A STUDY INTO THE EFFECTS OF USING PAIN/GAIN SHARING MECHANISMS TO IMPROVE THE CONTRACT MANAGEMENT IN THE SUPPLY CHAIN

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MASTER THESIS

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DESIGNING A STRATEGIC FRAMEWORK TO IMPLEMENT PAIN/GAIN SHARING MECHANISMS

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DURA VERMEER
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PREFACE

This report is the graduation thesis for the MSc Civil Engineering master track Construction Management and Engineering at the faculty of Civil Engineering at Delft University of Technology.

In this thesis I have researched pain/gain sharing mechanisms in the construction industry. The thesis explores the concept of pain/gain sharing mechanisms, aiming to provide a comprehensive understanding of their application, benefits, and challenges. This study can be useful for contractors, clients and other researchers.

During this research I had the opportunity to explore a relatively new concept and contribute to the existing body of knowledge. The journey of conducting this study has been truly fulfilling, and I have thoroughly enjoyed every step of the process, from inception to completion.

I would like to express my sincere gratitude to my graduation committee members, especially Marian Bosch-Rekveldt - our weekly meetings have been immeasurably valuable, for providing the guidance, support and encouragement throughout the research process. Their expertise and insights have been of value in this thesis. I am also grateful to the participants of Dura Vermeer who have shared their experiences and knowledge, making this research possible.

Lastly, I extend my heartfelt appreciation to my family and friends for their unconditional support and understanding during the course of my studies. Their encouragement and belief in my abilities have been invaluable in bringing this thesis to fulfillment.

I hope you find as much enjoyment in reading this report as I did in writing it.

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SUMMARY

The Dutch construction industry is facing the recurring issue in that delays and conflicts are causing an adverse impact on construction projects. It has been suggested by many scientists that implementing pain/gain sharing mechanisms can theoretically be successful for project progress.

This study aims to address the knowledge gap between the theoretical suggestions and the practical implementation of pain/gain sharing mechanisms by conducting empirical research. The objective of this research is to gain knowledge on pain/gain sharing mechanisms in order to explore how this mechanism can be of value to the contractor.

In the current literature, the contract form in which the pain/gain sharing mechanism has been implemented is the NEC4 contract ECS4 Option C. This contract is a target cost contract in which the pain/gain sharing mechanism occurs. In addition to option C in the NEC4, there are also secondary option clauses in NEC4 that can be added to the contract as a form of pain/gain sharing mechanisms. These secondary option clauses are:

- Option X6: Bonus for early completion;
- Option X20: Key performance indicators.

The literature also identifies some other pain/gain sharing mechanisms. The Target Cost Contract (TCC), risk sharing are forms that fall under pain/gain sharing mechanisms in the literature for alliances or Client-Contractor relationships. However, these mechanisms can be used for Contractor-Subcontractor relationships, if used in the correct way. There are some difficulties with implementing. The difficulties in short are: lack of understanding TCC and its purpose, resistance to change traditional work practices, absence of standardised TCC contracts leading to errors and confusion and lastly, unfamiliarity with TCC concept in certain regions. In order to implement TCC successful these are the important conditions: willingness and cooperation from both parties, mutual trust and close working relationships, joint agreements on risk sharing between clients and contractor, fair evaluation of fees and risk sharing to keep contractors motivated and lastly, alignment of aims and objectives of all parties to maximise project goals.

After reviewing the literature, pain/gain sharing mechanisms were also investigated in practice at Dura Vermeer. The pain/gain sharing mechanisms used mostly, are bonuses and fines. Not much is done to incentivise the stimulation toward their subcontractors/supply chains. The references in this chapter are almost entirely between the client/contractor, and not the contractor/subcontractor, showing more work and research needs to be done in to the implementation and discovery of these pain/gain sharing mechanisms.

After the projects were identified, three cases were then studied in depth. Eleven semi structured interviews were held about 3 cases. Based on qualitative analysis, it was concluded that essential conditions regarding pain/gain mechanism seem missing in the cases studied. Some of these essential conditions for the successful implementation of a pain/gain sharing mechanism so far identified are: transparency, align partial objectives, taking each other's interest into account and early involvement of the parties. This will eventually lead to meeting each other's objectives and having a high-level of satisfaction.

After the interviews for this project were completed and further analysed – it became apparent that several key steps as to how to implement a pain/gain sharing mechanism successfully were

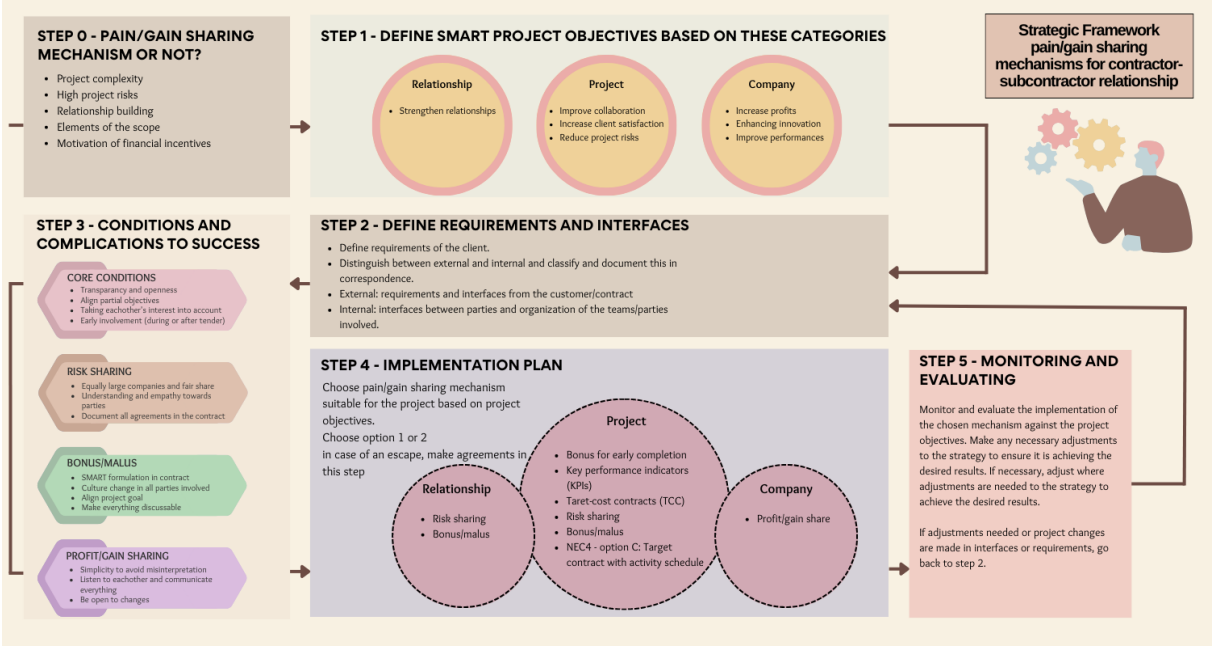
missing. These missing steps led to mistakes when implementing the pain/gain sharing mechanisms throughout the projects. To clarify the process, a framework was created, to implement the pain/gain sharing mechanisms. Both a visualisation image and a comprehensive document that could be simply followed was chosen to portray this framework. This framework could be used to in order to determine the most effective pain/gain sharing mechanism for the project.

This framework was presented to three experts. The experts were then asked whether the framework can be used in their practice and what their expert opinion is on the steps. In general, they found the steps clear and concise and that the framework fits in practice. The experts recommended steps 0 and 1 to define more SMART. The experts have also indicated that they want an escape plan in the framework. For this, 2 options are given in this chapter that Dura Vermeer could consider for the research. The options are as follows:

- **Option 1 – escaping pain/gain sharing mechanisms**
- **Option 2 – committing to pain/gain sharing mechanisms**

Option 1 can be done by writing an escape plan and make agreements on ending the pain/gain sharing mechanism beforehand. Option 2 is committing to the pain/gain sharing mechanism. Perhaps the pain/gain sharing mechanism works better without an escape plan.

The strategic framework is illustrated in the figure below.



The experts evaluated the framework and confirmed the reliability and effectiveness of the framework.

In order to answer the main research question, it was important to define the definition of pain/gain sharing mechanisms found in literature and exploratory study. This definition of pain/gain sharing mechanisms states “a mechanism or strategy that can be used to align goals, objectives and interests together by sharing pain and gain and using other incentives to encourage desired behaviour”.

The strategic framework developed through this project can be used to implement pain/gain sharing mechanisms. It allows for the most effective pain/gain sharing mechanism to be chosen. Whilst ensuring all parties are aware of the mechanism and how it may benefit/hinder them through the application. It also allows changes to the scope, requirement, and practical project changes to be considered, and fairly distributed between the parties.

It is important that agreements are respected and guaranteed in order to utilise the optimal effectiveness of pain/gain sharing mechanisms.

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1 INTRODUCTION

The Dutch construction industry continues to face challenges such as delays, conflicts, productivity loss and poor performances in construction projects. These challenges have a significant impact on project outcomes, resulting in financial losses, compromised quality, and strained relationships between contractors and clients (The Dutch Construction Industry: An Overview and Its Use of Performance Information, 2014).

Scientists have suggested pain/gain sharing mechanisms could be useful within the industry to help prevent various issues, including an adverse adversarial environment between contractor and client (Barlow and Cohen, 1996) and poor collaboration (Chen et al., 2014). These issues have led to an even bigger influx of problems of a higher severity: poor performance, a decrease in productivity, the quality of work has been lacking, and perhaps most severely a "win-lose climate" (ibid). The win-lose climate will be explained in further detail in the bulk of this thesis, however it's important to recognise the detrimental impact such a climate has on the construction industry. The aforementioned climate has led to an increase in conflict between the parties. Conflict is defined as "a process whereby one side perceives that self-interests are adversely influenced by another party's actions" (Wall and Callister, 1995). Indeed, we can infer from this that the conflict that arises from the "win-lose" climate is hugely responsible for the detriment affecting the Dutch construction industry. It would, however, be unwise to regard conflict as wholly a negative influence, conflict has been seen to "be remarkably constructive in some team-based work environments" (Tabassi et al., 2018).

Limited knowledge exists regarding the practical implementation and effectiveness of these mechanisms in the Dutch construction sector.

This aim of this study is to address the knowledge gap between the theoretical suggestions and the practical implementation of pain/gain sharing mechanisms by conducting empirical research. The objective of this research is to gain knowledge on pain/gain sharing mechanisms in order to explore how this mechanism can be of value to the supply chain.

By conducting research on pain/gain sharing mechanisms and addressing this win-lose climate that is prevalent, the research can be applied in a real-world context and potential solutions to combat this will be proposed.

The ultimate goal of this research is to promote a way (by implementing pain/gain sharing mechanisms) in which performance and productivity may be improved, leading to a potential enhanced quality of work.

This research focuses on the investigation of pain/gain sharing mechanisms in the Dutch construction industry.

NEC3 and NEC4's Engineering and Construction Contract (ECC) are the only contracts that currently use a pain/gain sharing mechanism in integrated contracts between Client and contractor, under option C (target costs), this is where parties involved share both the detrimental and beneficial impacts in accordance with the results of the contracts (Barton, 2020). Option C in NEC 3 and NEC 4 is a target cost-based contract meaning shares ratios will be set between the parties in the contract and are agreed upon before the start of the project.

The problem facing the implementation of pain/gain sharing mechanisms in other contracts other than NEC3 and NEC4 is the lack of knowledge surrounding pain/gain sharing mechanisms. This lack of awareness has led to pain/gain sharing mechanisms sometimes being implemented unknowingly which in turn leads to a lower effectiveness.

1.1 Setting the scene

In the Dutch construction industry, different types of contracts are used. And in different types of contracts, the contractor and client roles and responsibilities differ. The main types are: Traditional (RAW systematics), DBFM, UAV-GC, Maintenance Contracts and Alliance Contracts but there are many more types of contracts (de Ridder & Noppen, 2009). The latter, Alliances, are often seen as cooperation contracts what can consist of two or more parties where goals and objectives are shared (Hampson & Kwok, 1997). In practice, we see examples where there can be an Alliance between the client and the contractor, or the contractor can choose to form an alliance with other contractors.

According to Mesa et al. (2016) the performance of the supply chain relationship is vital for the completion of a project. His study shows clinical evidence that pain/gain sharing is one of the most important drivers, even more so than drivers such as conflict resolution and continually improving the project.

By focusing on the supply chains, extra productivity can be achieved. By working in a different way than the traditional and back-to-back, and not solely focusing on the top layer, the translation and transition to the layer below the contactor i.e., the supply chain can be examined, and therefore new knowledge can be shared amongst all parties – to the benefit of this project and any future projects any parties undertake. Akintoye (2000) argues that supply chain collaboration is a key element of construction as his study rates it as essential for future success.

Ooms (2021) has done research on the topic pain/gain share mechanisms in his thesis called “Collaboration through gain-and pain-share mechanism”. The research of Ooms focuses on the collaboration between client-contractor. However, in contrast to this thesis, Ooms’ thesis does not distinguish between “pain/gain” mechanisms and “pain/gain sharing” mechanisms. Lauret (2020) has done similar research on NEC4 and recommended further research into pain/gain sharing mechanisms.

