor. So with use of the framework agreement the project agreements are relatively simple.

Risk management is underexposed in the conceptual framework. RHDHV mainly steers on risk instead of cost, referring to bid evaluation. Risk analysis determines the price for tendering in the building construction market; ground pollution etc. Perform this risk analysis together with the subcontractor so agreements on possible risks are discussed beforehand.

VI. Interview with Robert van Alphen – OVG

Department Manager at OVG

Interviewer: Ruud Brockhus

Interviewee: Robert van Alphen

Date: 12/05/15

Subject: Subcontractor management

1. Introduction

Robert van Alphen graduated from the Delft University of Technology in 1998. He studied at the faculty of Technology, Policy & Management. After graduation he started working at Ballast Nedam as project manager for 8 years. Since 2007 he works for OVG as Development Manager was responsible for the development of several projects, such as the Rotterdam (the largest office in the Netherlands) and the Edge (the most durable building in the world).

2. Process of project development at OVG

OVG is a project developer that develops durable and innovative buildings. OVG has a working capacity of only 40 employees, which gives the employees a lot of freedom and responsibility in their projects. As project manager you are 'head of your own firm' to make the project a success and profitable for OVG.

The business cycle of OVG start with a party that wishes to rent an office space. This can be newly built or renovated. Together with the renter (client) OVG looks for the right location. This often involves the acquisition of land. This is why the municipality is an important player for OVG. The renter of a building is key in the business model of OVG, as a building without a renter cannot make profit. OVG takes the responsibility for the design and construction of the building. Usually an investment fund eventually buys the building to rent it out (operation).

OVG starts with the design of the project and at some point outsources the design and construction to a main contractor (the big four; BAM, Volker Wessels, TBI Holding & Dura Vermeer). OVG always uses one of these four contractors because it limits the risk of bankruptcy. This also allows for co-makership collaborations. The price here is thus not the only (main) driver. Next to the main contractor there is the installer, and they take upon the task of execution the project using different subcontractors. With some project OVG has already contracted subcontractors before contracting the main contractor.

OVG takes the main risk for the entire project, but outsources the risk for the design & construction. This is not done purely on price. OVG does not want the main contractor to be involved too soon, because then the risk is present that the main contractor deviates too much from the project goals.

The project starts with a sketch design, which is used for sales towards the potential client. After this a preliminary design is made, which contains the global goals and specifications for the project. The next stage is the specified design, the stage after which usually the main contractor takes over the responsibility from OVG. The main contractor here takes the responsibility for all drawing OVG made, so for the entire project. After this the final design (Bestek) follows. In a later stage the technical drawings are made, still guided by the architect, and production drawings are made by the respective subcontractor.

The main contractor is incentivized by OVG to take responsibility by means of an expenditure in the budget OVG accounts for 'Nadere Plan Uitwerking' (NPU), which translates into further development of the plans. The contract sum of a main contractor is usually build up from the direct building cost (Directe Bouwkosten; DBK), the general building cost (Algemene Bouwplaatskosten; ABK), the general costs of the contractor (Algemene Kosten van de aannemer; AK) and profit and risk (Winst & Risico). OVG adds NPU as extra expenditure to the budget, to ensure a 'geen gezeur garantie' (no nagging warranty) for small changes that fit within the defined scope of the project. This varies from 1 to 2% of its entire budget, which operationally varies from 500.000 to more than 1 million euro, without a clearly defined product in return. OVG puts this front-end incentive in the budget to reduce the risk of additional costs; "You win some, you lose some".

Naturally companies managing such projects are struggling with the management of subcontractors because there is no single good way to approach this. This is impossible to put in a theoretical model. Subcontractor management is mainly based on trust and human interaction. Previous interactions/projects play a major role in this approach, as this determines the relationship. Trust that together you will reach a solution for whatever problem you find. Continuously squeezing the profit margins of the subcontractor works counterproductive. A durable collaboration is transparent and thus based on honesty and no double agendas. For example; if OVG takes on a project of 1 dollar with 3 other parties Robert invites them for a table meeting to divide this dollar. In this negotiation OVG takes for example 0,40 as they take on the largest risk, which is the financial responsibility for the entire project. Risk is the main driver in projects; who takes risk should be paid for it.

Since the renters of the to be build or renovated building want to rent for the lowest price possible, OVG operates in a market with tight budgets. After all the rent can only be low if the costs of constructing the building are also kept low. This does not mean that all parties in the value chain need to be squeezed to ensure the profit margin as project developer. Together with the subcontractors OVG searches for the lowest price that will still ensure continuity for the subcontractor and allows them to make a decent living ('een boterham verdienen'). As long as you are continuously pushing your subcontractors for the lowest price you can never get a durable collaboration. In the end it is all about human interaction. Keep an open eye, no double agenda's.