In addition to pain/gain sharing mechanisms, which refer to sharing pains and gains, pain and gain mechanisms also exist in literature and practice. The latter mainly revolved around individual pain and gains. A pain can consist of fines, yellow and red cards, ratings and scores, and also social pains such as bad reputations. Gains can for example be bonuses, discounts based on scores/ratings, a good reputation and publications in the media which leads to positive recognition. Although these mechanisms might not be intended for use as sharing mechanism, still they might spark ideas on sharing mechanisms.

This research will primarily focus on pain/gain sharing mechanisms in the supply chain and aim to explore how pain/gain sharing mechanisms can help a project come to completion.

1.2 Problem definition

This section describes the problem definition. First the problem statement is described in section 1.2.1, that leads to the need for this research, which is described in section 1.2.2, research gap.

1.2.1 Problem statement

The construction industry is facing the recurring issue in that delays and conflicts are causing an adverse impact on construction projects. Despite improved management techniques and scientific research multiple issues such as delays, conflicts, productivity loss and poor performance still occur in construction projects (Tariq & S. D. A. Gardezi, 2022).

Successful completing a project depends on meeting objectives within time and budget (Baldwin et al., 1973). Delays and inefficiency play a significant role in the completion of construction projects and cause lot of losses for the owner and client. For the contractor, delays mean higher costs due to longer work time, labour cost increase and a higher fabrication costs which leads to inefficiency in construction projects (Haseeb et al., 2012).

1.2.2 Research gap

Several researchers like Chang 2014; Hosseinian et al. 2018; Hosseinian and Carmichael 2013, have conducted various studies on the implementation of pain/gain sharing mechanisms in TCC's over the last decade (Shehadeh et al., 2022). It has been proven by many scientists that implementing pain/gain sharing mechanisms can theoretically be successful for project progress. And a number of projects, including in Hong Kong, have been successfully completed through the use of pain/gain sharing mechanisms in contracts (Bayliss et al., 2004).

However, apart from these examples, there is a lack of knowledge about pain/gain sharing mechanisms.

This research will investigate and define pain/gain sharing mechanisms that can be used in the Dutch construction sector. This research will add new literature to the current literature on pain/gain sharing mechanisms.

1.3 Scoping the research

In this section the research objective is described in section 1.3.1, this is followed by the research questions which are formulated in section 1.3.2. Lastly, the research scope is described.

1.3.1 Research objective

The objective of this research is to gain knowledge on pain/gain sharing mechanisms in order to explore how this mechanism can be of value to the contractor.

The final aim of this research is to show the Dutch construction industry the opportunities of pain/gain sharing mechanisms and highlight the benefits and drawbacks of implementing pain/gain sharing mechanisms in contracts. The results will contribute to the Civil Engineering field by answering the still unknown question as to how pain/gain sharing mechanism contracts can benefit the contractual sphere within a supply chain, as well as highlighting the adverse effects of pain/gain sharing mechanisms that are important to be mindful of.

1.3.2 Research questions

The main research question for this research is formulated as follows:

How can a pain/gain sharing mechanism be implemented so that the contract prerequisites are met by all parties in the supply chain?

To answer this main question, the question is divided over 4 sub questions:

1. **What are the pain/gain sharing mechanisms in theory?**
2. **What are the pain/gain sharing mechanisms in practice?**
3. **What are the essential conditions of implementing pain/gain sharing mechanism?**
4. **How can one determine the most effective pain/gain sharing mechanism for the project?**

1.3.3 Research scope

The research is in collaboration with Dura Vermeer. The study focuses on the contract management of Dura Vermeer, with a small overlap of the purchasing department.
Within this research, contemporary contracts that are applicable in the supply chain will be researched.

The research is aimed at the projects Dura Vermeer's contract management and procurement departments have carried out. These projects are the projects the exploratory study and case study is based on. The research focuses only on the Dutch construction industry, with the expertise in the literature, on the other hand, being obtained outside the Netherlands.

1.4 Document structure

Chapter 2 describes the research methods used to conduct this study. Subsequently, the pain/gain sharing mechanisms are investigated. In chapter 3 the mechanisms from the literature are discussed, and in chapter 4 the mechanisms found in practice at Dura Vermeer are explored. Some of these projects are analysed in Chapter 5 in the chapter Case study. The results of the case study are presented in chapter 6 where the development of the strategic framework is discussed. This framework has been evaluated by a number of experts. This expert evaluation is found in chapter 7. Subsequently, the research is concluded with the discussion, final conclusions, and recommendations in chapters 8 and 9.

2 RESEARCH DESIGN

2.1 Research methodology

This thesis involved both empirical and non-empirical research. Empirical research is research that is "based on observed and measured phenomena and derives knowledge from actual experience rather than from theory or belief." Bearden (2021). During the interviews, the aim was to gather insights on pain/gain sharing mechanisms based on first-hand experiences of members involved in the projects.

Non-empirical research is focused "more on theories, methods and their implications" (Innovation and Education, 2022). Through the literature study, non-empirical research will be conducted by examining the theoretical side of pain/gain sharing mechanisms. Therefore, the interpretivist philosophy would be the best to use. The observation made throughout this research has shown there is no clear route to decide how the various pain/profit mechanisms best apply to NEC contracts. The interpretivist philosophy is epistemological in which "by its nature promotes the value of qualitative data in pursuit of knowledge" (Kaplan & Maxwell, 1994).

The topic of pain/gain sharing is in itself a convoluted topic which is impossible to quantify using statistics, facts and figures. This research will describe and define the different types of pain/gain sharing mechanisms and explain how they are best implemented in projects.

This research will consist of existing literature in a review format, conducting semi-structured interviews and case studies. Triangulating the research will facilitate the validation of the primary data through different sources and test the consistency of this research compared to others (Kennedy, 2009).

In order to get an answer for the main and sub questions in this research four different types of research methodology are used. The four main methods for this research are:

- Literature study
    - Sub question 1
- Exploratory study
    - Sub question 2
- Case study
    - Sub question 3
- Expert meeting
    - Sub question 4

2.2 Literature review

First a literature study was done to clarify the concept of pain/gain sharing mechanism for the research and to determine which mechanisms were included in the research. Also, with the help of literature it was explored how the mechanism could be applied to contemporary contracts.

In order to find relevant and appropriate literature for this research, the following databases were searched in: Google (Scholar), ScienceDirect, Scopus, ResearchGate, American Society for Civil Engineers (ASCE) and the TU Delft repository.

The terms that yielded the most and relevant data are as follows:

1. “pain/gain” & sharing construction.
2. “pain/gain” & sharing mechanism.
3. “Pain gain” & share
4. Partnering construction
5. “Pain gain” & supply chain
6. Incentives
7. Construction management

A lot of the articles were also found due to snowballing. Literature was collected through references of articles found with the search terms above.

2.3 Exploratory study at Dura Vermeer

In addition to the literature, Dura Vermeer's experience with pain/gain sharing mechanisms was researched. This was done by asking a number of people from contract management and procurement management what their understanding of pain/gain sharing mechanisms is and which reference projects they link to their definition of pain/gain sharing mechanisms. Based on these references, it will become clear how well-known pain/gain sharing mechanisms are and to what extent Dura Vermeer is already working with the aforementioned mechanisms.

2.4 Case study

The next research method that was used during this project was the case study method. Analysing cases will create the opportunity to garner a multi-faceted and thorough understanding of the varied and complex issue that is: how can pain/gain sharing mechanisms effectively stimulate desired behaviour. Analysing multiple cases is “an established research design that is used extensively in a wide variety of disciplines” (Crowe et al., 2011). Analysing these cases allowed me to get a true-to-world picture of the real-life situation regarding the implementation of pain/gain sharing mechanisms.

As a part of the case study, semi structured interviews were conducted. This helped gather data on how experts in the field view the mechanism. Conducting interviews in different fields, client/contractor/ experts in civil engineering gathered data on what is needed to implement pain/gain sharing mechanisms in the industry. Semi-structured interviews were most beneficial “because it allows for researchers to acquire in-depth information and evidence from interviewees while considering the focus of the study” (Mashuri et al., 2022).

2.5 Expert evaluation

The last sub-question was answered with the help of expert meetings. It can be argued that this expert meeting was the most important section of the entire study - this is because, the experts will be able to either validate or invalidate whether pain/gain sharing mechanisms could be implemented in the supply chain. The expert evaluated the strategic framework developed as a result of the case study.

The aim of this thesis is to research whether pain/gain sharing is real-world applicable, the experts will be able to share their opinions on whether or not this thesis findings are useful when contextualised in a real-world setting.

3 LITERATURE REVIEW

This chapter consists of the literature study. During this literature review, a range of sources will be analysed: from peer-reviewed journal articles to scholarly web articles. If it is relevant, academic, and reliable, it will be considered. It is important to draw a review from a wide range of studies, both contemporary and historic. “It is essential to read published peer-reviewed original research articles to formulate your literature review… strike a balance between old established papers and current ones” (Winchester & Salji, 2016). Winchester and Salji make it apparent that in order for a literature review to be whole, literature needs to be critically analysed that both disagrees and agrees with your research goal.

The literature study consists of 3 elements that are important for this research on pain/gain sharing mechanisms: NEC4, pain/gain sharing mechanisms found in literature and some pain/gain mechanisms that could be potential pain/gain sharing mechanisms. The latter are by definition not sharing mechanisms. Since the scope of this research is pain/gain sharing mechanisms the potential of becoming sharing mechanisms, when applied in a way both parties benefit or limit from it, is the reason they are being reviewed in this research.

The reason NEC4 is being reviewed, despite the fact that NEC4 is not applied in the Dutch industry, is because NEC4 contains good examples of implementing pain/gain sharing mechanisms in contracts.

The first section is about NEC4, this section contains the review about NEC4 subcontract forms that contain pain/gain sharing mechanisms between Contractor and Subcontractor. In the section 3.2, pain/gain sharing mechanisms in the literature are reviewed. Finally, in section 3.3 the pain/gain sharing mechanisms that are currently not ‘sharing’ mechanisms, but could potentially be, are reviewed and section 3.4 contains the conclusion of this chapter.

3.1 NEC4

In this section the NEC4 is reviewed. This thesis contains the NEC4 contracts between Contractor and Subcontractor and the important concepts of NEC4 where pain/gain sharing mechanisms occur. The defining contract that will be referred to in this literature review is Engineering and Construction Subcontract (ECS). The ECS series cover the contract between main contractor and the supply chain (*NEC4: Engineering and Construction Subcontract | NEC Contracts*, 2020). The ECS contain the same definitions of the NEC4 ECC contract.

First, the structure of the NEC4 is reviewed followed by the pain/gain sharing elements from the NEC4 ECS.

3.1.1 Structure of the NEC4

According to NEC, NEC has helped the engineering and construction industry for years by improving project management. NEC provides main contractors the ability to be flexible in pricing options as well as the opportunity to share risks and manage jointly (NEC contract, 2017).

NEC 4 has enhanced the already successful NEC3 and enhanced it (NEC contract, 2017). NEC4 is a suite of contracts developed by the Institute of Civil Engineering and is widely used in

United Kingdom and Hong Kong (Gerard, 2005). The principles that form the basis of the NEC contracts were aimed at good project management and cooperation.

All contracts in the NEC series are designed to encourage good management between parties, are applicable in different locations and types of work and are provided with clear and simple documents in understandable language and structure (Strang, 2017).

Chao-Duivis (2017) and (Chao, 2018) both named the 5 most important properties in the NEC suite NEC (2017).:

1. An integral coordination between different NEC3 contracts;
2. Modular and flexible structure per contract;
3. Spirit of mutual trust and cooperation;
4. Incentives to optimise the construction process;
5. Project management tools.

Point 4 is relevant to this study, because it has a link with pain/gain sharing mechanisms. This point is described later in this section.

The NEC 4 ECS, according to NEC4: Engineering and Construction Subcontract (2020) is structured as follows:

- 9 core clauses
  - 1. General
  - 2. The Subcontractor's main responsibilities
  - 3. Time
  - 4. Quality management
  - 5. Payment
  - 6. Compensation events
  - 7. Title
  - 8. Liabilities and insurance
  - 9. Termination
- 5 main option clauses
  - Option A: Priced subcontract with activity schedule
  - Option B: Priced subcontract with bill of quantities
  - Option C: Target subcontract with activity schedule
  - Option D: Target subcontract with bill of quantities
  - Option E: Cost reimbursable subcontract
- 2 dispute resolutions
  - Option W1
  - Option W2
- 21 main option clauses (X-options)
- Option to insert bespoke clauses ('Z' clauses)
- Contract Data, Works Information, Site Information

For this research the core clauses, main option clauses and secondary option clauses are important since pain/gain sharing mechanisms are referred to in these clauses.

Core clauses

These clauses are the pillars of the construction contract consisting of 9 parts. This contains standard agreements and requirements that are standardized in every NEC contract. While the

clauses here can be modified to meet client requirements, it is highly recommended that they be left as standard in the NEC in order to maintain the aims and objectives of the NEC. Leading to a standardised practice.

Main option clauses
In addition to the core clauses, a main option clause must be chosen. The main option clauses are 6 options (A to F) from which to choose for the contract. The main option clauses determine the final distribution of the risks between the parties and how the subcontractor is paid. One of the options here is Option C: Target contract with activity schedule. This will be discussed more in detail in section 3.1.2.

Secondary option clauses
These options, consisting of X, Y and Z, are optional clauses that can be added to the contract. In addition, X and Y are standard prescribed clauses that can be chosen, and Z are conditions that are modifiable by the parties and can be additionally added to a contractual condition in advance (Metroun, 2020).

According to Chao-Duivis (2017) NEC3, which is the successor of NEC4, focuses on cooperation, good project management and the NEC3 contracts allow flexibility in construction contracts. Chao stated in 2017 that the authors of the NEC3 ECC have opted for an innovative approach encouraging collaboration. Chao (2017) states the incorporation of incentives optimises the construction process and using various project management tools improve construction efficiency.

3.1.2 Option C: Target contract with activity schedule

In the NEC4 ECS there are two options for target cost contracts. Option C: Target contract with activity schedule and option D: Target contract with bill of quantity. In option C the target cost is set.

Option C in the NEC4 contracts is a target contract based on an activity schedule. This option contains a pain/gain share mechanism. Contractor and subcontractors use this contract due to the aforementioned mechanism whereby the parties involved share the benefits of cost savings as well as accept some losses together. Option C is a specific type of ESC (and ECC) type of contract that involves a cost-plus contract. This means that the subcontractor is paid for an agreed upon target cost built up from an activity schedule. This mechanism means that if the subcontractor is able to complete the project for less than expected, the savings (reductions) will be shared with the main contractor. However, if the subcontractor exceeds the price (overrun) the subcontractor will bear some of the additional costs (NEC Option C: Target Contract with Activity Schedule, 2018).

The distribution of costs (reductions and overruns) is predetermined in the contract. The subcontractor's estimated price is part of the defined costs in the project. These costs include not only the estimated work costs, but also the overhead and profits.

The option offers both parties a fair outcome. For example, parties can choose to divide the first 10% of gain or pain at 50/50. This ensures that both parties set fair and realistic goals and minimizes the risks for the Subcontractor to make a profit or suffer a lot of loss, which can cause the contractor to go bankrupt. In addition, this also ensures that the Contractor only has to bear the losses up to a certain level (Barton, 2020).

The (sub)contractor's share is the term known for pain/gain sharing mechanisms in this target contract. Under main option C, this mechanism is set out in clauses 53.1-53.4. In these clauses, the (sub)contractor's share is calculated. The (sub)contractor tenders the price together with an activity schedule and the division of the share percentages and ranges (Rowlinson, 2019).

3.1.3 Incentives in the NEC4

In the NEC4 suite there are a number of clauses that deal with incentives (and disincentives). These incentives included in the NEC4 have some interface with pain/gain sharing mechanisms. These following clauses related to incentives are included as standard in the NEC4. This section discusses the X clauses from the NEC4 contracts. These X clauses are secondary option clauses, the parties can choose to incorporate these options into the subcontract. There is also the possibility to incorporate them separately from each other (NEC 4: Engineering and Construction Subcontract, 2020).

Incentives to optimize the construction process:

- Option X6: Bonus for early completion.
- Option X20: Key performance indicators.

The options will be described below.

Option X6: Bonus for early completion

Option X6 in NEC 4: Engineering and Construction Subcontract (2020) contract state:

"X6.1 The Subcontractor is paid a bonus calculated at the rate stated in the Subcontract Data for each day from the earlier of

- *Completion and*
- *the date on which the Contractor takes over the subcontract works".*

Option X6 in the ECS4 is an option whereby the contractor grants the subcontractor a bonus for the early delivery of the project. The bonus is calculated based on a rate that is specified by the Contractor in the NEC ECS4 contract under "Part 1 – Data provided by the Contractor".

"If Option X6 is used without Option X5: The bonus for the whole of the subcontract works is … per day" (NEC 4: Engineering and Construction Subcontract, 2020).

This rate is a "day count", where the bonus is awarded for each day, the subcontractor delivers the work earlier. The count of the number of days is counted from the day the work is handed over to the delivery date fixed in the contract (Hughes, 2019). Option 5 is an option for Sectional completion. The difference in using X6 with or without X5 is the division of the sections and the bonus amounts per section per day.

When there is section completion (option X5) and the contractor only wants to reward the subcontractor if it succeeds in delivering one or a number of sections earlier instead of all sections, the contractor can choose to enter NIL (0) as a bonus rate on the sections where he does not want to award a bonus (Rowlinson, 2019).

Gerrard & Waterhouse (2019) have stated that this form of bonus can ensure the client (in this case the contractor) that the work is delivered faster. This ensures common goals for both parties and could reduce conflicts and disputes as contractor and client tend to be more collaborative with one another.

Option X20: Key performance indicators (KPI's)
In the ECS it is possible, by means of option X20, to measure the progress of the subcontractor using KPI's (Rowlinson, 2019). KPI's are incentives that the subcontractor can earn when the targets stated in the contract are met in the Incentive Schedule. The KPI's are only bonuses, the subcontractor does not have to pay a penalty/malus if the targets are not achieved. Cheung (2020) concluded that when suitable KPI's are used, with targets that are practical and achievable, it is possible to realise effective incentives.

X20 must not be used in conjunction with Option X12 (Multiparty Collaboration). The reason being that secondary option X12 includes its own incentive mechanism (Rowlinson, 2019).

3.2 Pain/gain sharing mechanisms

This section describes pain/gain sharing mechanisms outside the NEC. These pain/gain sharing mechanisms have been found in the literature and are similar to the incentives in the NEC and their effects. The Target Cost Contracts (TCC), risk sharing, KPIs and sharing benefits are discussed.

3.2.1 Target Cost Contracts (TCC)

Target Cost Contract, known as TCC, is a type of agreement that estimates the costs of the work to be carried out. During the course of the work, the initial cost estimate can be changed by both client and contractor if there are any changes tot the original specification. Any savings or overruns between the target cost and the actual cost at completion are shared between the parties. The specific share ratio is decided upon before the start of the project, and is documented in the contract (Chan et al., 2010). The mechanism can also be used for the relationships between Contractor and Subcontractor.

Target Cost Contracts are often used when client and contractor choose to enter into a collaboration contract. In addition to the option C in NEC4 as just discussed in 3.2.3, this is another type of TCC in the literature. The advantage of working with a TCC contact is the possibility to coordinate and align the goals of the parties involved (Chan et al., 2010).

According to Carmichael (2000), using pain/gain sharing allows parties involved in the contract to align their benefits. The client and contractor tend to work closely together, as they share the risks through this contract. By means of pain/gain sharing mechanisms, they share the risks of exceeding or falling below the target costs. This is a pain for both parties if costs exceed the target, and a gain for both parties if costs fall below the target.

A TCC works with the 'open book' principle. There is transparency between the parties involved in sharing information about costs. This ensures building trust between client and contractor.

The pain/gain mechanism is the most important part in the TCC contracts because of the main objective of saving costs. This pain/gain sharing ratio determines how the reduction (gain), or cost overrun (pain) of the established target cost is shared among the parties (Chan et al. 2011). Chan et al. (2010) state that TCC is a unique arrangement that changes the fixed price approach to a target cost approach. This happens when the client and contractor work together and decide on how to allocate the risks involved in the project.

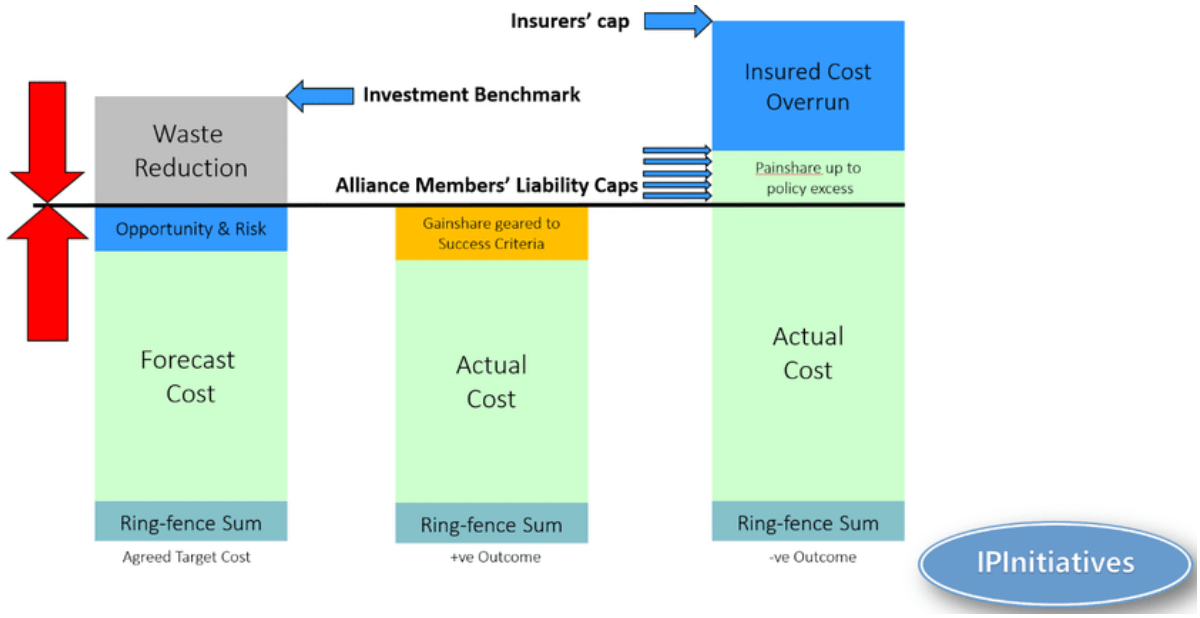

Figure 1, Target cost and the pain/gain share mechanism (source: University of Reading 2018)

Through research conducted by Chan et al. (2010) a year prior, it is shown that applying TCC's provides the best financial value and project stakeholders experience the best project performance. Assuming that the pain/gain ratio is optimally distributed, TCC's is the best win-win scenario for both parties.

Difficulties of implementing TCC

- Despite the findings from Chan et al. (2010) using a TCC can be a difficult process. There may not be a total understanding of what a TCC entails and is used for. For example, with projects where there is a high-risk profile, the common solution in Hong Kong would be to implement a "design-and-build lump-sum" contract, the difficulty with this is that the entirety of the risk is held by the contractor.
- The TCC was almost not implemented as the concept was relatively unknown in Hong Kong at the time, the contracts were only accepted by management after assurances that the cost reimbursement would be closely monitored throughout (Chan et al., 2010).
- Sadler (2004) discusses that as the project participants may not be used to working in this formula, they might have difficulty in changing the way they work traditionally. Further to this, Gander and Hemsley (1997), stated that the absence of a standardised form of TCC contract, will result in a higher level/possibility of drafting errors and cause confusion and misunderstanding of who incurs what liability between the parties.

Conditions to successfully implement TCC.

- There are a number of perceptions and ideas regarding the conditions to successfully implement TCC. For example, Tay et al (2000) argues that in order for a target cost contract to be successful, a genuine willingness to achieve co-operation needs to be shown by both parties. Along with this, a partnering spirit must be demonstrated between the collaborators.
- Therefore, it is clear to see that mutual trust and a close working relationship are critical in order to accomplish the open book philosophy of working. The target cost approach is unique in the sense that, there is a joint agreement between both the client and the contractor in regard to sharing the risks. The client side recognise that a realistic target

cost contract which needs to include risk contingencies, that are appropriate under the pain/gain sharing mechanism.

- In order to combat the risk disparity, Sadler (2004), recommends that the client should perform an evaluation and consider the fee, and share the risks fairly. As this should ensure the incentive sufficiently motivates the contractor to perform in agreement with their goals.
- Further to this, Broome, and Perry (2002), suggested that in order to have an appropriate strategy contractually, the aims and motivations of all parties should be aligned. This is to maximise the likelihood of these set project objectives being achieve. If they then take into account the different constraints and risks that both parties carry, the strengths and weaknesses of the different parties may be measured and fixed accordingly.

3.2.2 Risk sharing

Risk sharing is what the literature knows as equal allocation of risks between parties involved (Peckiene et al., 2013). Risk sharing can be found in contracts such as Alliance contractors (Klijn, 2019), the mechanism of risk sharing is purely looked at here since it is important for this thesis.

According to Klijn, (2009) most forms of cooperation in construction are contracts in which responsibilities and risks are divided and not shared. Risk sharing, according to Bayliss (2004), is an incentive that can be agreed upon at the start of a project to be used as an incentive. Project risks, as used in Alliances, are classified as profit and loss, and are shared in a certain way. In the case of an alliance, client and contractor are seen as equal partners who work together to achieve the same goal (Klijn, 2009).

When it comes to risk sharing in a construction project, it has to be done in a manner that does not harm any party involved (Peckiene et al., 2013). According to Wamuziri & Seywright (2005), the theory of risk sharing and incentives in contracts has been widely reported in the literature by many researchers. Weitzman concluded in 1980 that the risk distribution ratio should be at least around 50% in the most reasonable cases to encourage the contractor to save costs. In order to encourage the contractor more to save costs and minimize production costs, a division will have to be made into sharing the risks from which the contractor will benefit (Wamuziri & Seywright, 2005).