Per project the approach of contracting the main contractor differs. This is dependent on, amongst other factors, the payment agreement a main contractor has with the subcontractor. A good main contractor has a good cash flow, as he usually receives money after 30 days, while the subcontractors have to wait 90-100 days for their money. The main contractor can thus also play a role in financing the projects, which gives the main contractor a slight advantage during tendering.

In general the pricing of the main contractor depends on the economic situation of the building sector. As the contractors now have relatively little work because the building sector is not flourishing, the position of OVG is quite strong. The offer of a contractor will therefore almost automatically be competitive. Still OVG tries to keep all parties satisfied, as they hope to be treated the same if the market is flourishing again and OVG's position is less strong. In the time the Rotterdam was to be build (2005) there was hardly a contractor available that wanted to take the risk of this project, as there was lots of other work available.

"When you are in a hole, stop digging."

The Edge example: Roberts last project he managed. During the development of the project the decision was made to make it the most durable office building in the world (highest BREEAM classification). All subcontractors were already contracted for a building with a lower classification.

Robert therefore set a considerable bonus if the main contractor would manage to get the right classification. On the other hand the main contractors agreed upon a discount if they would not be able to reach this level.

OVG acknowledged the intrinsic dependency on the performance of the main contractor and set a bonus in prospect. By doing so it created commitment from the contractor to perform.

Robert often works with the same advisors in the projects; the installation advisor, construction advisor, fire-safety advisors. Although he knows he will probably not pay the lowest price, he trusts these advisors and knows that he can build upon them. This is only possible because the advisory costs within the total project budget are relatively small.

3. Contracting

OVG uses a standard Engineer & Build agreement, which covers the responsibilities between OVG and the main contractor up until the level of screws and bolts. However, because OVG often makes use of the same main contractors, these contracts are iteratively tailored to the satisfaction of both parties. In the past 10 years Robert has hardly ever looked at the contract after signing. So all details are put in the contract, but in practice they solve their problems with human interaction (exchange of disputes).

OVG does officially work only with one contractor; the main contractor. However in practice OVG has a lot of informal power to determine which subcontractors are used for the project. Besides they also regularly involve a subcontractor earlier than the main contractor because of certain complexities. Still the main contractor takes the responsibility over this subcontractor after signing the contract. The reason the main contractor takes this responsibility from OVG is trust; they have already done multiple projects together this way. OVG could actually do the projects without the main contractor, but this would require contracting all subcontractors themselves and this would cost a lot of resources. This is not the strategy of OVG.

Robert thinks that for Oceanco it might be wise to get a stake in, or acquire, contractors that are solely working for Oceanco. Drawn from its experience at Ballast Nedam Robert knows that constructions with sister companies are not always beneficial.

The initial offer Robert often gets is not realistic, but on reference numbers this price is corrected. Therefore full tendering is not always necessary. At OVG they follow the principle of “live and let live”. The best projects are project in which all stakeholders are satisfied; so all parties have their stake in the pie. In such projects many conflicts are resolved with a closed purse. If subcontractors have to start with a loss (lowest tendering price) they will do everything to compensate this. This creates a totally different environment.

You have to analyse where the margin is in the price (front-end). So Oceanco has to analyse this upfront. For OVG the costs of the building are not translated back to the client, because they agree beforehand a certain renting price. This can also result in a ‘vechtproject’ where the client is promised a low rent beforehand, which makes the margins for the building very slim. Besides the client hires the office for 10 to 15 years, so will not regularly return for new projects.

4. Feedback on Framework

The framework gives a rather comprehensive view on the practices of subcontractor management. On the collaborative tools OVG also works with BIM. The 3d design where you let the architect,

installation engineer and civil constructor work together in the model. OVG generally works with the same team of advisors regardless of the project. Without influence of the subcontractor they, together with these advisors, set up the design of the building and subsequently they tender this design. Normally the subcontractor is not involved in early stage, but after the specified design. OVG uses reference numbers to see if the tender offers are competitive. However, if for example the façade is rather complex, this subcontractor will already be involved early on.

Ownership of the project is important; the project manager has to be actively involved with the project and is also responsible for encouraging the subcontractors to become actively involved. The approach needed to activate the subcontractor will differ per situation: some need positive incentives, some negative ones.

OVG does also work with the same subcontractors in multiple projects, but does not engage in framework agreements. Instead, OVG works like Oceanco: project-based. However, the awareness of mutual dependency is there.

A theoretical model on subcontractor management is rather difficult. However, the distinctions made in the process design are very relevant. The impact of the type of subproject (off the shelf versus blue sky) on the choices to be made is good. For an off the shelf project you can use twenty different payment schemes, but at the end of the day the best approach is to just buy it for a fixed price. The only critique one can have on the model considers the soft variables, because the reality will be capricious. This is however not necessarily a limitation of the model, it merely simplifies the process to make it understandable and enable using it in practice. Personal interaction plays a major role in the process of subcontractor management ('the gunfactor'). This shows the importance of the relation, which can also be seen in the process design.