3.3 Potential pain/gain sharing mechanisms

This section is about potential pain/gain sharing mechanisms, potential pain/gain sharing mechanisms are 'pain/gain' mechanisms that are not so much seen as sharing mechanisms but can be used as sharing mechanisms through specific use.

3.3.1 Bonus/malus

The first potential pain/gain mechanism is the bonus/malus system. This system is based on performance incentives that can come in the form of rewards and sanctions. The rewards (bonus) and sanctions (malus or penalty) are predetermined in the agreement.

Bonus

A bonus can be a positive incentive to get desired behaviour. By awarding a bonus, the client can encourage a contractor to deliver more performance, or to deliver the work sooner.

According to Dekens (2013) bonuses can be categorised into 3 forms:

1. Bonus on the requirement;
2. Bonus higher than the requirement;
3. Bonus without requirement.

Bonus on the requirement
With this form of bonus, the contractor receives a bonus if exactly what is actually required is completed. In the event of both a lesser performance in regards to the requirements, and also a better performance than the requirements, the bonus will lapse. This bonus is not often used, because it is a bonus for meeting the requirement.

Bonus higher than the requirement
With a bonus on the requirement, the contractor receives a bonus based on higher performance than the requirement. The better the performance than required, the higher the bonus. For example, the requirement is a score of 6 on satisfaction, then a bonus is awarded at 7 or higher. A score of 9 gets a higher bonus than a score of 7. This form of bonuses is used more often because it can stimulate desired behaviour.

Bonus without requirement
According to Dekens (2013) bonusses can also be awarded in the case of a bonus without a requirement. This bonus is awarded to the contractor upon achieving a certain performance. This performance is not stipulated as a requirement in the contract. However, the contract must specify the conditions under which the contractor is awarded the bonus.
These bonuses can be simple bonuses like financial bonuses, but they can also be in the form of good publication, a news item, or a positive reference.

Malus

A malus is a sanction that is not defined as a fine according to article 6:91 BW of the Dutch Civil Code. Article 6:91 BW states: *"Penalty clause means any clause stipulating that the debtor, if he fails to fulfil his obligation, is obliged to pay a sum of money or another performance, regardless of whether this serves to compensate damage or merely to encourage performance over to go."*

This article is about non-compliance with a contractual obligation. The main purpose of a malus is to prevent undesirable behaviour. This may be poor quality delivered by the contractor. When adding a malus to a contract, the undesirable behaviour is described in the contract, and the contractor uses the malus to reduce the pay out to the contractor. In this way, the contractor will do a better job to prevent the malus, but will not provide added value, since this costs the contractor itself money and yields nothing.

Maluses can be categorized into 4 forms:

1. The penalty for undesirable behaviour;
2. The penalty as leeway for the contractor;
3. The malus as a surplus value scheme.

The penalty imposed on undesirable behaviour
A malus for undesirable behaviour is used to impose a sanction on avoiding choices made by the contractor. By imposing a penalty on choices that are not desirable for the client (such as closing a road on a weekday), the client can encourage the contractor to make a different choice

for the work (such as closing the road in the night on weekends). In the contract, the contractor imposes a penalty on closing the road during the week, and has no objection to closing the road during the weekend or at night.

The malus as leeway for the contractor
A penalty as slack is when there is a deterioration for the contractor. When it is included in the contract that deterioration is accepted to a certain extent against a reduced payment (the malus), there is a malus as a leeway for the contractor. It is therefore not directly a shortcoming, but a reduction in the agreement (in other words, as opposed to a reduction in payment).

The malus as a surplus value scheme
The Client may also choose to withhold part of the standard payment amount and only award it to the Contractor when undesirable behaviour has been prevented. This form of malus offers the client certainty that undesirable behaviour will not occur.

Some examples of maluses are:
- Financial maluses;
- The suspension of one or more payments;
- Shutting down the project;
- Poor past performance score or poor performance measurement;
- Place on the 'reserve bank' if you have a framework agreement with several parties;
- Early termination of the agreement (PIANOo, 2016).

Use of bonus/malus system
The research by Dekens (2013) shows that the implementation of the bonus/malus system can offer positive outcomes. The contractor can take measures in the execution phase to improve performance and receive a bonus on that basis. However, if the contractor expects the bonus at an earlier stage of the project, the tendering phase, and on the basis of this performs better than requested, it can feel like a malus for the contractor. Dekens (2013) also concludes that giving a malus has the effect that the contractor delivers the performance requested by the Client.

The associated risks do play a major role in the effectiveness of the bonus/malus system. According to Dekens (2013), a bonus has no effect if it is depended on the performances of third parties, as long as the contractor cannot influence third parties, awarding a bonus/malus is not a solution.

3.3.2 Disincentives in NEC4

Option X7: Delay damages
Although X7 might not be defined as “pain and gain sharing mechanisms”, it depends on the use of the options between Contractor and Subcontractor that can make the option “sharing mechanisms”, in case the “damage” is shared between the parties.

NEC4: Engineering and Construction Subcontract (2020) states Option X7:
“The Subcontractor pays delay damages at the rate stated in the Subcontract Data from the Subcontract Completion Date for each day until the earlier of
- Completion and
- the date on which the Contractor takes over the subcontract works.” (*NEC4: Engineering and Construction Subcontract*, 2020).

Delay damages are traditional “liquidated damages” that we know from the aforementioned article 6:91 BW in contracts. These are damages for delay that must be paid by the Subcontractor to the Contractor when the work is not delivered on time (Hughes, 2019). These damages are predetermined in the contract and settled per late day. The amount included in the contract is not a penalty, but an estimate of presumable loss. These fines are often seen in the Dutch construction industry.

Contrary to many other contracts, the Contractor does not have to prove in writing where this amount comes from, but the subcontractor must, according to the NEC4 ECS contract, pay a delay damage of the amount stipulated in the contract to the Contractor. This is an amount calculated up to the delivery date, or takeover of the work by the Contractor, whichever is earlier.

In the event that the Contractor takes over the work before delivery, the amount of delay damages will be calculated on a pro rata basis. What is seen as an 'advantage' by the takeover by the Contractor in relation to waiting for the entire work to be taken over, will be deducted from the total amount that the subcontractor must pay in delay damages. This reduction in compensation in ECS is different than in most contracts because a margin of taken over work is calculated there and equals reduction in compensation (Hughes, 2019).

3.4 Conclusion

Based on the literature study of this chapter, sub question 1 can now be answered. Sub question 1 reads:

What are the pain/gain sharing mechanisms in theory?

In the current literature, the contract form in which the pain/gain sharing mechanism has been implemented is the NEC4 contract ECS4 Option C. This contract is a target cost contract in which the pain/gain sharing mechanism occurs, namely the option whereby the contractor and subcontractor share the benefits of cost savings as well as accept some losses together.

In addition to option C in the NEC4, there are also secondary option clauses in NEC4 that can be added to the contract as a form of pain/gain sharing mechanisms. These secondary option clauses are:
- Option X6: Bonus for early completion;
- Option X20: Key performance indicators.

The literature also identifies some other pain/gain sharing mechanisms. The Target Cost Contract (TCC), risk sharing are forms that fall under pain/gain sharing mechanisms in the literature for alliances or Client-Contractor relationships. However, these mechanisms can be used for Contractor-Subcontractor relationships, if used in the correct way. There are some difficulties with implementing. The difficulties in short are: lack of understanding TCC and its purpose, resistance to change traditional work practices, absence of standardised TCC contracts leading to errors and confusion and lastly, unfamiliarity with TCC concept in certain regions. In order to implement TCC successful these are the important conditions: willingness and cooperation from both parties, mutual trust and close working relationships, joint agreements on risk sharing between clients and contractor, fair evaluation of fees and risk sharing to keep contractors motivated and lastly, alignment of aims and objectives of all parties to maximise project goals.

Along with the aforementioned mechanisms, some other pain/gain sharing mechanism have been found in the literature, only they are classified in this thesis as “potential pain/gain sharing mechanisms”. These are bonus/malus and NEC4’s secondary option clause option X7: Delay damages. These have the potential to act as 'sharing' mechanisms in contracts if they are used this way between parties with a common goal.

These forms of pain/gain sharing mechanisms can be added to the current contract forms by adding one or more clauses. Bonus/malus system can be added to any type of contract. This is also the pain/gain sharing mechanism that we see most often in current forms of the aforementioned mechanism.

According to the literature using pain/gain sharing allows parties involved in the contract to align their benefits and objectives and use incentives to stimulate desired behaviour.

Above is the conclusion of what is known about pain/gain sharing mechanisms in the literature. From this it can be concluded that little is known about pain/gain sharing mechanisms. Next is to explore what is known in practice about pain/gain sharing mechanisms. To see what the status of pain/gain sharing mechanisms is in practice, the next step of this research is to ask Dura Vermeer the question.

4 EXPLORATORY STUDY AT DURA VERMEER ON PAIN/GAIN SHARING MECHANISMS

In order to get a clear picture of what Dura Vermeer understands by pain/gain sharing mechanisms, their current practice was studied.

4.1 Setup of the study

The study was conducted at Dura Vermeer in Hoofddorp. Dura Vermeer is a Dutch construction company that was created in 1998 through a merger of two construction companies, Dura, and Vermeer. Dura Vermeer's headquarters are in Rotterdam and the company is one of the biggest Contractors in the Dutch construction industry.

One email was sent out to a total of 18 employees of Dura Vermeer. These employees were the members of contract management and procurement department. These were the two departments with most knowledge of implementation of pain/gain sharing mechanisms. The emails briefly outlined this thesis and the employees were asked for two references of projects that incorporated a pain/gain sharing mechanism and also their impression on what the concept of pain/gain sharing entails and their experiences with it.

Following a positive response from the respondents, conversations took place in-person. The conversations took place after the literature study. The knowledge gained from Dura Vermeer was compared to the existing literature to check if Dura Vermeer were using pain/gain sharing and the mechanisms.

4.2 Reference projects

In this section the reference projects that have been found are explained. These consist of reference projects and illustrations of practice.

4.2.1 Project 1:

Project: known by Dura Vermeer
Contract: DBFM-contract.
Role of Dura Vermeer in this project: Contractor (part of "De Groene Boog" (DGB)).

Mechanisms	
Payment based on the availability of the infrastructure	If parts are not available for traffic, you will receive a discount on your fixed fee per quarter.
Lost Vehicle Hours Model (VVU)	In which the contractor specifies the expected nuisance on the road network in the tender and must keep track of the actual nuisance in the model. If the contractor has more VVU than offered in the tender, a fine will be charged.
Environmental cost indicator (MKI)	In which the contractor determines the environmental impact of the design and implementation using a prescribed model in the tender and does so again in the realization phase on the basis of the final design. If the contractor has more MKI than offered in the tender, a fine will be charged. In this case, we (Dura Vermeer) have offered a mechanism with a budget, whereby we receive a bonus from that budget if we have less MKI than offered.
Penalty points system	In the event of non-compliance with contract conditions.

Project: known by Dura Vermeer
Contract: Contractor-Subcontractor contract
Role of Dura Vermeer in this project: Client (part of "De Groene Boog" (DGB)).

Mechanisms	
Gain sharing	An agreement has been concluded with a subcontractor for the provision of expertise for the design, delivery of reinforcing steel and the execution/assembly of prefab nets and baskets for the underwater concrete floor. Subcontractor then looks at possible optimizations of this DO, which then will be divided 50-50% between DGB and the subcontractor after taking into account any additional costs (by one and/or both parties).

4.2.2 Project 2:

Project: known by Dura Vermeer
Contract: Contractor-Subcontractor contract
Role of Dura Vermeer in this project: Client.

Mechanisms	
Bonus on satisfaction (within planning and no settlements except for deviations on DO)	In addition to the fixed price of € XXX there is a € XXX bonus if the Client is satisfied. The purpose of this bonus is to safeguard the project interest, whereby safety, cooperation and achieving planning are essential.

This is not only intended as a fine by date. With this, Dura Vermeer also wanted to prevent them from getting miscellaneous and seemingly particular receipts, questioning the validity of meaningless changes,

"for example; 'this had to be a meter longer' or 'I couldn't reach it and had to come back for it'. If the subcontractor would cooperate proactively and set metrics and targets were reached, the subcontractor would receive a bonus." – quote respondent

4.2.3 Project 3:

Project: known by Dura Vermeer
Contract: Prorail Alliance contract
Role of Dura Vermeer in this project: Contractor (Dura Vermeer + partner).

Mechanisms	
Alliance fund Risk sharing	The alliance fund is a joint money pot, which is the amount made available by ProRail for the project. The amount from this fund provides cover for all kinds of costs incurred, including carrying out the work, changes, repair, risks, permits and more. In the event that the actual costs are lower than the alliance fund, the profit will be divided 50-50% between the Client and the Contractor (Dura Vermeer+Mobilis). Also in the event that the costs are overwritten, the loss is also divided 50-50% between the parties.

4.2.4 Project 4:

Project: known by Dura Vermeer
Contract: E&C based on framework agreement
Role of Dura Vermeer in this project: Shareholder

Mechanisms	
Key Performance Indicators (KPI's) Alliance fund Risk sharing	An incentive system is agreed regarding the distribution of profit and risk so that all Parties benefit from good and suffer from poor performance.

This reference is a contract where Dura Vermeer is a shareholder of ASG (Contractor). In this project ASG, along with 7 other contractors, form an Alliance. This is a case in which all parties in the entire chain work on cost price in relation to a fixed budget, and if there is money left over, the profit per party is determined in relation to the remaining budget. They do not share a risk since the risk is already included in the budget price. If the budget price is exceeded, no profit will be paid out.

4.2.5 Project 5:

Project: known by Dura Vermeer
Contract: FIDIC – Yellow book
Role of Dura Vermeer in this project: Contractor.

This project is a project where Dura Vermeer, as a Contractor, works on a project involving a form of Value Engineering. This agreement states that Dura Vermeer, the contractor, may submit a proposal to the client at any time, whereby the contractor indicates to improve the project in the following ways:

(i) accelerate completion of the Works and/or the Project;
(ii) reduce the cost to the Employer of executing, maintaining, or operating the Works and/or the Project,
(iii) improve the efficiency or value to the Employer of the completed Works and/or the Project; or
(iv) otherwise be of benefit to the Employer.

"If and when the client agrees with one of these proposals, the client can deduce whether or not the obligation has been fulfilled in accordance with the contractor's proposal. This states the fee shall be 30% of the difference between the following amounts: with the agreement predicated on either the reduction in contract price as a result of the changes or the reduction in the value to the employer to the varied works." – quote respondent

4.2.6 Project 6:

Project: known by Dura Vermeer
Contract: D&C (UAV-GC)
Role of Dura Vermeer in this project: Contractor.

The next reference project is another contract with a form of Value Engineering. In this project the parties agree that until Financial Close, optimisations (savings) will be jointly pursued on the 'foundation reinforcement' component, by means of detail-engineering.

"Financial savings from optimisations accepted by both parties and actually happens will be divided equally between the Client and the Contractor on the basis of the prices and starting points known in the final Offer. The results of the optimizations are distributed as follows: '0.5 x (savings + storage percentage) = the share of each party in the optimisation'. The Client's share will be deducted from the total amount." – quote respondent

4.2.7 Project 7:

Project: known by Dura Vermeer
Contract: Contractor-Subcontractor contract
Role of Dura Vermeer in this project: Client.

Mechanisms	
Risk sharing / opportunity sharing.	Dura Vermeer and the contractor together saw an opportunity for which they wanted to share the risk. Reusing aggregate, subcontractor had seen an opportunity but did not know whether this would work. Dura Vermeer has said it will pay the subcontractor for half the cost of replacing the generator. If this succeeds, the subcontractor will have an aggregate left over and will have been paid for "nothing". And if it doesn't work, he supplies a generator. And in that way we have, as it were, shared the risk. Concrete sharing mechanism of an opportunity we saw to win in the tender.

4.3 Illustration of practice:

Below, a number of illustrations are elaborated. These are not Dura Vermeer reference projects, but experiences of a number of employees in their career.

4.3.1 Illustration 1:

Illustration 1 is not a project reference, but a finding of one of the people I asked to share his pain/gain sharing mechanisms with me. Person A shared his impression of what he worked with in his previous role as project leader.

Person A has asked numerous subcontractors he has worked with in the past, how person A could positively impact the work production, so that the project could run smoother and more efficiently, without costing Dura Vermeer this money. The responses were mostly planning related. Many subcontractors wish to speed up their planning so that they can generate the same turnover in a shorter period of time.

Other subcontractors (particularly for groundwork) would like flexibility in the planning. By having the choice of what effort they deploy on a project, they have the leeway to deploy their equipment and people more efficiently across all their projects.

"If they ensure that they meet the end date, this does not have to have any impact for us (Dura Vermeer) as a client. The subcontractor can make optimal use of his own equipment and does not have to temporarily hire equipment from third parties if he is busier, which leads to extra costs for the subcontractor." – quote person A

As a result, the subcontractor achieves a better return without costing Dura Vermeer anything. As a result, the subcontractor is more satisfied, which benefits the cooperation and the project.

4.3.2 Illustration 2:

Illustration 2 is also not a project reference, but another finding from one of the people I asked to share his pain/gain sharing mechanisms with me. Person B shared his impression of pain/gain sharing with me and shared that he is under the impression that the public authority (client) thinks that only financial pain in the contract is doing society a good service. This is also reflected in the contracts with the general purchase values. Person B is of the opinion that provinces and clients copy these from each other. The result of this is that Dura Vermeer often does not register for the work due to the great liability.

"An example of this liability is shown in the figure below. This shows that for a work from € 500,000. there is a risk of € 9,000,000. The money for fines comes from the risk provisions taken up by the contractor. The client therefore pays the fines himself." – quote person B

Artikel 9 - Aansprakelijkheid

1. Tenzij anders overeengekomen, is de partij die toerekenbaar tekortschiet in de nakoming van haar verplichtingen, tegenover de andere partij aansprakelijk voor de door de andere partij geleden dan wel te lijden schade, met dien verstande dat de aansprakelijkheid per contractperiode beperkt is tot een bedrag van:

a. € *150.000,00* per gebeurtenis met een maximum aantal van 3 gebeurtenissen voor opdrachten, waarvan de totale waarde kleiner is dan of gelijk aan € 50.000,00 exclusief BTW;

b. € *300.000,00* per gebeurtenis met een maximum aantal van 3 gebeurtenissen voor opdrachten, waarvan de totale waarde meer is dan € 50.000,00 exclusief BTW, maar kleiner dan of gelijk aan € 100.000,00 exclusief BTW;

c. € *500.000,00* per gebeurtenis met een maximum aantal van 3 gebeurtenissen voor opdrachten, waarvan de totale waarde meer is dan € 100.000,00 exclusief BTP, maar kleiner dan of gelijk aan € 150.000,00 exclusief BTW;

d. € *1.500.000,00* per gebeurtenis met een maximum aantal van 3 gebeurtenissen voor opdrachten, waarvan de totale waarde meer is dan € 150.000,00 exclusief BTW, maar kleiner dan of gelijk aan € 500.000,00 exclusief BTW;

e. € *3.000.000,00* per gebeurtenis met een maximum aantal van 3 gebeurtenissen voor opdrachten, waarvan de totale waarde meer is dan € 500.000,00 exclusief BTW.

Figure 2, general purchasing conditions province X

Person B also indicates that when making inquiries to extend the fine system to a bonus system. A fine for delivering the work a day late should result in a bonus of the same for delivering the work a day early. The client never agreed to this. Person B thinks this is because the public Principal feels they are giving something away, probably because they don't see the value this could bring to the Client.

4.3.3 Illustration 3:

Illustration 3 is an illustration regarding a project outside Dura Vermeer. Person C gave this reference project because it was about a sharing mechanism with a subcontractor. This project involved a so-called Guaranteed Maximum Price contract in which an item is included for unforeseen circumstances (Contingencies). Partly to lower the subcontractor's risk profile, but above all to create more budgetary certainty at the front for us as the Client and our customer. The aim is, of course, to make as little claim as possible on this contingency item and to share any savings on this with the subcontractor. Below, in figure 3, you can see how this is included in the contract.

Contingencies. Subcontractor may protect its GMP by including a contingency within the GMP ("Subcontractor's Contingency"). Subcontractor shall maintain a Subcontractor's Contingency log indicating any transfers from Subcontractor's Contingency to other line items within the GMP. The Parties shall review the log at each monthly pay request meeting and at each weekly change management meeting. Use of Subcontractor's Contingency is subject to the following terms, and the prior approval of the Contractor in writing in each instance, which approval shall not be unreasonably withheld with respect to the items set forth in Subpart (g)(1) below. Notwithstanding the forgoing regarding requirement for Contractor's prior approval of Subcontractor's use of the Contingency, on a monthly basis the Subcontractor may utilize funds from the Contingency otherwise in accordance with this Section but without obtaining Contractor's approval up to an amount not to exceed $20,000.00 in the singular or $50,000.00 in the aggregate for any given month.

(1) Acceptable uses of Contingency:

(A) Costs arising from unanticipated events such as: (i) unanticipated market or materials conditions, or (ii) acts performed by Subcontractor to account for unforeseen weather conditions (not covered by force majeure events), but only to the extent such event does not entitle Subcontractor to a Change Order;

(B) Estimating errors, including quantities, minor scope gaps and Subcontractor errors within the approved Contract Documents;

(C) Emergencies and repairs to damaged work where the damage is not identified to a particular subcontractor;

(D) Costs incurred by Subcontractor for corrective work, to include costs incurred by Subcontractor to correct any Work that is not properly the subject of a Change Order;

(E) Costs associated with schedule impacts or acceleration to include schedule recovery costs if the Project falls behind schedule for reasons within the control of Subcontractor; and excluding schedule impacts or acceleration caused by Contractor that are properly the subject of a Change Order;

(F) Any actual costs incurred by Subcontractor to the extent the same exceeds the line item budget amount for such related work in the estimated cost component of the GMP provided however, Subcontractor's Contingency may be used to fund overruns in the Guaranteed General Conditions Costs and Subcontractor's Labor; or

(G) Other costs not reasonably anticipated or foreseeable by Subcontractor in excess of the GMP budgeted amounts.

(2) Use of Contingency Prohibited. Subcontractor may not utilize Subcontractor's Contingency if the underlying event(s) or circumstances were caused by or related to any negligence, willful act intended to cause harm or injury, or violation of written state, federal, or local laws, statutes, ordinances, or regulations by Subcontractor, its -sub-Subcontractors, or their employees; payment of liquidated damages; reimbursement of additional consultant services due to deficient or delayed work, similar back charges, or damages from Contractor caused by the negligence or breach of the relevant PA.

(h) Savings. If the total of the Cost of Work and Subcontractor's Fee is less than the GMP, then the difference will represent "Savings" and, unless otherwise provided in a PA, one hundred percent (75%) of those Savings will be retained by Contractor.

Figure 3, clauses project Y (outside Dura Vermeer)

4.4 Analysis of the exploratory study

Of the 18 employees that I asked to send me two references each, I received a total of 10 responses. These responses are reference projects or illustrations of practice included in this section.

The responses were mainly examples of pain/gain mechanisms, and their knowledge was rudimentary at best, consisting only of; DBFM contract, Alliances, and Value Engineering. Few respondents showed some inclination of understanding what a pain/gain sharing mechanism was, but the responses showed a lack of understanding the difference between a pain/gain mechanism and a pain/gain sharing mechanism.

These references show that Dura Vermeer does not realise they are working with pain/gain sharing mechanisms. Asking follow up questions made them realise they do in fact have experiences with it.

Project 1 consisted of the traditional monetary penalties and reductions on promises that we mainly see in EMAT (Economically Most Advantageous Tender), in awarding tender procedures. In addition, this project has a sharing mechanism with a subcontractor of the project. The subcontractor can make a profit from this project by using collaborating and sharing expertise with Dura Vermeer.

Project 2 is a typical bonus/malus scheme from the literature. The bonus/malus scheme has been referred to in this thesis as a 'potential pain/gain sharing mechanism' and in the case of this project it has been deployed as a sharing mechanism. By working together towards a common goal, both parties can earn a gain. The subcontractor 'a bonus', and the contractor 'will not lag behind in his schedule'.

Project 3 has a joint money pot which includes all risks and costs. This is a sharing mechanism with the client because the client and the contractors share risks together. If the costs are higher or lower, the overrun or savings are shared together using a 50-50% ratio. Meaning both the gains and pains are shared.

Project 4 has an alliance form with an alliance fund. This mechanism is also seen in the literature as a pain/gain sharing mechanism through the possibility to share risks. The mechanism in this case is an alliance/combination with several parties and risks, profit and loss are shared jointly.

Project 5 is a form of Value Engineering in which the contractor, Dura Vermeer, has the opportunity to improve the work. This is reflected in the 'potential' bonus/malus scheme. The client gets something in return for the improved work that Dura Vermeer delivers. Dura Vermeer earns a bonus doing so. By working together this way, the contractor is stimulated to put in maximal effort and is being rewarded through this incentive.

Project 6 is a form of value engineering on a small part of the project. These small parts in a project can have a big impact. The contract type is UAV-GC, a contract that Dura Vermeer works with a lot, so these forms would be feasible in practice.

Project 7 is another form of risk sharing, contractor and subcontractor see an opportunity and share the risk together. These types of joint risks reduce the impact for a party compared to the alternative.

Illustration 1 is based on someone's beliefs about non monetary pain/gain sharing mechanism. This is an illustration about a previous subcontractors the person has worked with. This shows the 'mechanisms' applied in this case show that the person A shows interest in the needs and interests of the subcontractor.

Illustration 2 shows a case of a member of pointing out a fine, that is known as a fine described in 6:91 BW, as a "pain" on pain/gain sharing mechanism. This is not a pain/gain sharing mechanism, but a fine that is found in every contract. Besides, person B describes as a fine as a "risk". This is not a risk like it is defined in civil engineering. *"Risk is a future uncertainty about deviation from expected earnings or expected outcome"* (Dziadosz & Mariusz Rejment, 2015).

Illustration 3 is about a project person C worked with before they joined Dura Vermeer. This is about a sharing mechanism with a subcontractor.

Based on the literature, several pain/gain sharing mechanisms have been found. These are plotted in the Table 1 against Dura Vermeer's reference projects in order to sketch a picture of the mechanisms from the literature that Dura Vermeer is currently working with. In addition to the literature, other pain/gain sharing mechanisms were also found during the study of the reference projects. These are plotted on the right side of the table under "practice". The mechanisms in the 'practice' column are mechanisms referred to by Dura Vermeer respondents as "pain/gain sharing mechanisms".

Table 1, reference projects with corresponding mechanisms

		Mechanisms retrieved from literature							Mechanisms retrieved from practice			
		NEC4 Option X20 KPI's	Risk sharing	Bonus/malus	NEC4 Option X6 Bonus for early completion	NEC4 Option C	TCC	X7: Delay damages	Gain sharing	Fine	MKI	"pain"/" gain"
Projects												
Project 1	DBFM-contract A16							✓	✓	✓	✓	✓
Project 2	contractor-subcontractor Known by Dura Vermeer			✓								
Project 3	Prorail alliance Spooromgeving Geldermalsen		✓									
Project 4	E&C Tank maintanance	✓	✓									
Project 5	FIDIC - Yellow book Centre construction			✓					✓			
Project 6	UAV-GC Windplan blauw								✓			
Project 7	contractor-subcontractor Lelystad Airport		✓						✓			

As can be seen from this table, the projects of the respondents I asked at Dura Vermeer do not often work with pain/gain sharing mechanisms. The simple fines, penalties and “pain” and “gain” mechanisms are the most commonly used mechanisms in the projects, although they are not “sharing” mechanisms. In addition, the mechanisms that are included in the contracts are mainly collaborations and combinations, and not so much in the supply chain with the subcontractor.

The illustrations show that there is some experience and experiences in the field of “pain/gain” and pain/gain sharing mechanisms, but the practice lacks behind.

4.5 Conclusion

In this exploratory study, several relevant professionals at Dura Vermeer were contacted to gain insights into the existing level of knowledge on pain/gain sharing mechanisms within Dura Vermeer.

Based on the literature study of this chapter, sub question 2 can now be answered. Sub question 2 states:

What are the pain/gain sharing mechanisms in practice?

As shown through the literature review, there are not a lot of pain/gain sharing mechanisms in practice. There are some pain/gain mechanisms in place – but the amount of wholly pain/gain sharing mechanisms are minimal. However, following this, it is also apparent that the parties are aware of pain/gain sharing mechanisms, unfortunately this does not translate into them being consciously applied in practice. Some are used, but the parties either do not realise they are using the mechanisms, or the pain/gain sharing mechanisms are not referred to by name.

From the literature reviewed, it is made clear that pain/gain sharing mechanisms are hard to find on the client side. However, Dura Vermeer as an entity have implemented some pain/gain sharing mechanisms in their project as a client to their subcontractor in a main contractor/subcontractor relationship. Dura Vermeer are more likely to use the pain/gain sharing mechanisms to benefit their supply chain, as evidenced by the references.

The pain/gain sharing mechanisms used mostly, are bonuses and fines. Not much is done to incentivise the stimulation toward their subcontractors/supply chains. The references in this chapter are almost entirely between the client/contractor, and not the contractor/subcontractor, showing more work and research needs to be done in to the implementation and discovery of these pain/gain sharing mechanisms.

The next steps of this thesis are to focus on sharing within the supply chain in the next chapter. In sub questions 3 and 4, specifically sharing in the supply chain will be researched.

5 CASE STUDY

This chapter consists of the setup of the case study, a description of the cases and the analysis of the cases. Finally, the conclusion of this chapter provides an answer to sub-question 3 of this study.

5.1 Case study set up.

Each of the cases involved in these case studies consists of the relationship between contractors and subcontractors. The cases were selected from projects Dura Vermeer have worked in. Each of these selected cases, involves a unique construction project. These cases will be analysed by conducting semi-structured interviews with both the contracts and subcontractors involved in these projects, in order to gain insight on their differing experiences and perspectives. Four participants from each of the three cases will be interviewed, two from the contractor side and two from the subcontractor side.

The research sub question 3 for this case study is as follows:

What are the essential conditions of implementing pain/gain sharing mechanism?

To answer this research question, a qualitative research approach will be followed, specifically semi-structured interviews. Semi-structured interviews provide a flexible framework for collecting rich, in-depth data while allowing for open-ended exploration of the research questions. The interviews will be conducted through Microsoft Teams and will be audio recorded with consent of the participants. The interviews will then be transcribed and processed using Atlas.ti software. Atlas.ti makes it possible to link relationships in interviews using coding. In this way, similarities and differences can be found and trends in mechanisms and cases can be highlighted. The codings of Atlas.ti can be found in Appendix C.

For the selection of the cases in this study, several criteria were considered to ensure that they were relevant to the research questions. First of all, it was important that the cases were projects by Dura Vermeer. Secondly, the cases needed to contain a pain/gain sharing mechanism, as this is a key aspect of the contractor-subcontractor relationship that we sought to explore. Finally, the mechanism had to be shared between the contractor and subcontractor, as this is the specific relationship that the study aimed to investigate. By selecting cases that meet these criteria, we can ensure that the data collected is directly relevant to the research questions and provides insights into the contractor-subcontractor relationship within the construction industry.

In order to compare the data, it was important to select the relevant interviewees. In order to do this, relevant professionals were identified from the different projects through the snowballing method. A small group of participants who met the criteria for inclusion in the study were identified, there participants were asked to refer other individuals who they think are relevant, eligible, and potentially willing to take part in this study (Kennedy-Shaffer et al., 2021).

The chosen cases for this exploratory study were of different nature and had a different pain/gain sharing mechanism. As a result, it is not possible to do a cross-case analysis, hence it was decided that a comparative case study approach would be more appropriate (do Amaral, 2022).

Case 1, a DBFM infrastructure project A16 incorporated gain sharing. Case 2, a large D&B civil railway project utilised bonus malus and finally Case 3, a large DBM Airport infrastructure project involved risk sharing.

To maintain consistent and standardised valid results, an interview protocol was designed. The protocol was viewed as a guide for the interview, so how to structure the introductions between the interviewer and interviewees, the topic of the interview, how to collect the interviewee consent, the questions themselves, how they were structured, what was asked and when during the interview, and finally how to end the interview (McGrath et al., 2018).

There were 3 steps are taken in conducting interviews. They are as follows:

- Interviewees: When selecting the individuals to interview, it was crucial to find individuals who were closely involved in the project. It was important to interview at least one person from each party. The table with the interviewees and their roles is illustrated in table 2.
- Interview protocol set up: It was important to develop a research protocol, as with the type of research in this study (video and audio) some ethical liabilities can arise. The main ethical principles in research include but are not limited to: respect for participants, informed consent, specific permission required for audio and/or video recording, voluntary participation, no coercion and the participants right to withdrawal of their answers (Vanclay et al., 2013). The research protocol allowed all of these ethical quandaries to be addressed and resolved in a systematic and objective manner.
- Validation of the transcripts: Furthermore to the interview protocol, the validity of the transcripts had to be met. The transcripts were sent to the interviewers for them to read and validate to ensure the findings were displayed accurately and their words were not taken out of context of misinterpreted.

Table 2, the cases and the roles of the interviewees.

CASE	MECHANISM	ROLES OF THE INTERVIEWEES
DBFM infrastructure project	Gain sharing	Contractor: - Procurement manager Subcontractor: - Director - Project manager
A large D&B civil railway project	Bonus/malus	Contractor: - Contract manager - Discipline leader Subcontractor: - Project supervisor - Director
A large DBM Airport infrastructure project	Risk sharing	Contractor: - Contract manager - Project manager Subcontractor: - Director - Project manager

5.2 Case 1

The first case for this case study is project DBFM infrastructure project.

5.2.1 Case description

The DBFM infrastructure project is a project constructed by a combination which consist of Dura Vermeer and 5 other contractors. The project is being constructed on behalf of Rijkswaterstaat.

Dura Vermeer worked together with the subcontractor in the project on the part of the underwater concrete floor of the tunnel. In this part, a pain game sharing mechanism was applicable, namely sharing a gain. Dura Vermeer has agreed with the subcontractor and the contract states that the subcontractor must contribute to the optimisation of the final design of the underwater concrete floor. Everything they would save with this optimisation is 50-50% split. The subcontractor was asked by Dura Vermeer to deliver expertise for designing, delivery of concrete steel, implement/compiling prefab nets and prefab baskets for the underwater concrete floor of the tunnel. This optimization has been applied in the final design.

The subcontractor is a concrete steel supplier and agreed to work together with Dura Vermeer to see if they could save kilograms of rebar in the design, it was a large scope so anything you would save would be a profit. However, Dura Vermeer has set a margin, the subcontractor was instructed to stay below this margin at all times in order to qualify for the 50-50% profit.

5.2.2 Results of the interviews

The mechanism used in the infrastructure project case was a gain sharing.

The procurement manager of Dura Vermeer believed they would not want to use this mechanism too often, it seemed to be *"too much"* to be used in every contract (Appendix C, 12:8). The procurement manager of Dura Vermeer stated that one of the disadvantages of implementing a gain mechanism is the fear of subcontractors taking advantage of this mechanism by taking more space in their design, in order to then optimise (Appendix C, 12:6, 12:9).

The procurement manager of Dura Vermeer also indicates that the project itself has suffered many losses. The procurement manager of Dura Vermeer has indicated that it sees disadvantages in the relationship between this mechanism and the losses of the entire project. They made many losses during this project. He stated "and you will not be happy when you have to pay someone for an optimisation" (Appendix C, 12:12). He also stated that he found difficulty in accepting optimization versus overruns in the entire project. He indicated that the optimization of one part of the project was offset by an overrun in another part of the project, which lowered morale (Appendix C, 12:7).

In addition, the procurement manager of Dura Vermeer also sees advantages in a gain mechanism, namely the common motivation to ensure less waste and optimization together (Appendix C, 12:5). The procurement manager of Dura Vermeer indicates that a degree of "maturity" is expected to make this possible (Appendix C, 12:13).

On the subcontractor's side the director of the company was very satisfied with the mechanism and believed they only benefitted from this mechanism (Appendix C, 9:4). The director recognizes the added value of this mechanism and tries to emphasize this value and tries to apply the mechanism more often in projects (Appendix C, 9:14, 9:15, 9:8). However, the project leader of the subcontractor, in fact, expressed that the results were not as positive as they expected. He stated the they not benefitted as much as the director revealed earlier (Appendix C, 10:3, 10:5, 10:21).

The subcontractor felt that this mechanism contributed to good cooperation. The subcontractor indicated that the cooperation was very good and that everything could be discussed (Appendix C, 10:10, 10:14, 9:18). According to the subcontractor, during the phase where this mechanism was established, there was no friction between the parties (Appendix C, 10:15).

The subcontractor has indicated that the simplicity they have applied to this project has been an important part of achieving these gains (Appendix C, 9:6). Smaller projects or parts are easier to oversee than larger projects (Appendix C, 10:7).

In addition to financial incentives, the subcontractor also sees advantages in reputation gains and the acquisition of new contracts (Appendix C, 10:25). The subcontractor indicates that this project has resulted in many new assignments, also abroad (Appendix C, 9:7). The subcontractor indicates that they also see this as a bonus (Appendix C, 10:7, 10:22, 10:24).

5.2.1 Analysis of the case

The gain sharing mechanism, seemed to benefit the subcontractor rather than the contractor. According to the previous section it has been shown that the subcontractor benefitted more from the mechanism than the main contractor. The main contractor showed some concern about the frequency of this mechanism. The procurement manager of Dura Vermeer is afraid this mechanism will be abused, in order to avoid this it is important both parties show 100% transparency, openness and honesty.

Another aspect seen during the interviews is the significance of the losses in the project. The large losses on the project of Dura Vermeer could be the reason the main contractor was not as satisfied with the mechanism as the subcontractor. The subcontractor benefitted from the gain, because they were solely responsible for this part of the project and did not experience losses elsewhere.

Dura Vermeer found a number of difficulties, they believed collaboration was difficult, as it was difficult to agree on shifts in costs, this was because Dura Vermeer believes the subcontractor was afraid of incurring additional costs, because this would be deducted from their optimisation pot. However the subcontractor believed the collaboration went well, because before the start of the project the members of the project team engaged in a collaborative activity, which allowed them to get to know each other. They believed that this experience fostered a stronger band resulting in better collaboration.

At the subcontractor, the director and project manager differed in some areas, the director was much more positive about it than the employee. The project manager had said there were no benefits, as they did not stay below the agreed marge due to unforeseen circumstances, however Dura Vermeer confirmed they paid out the share of the gain. Both parties, Dura Vermeer and the subcontractor acknowledged the challenge of communication within the construction industry.

Both parties offer valuable insights into this mechanism. The main contractor is concerned about possible abuse of this and emphasizes the financial impact of optimization costs and overruns on the total project. At the same time, the subcontractor emphasizes the positive effects on collaboration, simplicity and non-financial benefits such as reputation and new business opportunities.

Before applying a gain-sharing mechanism to a contract, there are certain preconditions that should be met. First, both parties must share a common goal and understand how success will be measured. Second, there should be a clear set of metrics in place to evaluate performance and determine how gains will be shared. Third, both parties must have some degree of joint control over the project, such as shared decision-making or resource allocation, in order to work together towards the shared goal. Fourth, the potential gains should be significant enough to incentivize both parties to work collaboratively and contribute to achieving the common goal. Lastly, a high degree of trust is necessary to ensure that both parties are committed to the success of the project and will share gains fairly. Overall, applying a gain-sharing mechanism to a contract requires a strong sense of collaboration, shared goals, and trust, as well as clear metrics and joint control to ensure that gains are shared fairly.

5.3 Case 2

The case for this case study is project large D&B civil railway project

5.3.1 Case description

This case is about a large railway route. This is a 4 km, railway line in the port of Rotterdam. The Port of Rotterdam Authority was the client. In this scope there was an existing railway line in the port of Rotterdam that went over a bridge. This bridge was a bottleneck for a project because every time that bridge opened, the trains stopped. This was seen as a nuisance by ProRail and the Port of Rotterdam Authority. They then came up with a new route, but this

route still went over the bridge, but on the other side of the harbour. This was a fixed bridge and no longer needed to be opened for large seagoing vessels. During construction, Dura Vermeer found out that a fire extinguishing water supply had to be installed along the entire route. This was not originally a Dura Vermeer scope. However, it was necessary from the licensing authority that this should be installed.

Given the schedule, it was necessary for Dura Vermeer to choose a subcontractor who can quickly and efficiently realise this fire extinguishing water supply. There was a lot of time pressure on the schedule, since the fire extinguisher was necessary to obtain permits for the use of the track.

There was a need for designs and time pressure because the fire extinguisher was needed to get the permit for the use of the sports complex. Dura Vermeer has therefore looked for partners to realise this and when looking for partners, attention was paid to efficiency and speed of implementation. At the subcontractor, a bonus of € XXX has therefore been included in the contract. This bonus was called the “no nagging bonus” and was paid in exchange for independence, flexibility and thinking along during the project. This bonus was also part of the negotiation that Dura Vermeer conducted with the subcontractor. the subcontractor has said that it can do the work for € XXX, but Dura Vermeer itself has calculated this work at € XXX. Instead of negotiating the price, the parties have decided to make time and quality more important. For that reason, Dura Vermeer has offered the subcontractor € XXX, including a € XXX bonus, so they do not have to negotiate the price. Dura Vermeer thought that the € XXX is justified and we do not want any complaints about the costs. The subcontractor receives a one-off bonus of € XXX that would cover all additional work. Dura Vermeer knew that if we start a day later, it will cost € XXX extra, hence the € XXX bonus. With this, Dura Vermeer expects the subcontractor to solve this for them without us having to incur extra costs. At the end of the work, the subcontractor receives the € XXX as appreciation for your work and to absorb minor setbacks. Dura Vermeer did not want to be confronted with extra costs of € XXX or € XXX every time. The budget is € XXX and with that they trust that the subcontractor will carry out the work quickly, properly, and neatly, so that the project is completed on time.

At the time the contract was concluded, not everything was known about the environment outside the construction site, such as the development of the construction site, the construction of cycle paths and the presence of cranes. If Dura Vermeer asked the subcontractor to lay the pipeline in a month's time, there may be a crane that could prevent the work. Dura Vermeer will do its best to remove the crane, but the crane may have to remain in place to complete the job. In that case, Dura Vermeer can ask whether the subcontractor can come a day earlier or later and whether they can coordinate with Dura Vermeer over the coming month which crane is where and when it can be removed. Dura Vermeer wanted to prevent the subcontractor from registering additional work, but instead wanted flexibility from the subcontractor with this bonus.

The bonus is not just a bonus, it is also a fine by date. Dura Vermeer wanted to prevent them from getting miscellaneous and seemingly particular receipts, questioning the validity of meaningless changes, for example; 'this had to be a meter longer' or 'I could not reach it and had to come back for it'. If the subcontractor would cooperate proactively and set metrics and targets were reached, the subcontractor would receive a bonus.

5.3.2 Results of the interviews

The mechanism used in the railway project case was a bonus/malus.

The main contractor indicated that they did not put any constraints on the bonus agreement (Appendix C, 6:2). The main purpose of this agreement was the flexibility of the subcontractor. The main contractor did not want a subcontractor who would complain about every little thing (Appendix C, 7:1). The subcontractor stated that a downside of this could be the fact that they can not specify when the subcontractor would or would not lose the bonus. There was not a way to measure it. Dura Vermeer believed the bonus was purely based on a subjective agreement because there was no definitive definition (Appendix C, 6:3, 6:7, 7:3).

The advantages of implementing this mechanisms is that the subcontractor will be stimulated to work harder according to the contract manager of Dura Vermeer. He stated that the subcontractor will be challenged to work as efficiently as possible, because the more efficient they are, the 'more' bonus they will gain (Appendix C, 6:4, 6:5, 6:6, 6:11).

The contract manager of Dura Vermeer stated that financing the bonus went through the Client. They invoiced the € XXX bonus and it did not cost Dura Vermeer extra (Appendix C, 6:9, 6:10).

The main contractor stated that the next time they wish to describe the mechanism more SMART (Appendix C, 7:2, 7:8, 7:9, 7:12).

The subcontractor also stated that the bonus agreement was not defined in a lot of constraints and rules. The subcontractor described the bonus as "no nagging" and indicated that there were no harsh constraints linked to the mechanism (Appendix C, 8:6, 8:7, 8:8).

The subcontractor expressed the importance of transparency and honesty. The subcontractor declared that transparency, honesty and full commitment to each other are important to successfully implement a pain/gain sharing mechanism (Appendix C, 8:11, 8:12).

The subcontractor also stated they benefited from a non financial incentive, which is the ability to show their skills (Appendix C, 8:13).

5.3.3 Analysis of the case

In the case of the civil railway project, there were some difficulties, but also some successes from the mechanism. Dura Vermeer found it important to link performance indicators to the project, it was literally defined as a "no nagging bonus" from their side. The approach was that they did not want additional work receipts for small things, and that the bonus was more of a feeling, a feeling that if the subcontractor is cooperating and not whining, the bonus will be paid out.

Both the main contractor and subcontractor stated that the bonus was not defined and no conditions were applied. For example, one party could deem the collaboration to be fine and demand the bonus, and the other could think the collaboration was not sufficient and decline to give the bonus. As this metric cannot be measured it could lead to dissatisfaction or discussions.

Both parties acknowledged the benefits of a bonus agreement to motivate subcontractors. The main contractor sees the potential for increased efficiency and rewards, while the subcontractor

appreciates the absence of strict constraints. However, both sides also recognised the subjective nature of this mechanism and lack of specific definition in the bonus agreement as downsides.

The award of the bonus was not really a bonus. There was a discussion about the cost of the work between the two parties. The subcontractor wanted to take on the work for € XXX and the main contractor estimated the work at € XXX. The difference between the two parties is defined as the bonus. Since it concerns a difference in the contract price, this cannot really be defined as a bonus by Dura Vermeer, also because Dura Vermeer had this bonus paid by the Client and did not award it out of its own interest.

Both parties agreed that the mechanisms needed to be defined more clearly in the future, otherwise there could be a breakdown in communication again.

As with all mechanisms, there are several prerequisite conditions that need to be met in order to work successfully.

The first precondition is apparent – all parties must be made aware of its existence. Indeed, there are a number of possible negative consequences for either side of the party not knowing the existence of this. For example, without knowing the bonus is included in the contract, the party could claim this is invalid, which would negate the bonus and lead to a negative opinion of the other party for their secrecy.

Another condition is that the contractor has the ability to pre-calculate their bonus, and if this bonus is not met then the bonus becomes a negative penalty. That the sub-contractor did not sign up to.

5.4 Case 3

The case for this case study is project large DBM Airport infrastructure project.

5.4.1 Case description

Dura Vermeer and the contractor together saw an opportunity for which they wanted to share the risk. Reusing an emergency aggregate (NSA), subcontractor had seen an opportunity but did not know whether this would work. Dura Vermeer has said it will pay the subcontractor for half the cost of replacing the NSA.

The original offer from Dura Vermeer to the client was based on a conventional system, which would be supplied by the subcontractor. Since this was a best value procurement tender, there was an opportunity to offer opportunities. During this tender, Dura Vermeer offered the application of an innovative, CEDD. CEDD is a type of lightning technology. This CEDD system needed to be maintained by the emergency power generator (NSA).

The subcontractor had bid on the offer based on the conventional system. When Dura Vermeer brought in that new system, CEDD, the subcontractor had to surrender part of the scope. Both parties tried a lot to shift the scope from conventional to innovative and this led to many discussions that lasted 1.5 years. One of the discussions was the emergency power generator (NSA). The discussions were mainly about sharing the risks.

In this situation, in which both parties shift back and forth between different risks, Dura Vermeer and the subcontractor have looked together at the chance or the risk of the NSA. In all cases, the parties assumed that the NSA would be replaced and made suitable for the next 15 years. However, with the new individual lighting, it was expected that energy consumption would drop substantially. The subcontractor had initially made an offer to supply a new NSA.

The parties saw an opportunity that if they succeed in improving the existing generator in such a way that it will last reliably for another 15 years and provide sufficient power to maintain the emergency power supply with the innovative lamps, then no new generator will have to be installed by the originally budgeted capital requirement of the subcontractor. At the time, the parties had not yet clearly identified this opportunity and there was discussion about who this opportunity actually belonged to if they succeed. It was unclear whether this opportunity is for the main client because he defines the scope, or for the subcontractor, because it falls within the electrotechnical scope.

This agreement states that Dura Vermeer will receive € XXX from the client for this part of the scope and that € XXX will be paid to the subcontractor. In this way the parties have applied the risk distribution of this specific component. If the innovative lamps are not installed, it can be said that the subcontractor received € XXX "too much" because they did not deliver anything, but received € XXX. In this case, Dura Vermeer also has € XXX left over, because she received € XXX from the customer and paid out € XXX of this. If the innovative lamps do have to be installed, the subcontractor will have received € XXX, but they will have to pay € XXX.

This scheme shows the division of the € XXX from the client.

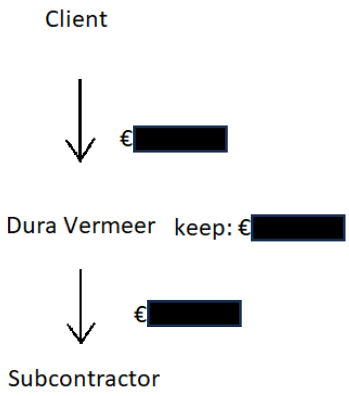

Figure 4, division of the costs for NSA

5.4.1 Results of the interviews

The main contractor has indicated that he has had difficulty implementing this mechanism. This is due to the wording of the agreements in the contract. The contract manager has indicated that there has been a lot of discussion about reading and interpreting the agreements. This was not clear enough to the parties themselves. (Appendix C, 5:10, 5:11). According to the contract manager, this had an enormous influence on the collaboration, because it was full of emotions and tensions (Appendix C, 5:5).

The contract manager stated that simplicity is the essence of the success of this risk sharing mechanism. Keeping agreements simple is important when implementing this mechanism again in the future (Appendix C, 5:12, 5:13, 5:14).

The project manager concludes that understanding each other and each other's interests is important (Appendix C, 4:17, 4:4, 4:14). He also believes that transparency and openness is the most important element in mechanisms like these. It is important that everything is open accessible to everyone (Appendix C, 4:5).

The subcontractor has indicated that there were many uncertainties in this project. He stated that agreements were not documented and they all relied to much on 'we understand each other', but those agreements still brought up confusion and discussions. When new people joined the project, they did not know certain agreements because the people who made those agreements left the project (Appendix C, 1:2, 1:3, 1:4, 1:10, 1:11, 1:16, 1:17, 1:18).

There was a lot of confusion according to the subcontractor. He stated that the agreement was to keep the NSA and not replace it, however, eventually they had to replace it and maintain the old one due to a change in the scope of the client (Appendix C, 1:12, 1:13).

The collaboration between the parties was good according to project manager of the subcontractor. They often had meetings and had a well-organised communication structure (Appendix C, 1:19, 1:20). However, the director disagreed and stated they have not collaborated integral enough (Appendix C, 2:9). He stated that if collaboration is optimal, it can eliminate risks (Appendix C, 2:17, 2:18). He also concluded that the motive to implement this mechanism was wrong from the start. He stated that this mechanism is implemented to lower the price of the project (Appendix C, 2:10, 2:11, 2:15).

The subcontractor has indicated that in order to implement again in the future a few conditions have to be met. The condition that it has to be a 'real' sharing mechanism and the condition that it is shared with a company that is equal of size (Appendix C, 1:1, 1:15, 2:37).

5.4.2 Analysis of the case

Dura Vermeer and the subcontractor had a lot of difficulties when trying to apply this mechanism to the contract. There were lots of discussions and a lot of irritation during the planning side of this, there was seen to be a lot of ambiguity about the agreements and the deciding factors of the risk sharing. Both agreed that transparency was very important, and that it needed to be open and fair to all parties.

The subcontractor was not happy with the mechanism, they did not benefit from it. The idea of risk sharing would have saved them from having to provide a new NSA, but in the end they had to provide a new NSA had to maintain the old one for 15 years, which led to a negative experience by the subcontractor.

From Dura Vermeer's perspective, they found it difficult to put it into the contact, but eventually they managed it – they think the agreements were hard to nail down in the contract and they were self-admittedly not as clear as they could have been from the perspective of The subcontractor, however they did believe they were clear enough from their side. On the other hand, the subcontractor held a different perspective, arguing that the contractual agreements were ambiguous as newly added project members lacked clarity on them.

There were lots of different opinions from Dura Vermeer and the subcontractor, so one key factor is that the mechanism was agreed between a member of Dura Vermeer and the director of the subcontractor, however the director left the subcontractor, and there were little records or documents or documents of this agreement. Due to this, nobody at the subcontractor knew

about it, and this led the entire thing up to interpretation. Which led to the subcontractor having a negative impression of this. However, Dura Vermeer believed the bond was increased and everyone was satisfied.

The subcontractor had some recommendations for implementation in the future. Since they are considerably smaller than Dura Vermeer, they thought it was unfair for them to absorb this much risk, and that risk sharing could only be applied to similar sized companies, there needed to be more empathy and transparency between parties, and that the interests for and of the customer need to be kept in mind.

Since the subcontractor had to supply a new NSA 'alone', the final scheme of the costs is as follows.

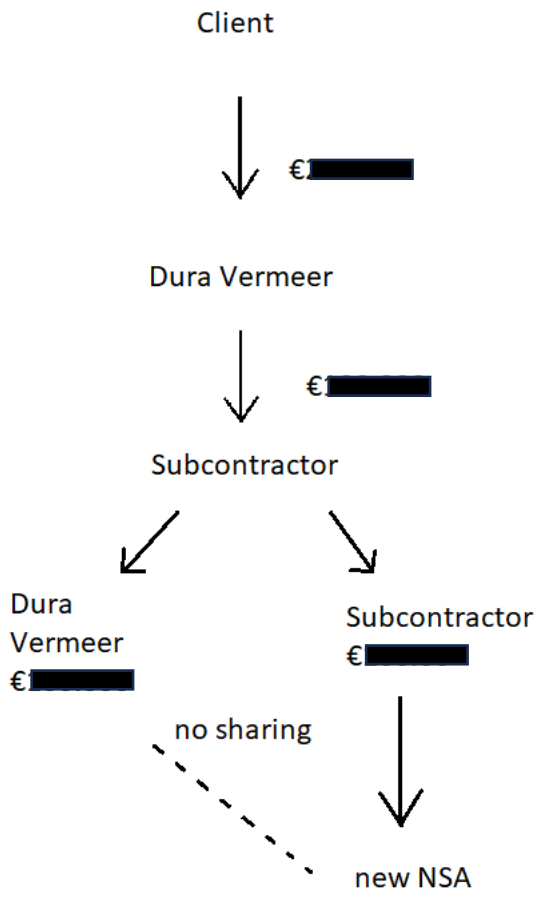

Figure 5, new division after amendment

When using pain/gain sharing mechanisms it is important to share everything, including changes to scopes that affects both parties, just as much as when it affects one.

The bonus used in the DBM Airport infrastructure project case was risk sharing. There are pre-conditions needed to be met in order for a risk sharing mechanism to be applied successfully.

Before applying a risk-sharing or gain-sharing mechanism to a contract, there are several important preconditions that must be met. Both parties involved must have a clear understanding of the project's goals and be working towards the same objectives, using objective metrics to measure progress. It is also crucial that both parties have some degree of joint control over the project, with shared decision-making, resources, or risk management. The

risks involved must be identified and analysed, and an appropriate risk-sharing mechanism must be put in place. Finally, a high level of trust is essential to allow both parties to take risks and share gains without fear of being taken advantage of. In summary, implementing a risk-sharing or gain-sharing mechanism in a contract requires careful planning, collaboration, and shared goals for mutual success.

5.5 Comparative case analysis

The selected case have different mechanisms. The specific different pain/gain sharing mechanisms used in these cases are not directly comparable.

Due to this, a comparative case study approach was decided instead. A comparative case study involves selecting cases that share common themes, and goals.

By selecting cases with commonalities of themes and goals, it was possible to compare and contrast the cases in a meaningful way, even if they had different pain/gain sharing mechanisms.

The comparative case study approach involved a detailed analysis of each case, focusing on the specific pain/gain sharing mechanisms used and their effectiveness in achieving the desired outcomes.

To compare the cases, we can look at similarities and differences in the use and effectiveness of the different pain/gain sharing mechanisms for transparency, quality outcomes, and satisfaction/happiness. These themes were recurring in the conducted interviews.

- Transparency: It can be examined how transparency relates to the different cases.
- Quality outcomes: When it comes to quality outcomes, it can compared how the different mechanisms used by the cases to ensure quality outcomes. For example, we can look at how the use of bonus/malus versus gain sharing impacted the quality of work. Further to this, analysis in regard to the effectiveness of the mechanisms can be performed by analysing whether or not cost savings were sacrificed for quality outcomes, and whether this sacrifice was effective in achieving desired quality outcomes.
- Satisfaction/happiness: Finally, we can compare the happiness of the contractor and subcontractor in each case. This can be assessed by looking at factors such as job satisfaction, morale, and the level of trust and collaboration between the parties.

By comparing the cases on these themes, we can gain a better understanding of the relative effectiveness of the different pain/gain sharing mechanisms used and identify best practices for achieving cost savings, quality outcomes, and happiness in similar contexts.

Trust and transparency

All participants interviewed responded by saying trust and transparency within these projects was a vital component of the successful usage of pain/gain sharing mechanisms. This is one of the important pre-requisites into applying a pain/gain sharing mechanism. As evidenced in the literature study, trust and cooperation are a fundamental condition in the successful implementation of pain/gain sharing mechanisms. These interviewees further evidenced this.

Case 1 indicated that transparency was vital as it related to the optimisation of the final design. Both parties indicated that in order to co-operate efficiently a high level of trust was essential. Further to this, in case 2 both parties were transparent in their workings, and this led to parties trusting each other. The contractor for this project Dura Vermeer were able to select a confidential subcontractor who carried out the word correctly and quickly.

Contrary to this, in case 3 the subcontractor showed a level of dissatisfaction not identified in cases 1 and 2. The interviews with the subcontractor, showed that there was less transparency in this case, which led to issues throughout the project.

Case 1, 2 and 3 were all cases where transparency was important. It was especially important with 3 since it was not completely transparent in this case. The client came up with a new requirement change and Dura Vermeer did not share the consequences on the risk sharing mechanism of this change with the subcontractor, since the subcontractor had to pay the new NSA 'alone', which ultimately left a negative experience with the subcontractor.

The aforementioned point about sharing the consequences together is also shown in the literature in 3.2.2 regarding risk sharing. This showed that in a risk-sharing mechanism transparency is vital, when amendments are made to a project, trust falls due to one party often absorbing less of the risk due to the amendment.

Quality outcomes/meeting objectives

As each case was different, there were varying conditions between the cases that needed to be met, in order for it to be classed as a success. These conditions are defined in this thesis as quality outcomes/meeting objectives.

Both parties in case 1 agreed that these quality outcomes/meeting objectives had been fulfilled due to the successful implementation the gain sharing mechanism.

The parties of case 2 both agreed that the project goal, for which the mechanism was initially chosen to be implemented was achieved. The aim of this was for the project to be completed as fast as possible. Both parties agreed that the subcontractor needed to show high effort, and maximum cooperation – in exchange for the bonus. The subcontractor took this feedback on board and understood the quality outcomes and made every effort to achieve this objective.

In contrast to case 1 and 2, the parties involved in case 3 identified that the risk-sharing mechanism of case 3 was not a great success. The subcontractor felt that the agreements were not fulfilled, thus the goals were not achieved. The goal for the subcontractor was that the NSA wouldn't need to be replaced. However, the client changed the scope, and this meant the subcontractor was responsible for both maintaining and providing a new NSA. This meant that the parties stopped sharing risks when the scope was changed.

Under other conditions, the risk sharing mechanism could lead to the successful achievement of the project objectives. If the transparency was maintained throughout the project, this could have been met.

Satisfaction/happiness

If the previous two conditions, trust/transparency and quality outcomes/meeting objectives are met, and the project is a success then usually satisfaction/happiness will be met.

In both cases 1 and 2, both of the subcontractor parties were satisfied with the mechanism and showed a willingness to implement these mechanisms in future contracts, the main contractor was also satisfied in both cases. However, there is a level of hesitation of the contractor to make this a standard procedure, they believe instead it is best suited to being an ad-hoc measure that can be implemented when the need for it arises. Although it can be argued that this is related to the type of mechanism implemented, as both the bonus/malus mechanism and the gain mechanism are mechanisms in which the main contractor absorbs a financial loss to increase productivity in the subcontractor (Boogaard 2021).

The subcontractor in case 3 showed dissatisfaction with the use of the mechanism, as ultimately they absorbed more of a loss than the contractor – however they did note that they were satisfied with the collaboration with the main contractor. They did also state that they think the mechanism can be useful and will apply it to further contracts in the future, providing the parties involved are of a similar size.

5.6 Conclusion

Based on the case study, sub question 3 can now be answered. Sub question 3 states:

What are the essential conditions of implementing pain/gain sharing mechanism?

The interviews allowed the conclusion that many essential conditions are set by all parties involved. The essential conditions for the successful implementation of a pain/gain sharing mechanism so far identified are: transparency, align partial objectives, taking each other's interest into account and early involvement of the parties. This will eventually lead to meeting each other's objectives and having a high-level of satisfaction.

The analysis of these cases showed that the conditions have not always been in place during these projects, which ultimately led to issues that prevented pain/gain sharing mechanisms from reaching their full usefulness potential.

One of the important conditions that needs to be met before a pain/gain sharing mechanism can be met is transparency. As evidenced in this comparative case analysis, all parties involved thought transparency was an essential condition in successfully implementing a pain/gain sharing mechanism – as shown by the success of the mechanism in cases 1 and 2, and the failure of the mechanism in case 3. Cases 1 and 2 showed clear and honest transparency throughout, and case 3 lacked transparency. It is important that both parties have a sense of security when using a pain/gain sharing mechanism. The consequences and consequences of changing the scope and requirements from the customer must also be shared by the parties involved. In the case of a large airport infrastructure project, we saw that sharing was 'stopped' as soon as there was a change from the client, which put the subcontractor at a disadvantage.

Another essential condition is to have clear and easy to follow quality outcomes/meeting objectives. This can be achieved by aligning the interests or objectives. By having these quality outcomes, there is a point of reference to judge the success of a pain/gain sharing mechanism at the completion of the project, but also to aim towards during the completion of the project. Having quality outcomes is a factor in the successful implementation of a pain/gain sharing mechanism. Again, this is evidenced by the successful implementation of the pain/gain sharing mechanism in cases 1 and 2. In case 3 the outcomes were abstract and weren't achieved due to a lack of clarity.

The final essential condition identified by the comparative case study and semi-structured interviews of the subcontractors and contractors was satisfactory performance/happiness. In order for a pain/gain sharing mechanism to be successfully implemented, and for it to be truly judged as a success – all parties involved need to be satisfied with the outcome. Once satisfaction is met, the mechanism can be reflected on, and deemed to be successful or not. As evidenced through the cases, every party that was satisfied, was because the mechanism was successfully implemented.

6 STRATEGIC FRAMEWORK

In this chapter, the results of the literature study, the exploratory study and the case study come together.

6.1 Framework design

After the interviews for this project were completed and further analysed – it became apparent that several key steps were missing. This lead to a lot of discussions and delays according to some respondents of the interviews in the previous chapter (Appendix C part “falen van mechanisme”). These missing steps led to mistakes when implementing the pain/gain sharing mechanisms throughout the projects.

To clarify the process, a framework was created, to implement the pain/gain sharing mechanisms. Both a visualisation image and a comprehensive document that could be simply followed was chosen to portray this framework.

The framework consisted of the idea that a documentation of an implementation plan, should be created by the parties, this can be attached as an appendix to the contract, if the pain/gain sharing mechanism is used – so all agreements are documented in written format, so all parties are kept informed. This leads to less discrepancies as there are clear records of this.

In order to design the framework, the purpose and scope of the framework needed to be defined. It was decided that the purpose was to provide a standardised, structured approach as to how to implement a pain/gain sharing mechanism successfully, the scope was to cover all aspects of the pain/gain sharing mechanism – from the initial identification of the need to implement this, to the implementation and finally the eventual monitoring of the mechanism.

The next step was to determine the steps in the process. The steps chosen were: determining the need for a pain/gain sharing mechanism, definition of the objectives (why are the parties implementing this?), definition of requirements and interfaces (what is needed to implement this successfully?), identifying and alleviating the conditions needed to implement this successfully (what could go wrong during implementation, and how do the parties prevent this?), creating the implementation plan (a complete and comprehensive plan as to how to implement the mechanism), and finally monitoring and evaluating the implementation. The last step is paramount to the continued usage of pain/gain sharing mechanisms in future contracts.

Furthermore, sub-steps were needed, as previously mentioned in the case study, there were great difficulties in implementing pain/gain sharing mechanisms to previous contracts – the sub-steps provide knowledge to implement these successfully.

Once the core framework was defined, these steps needed to be organised into a logical sequence. The steps needed to flow together, to be as clear as possible. The visualisation document shows an easy to follow and intuitive flow diagram.

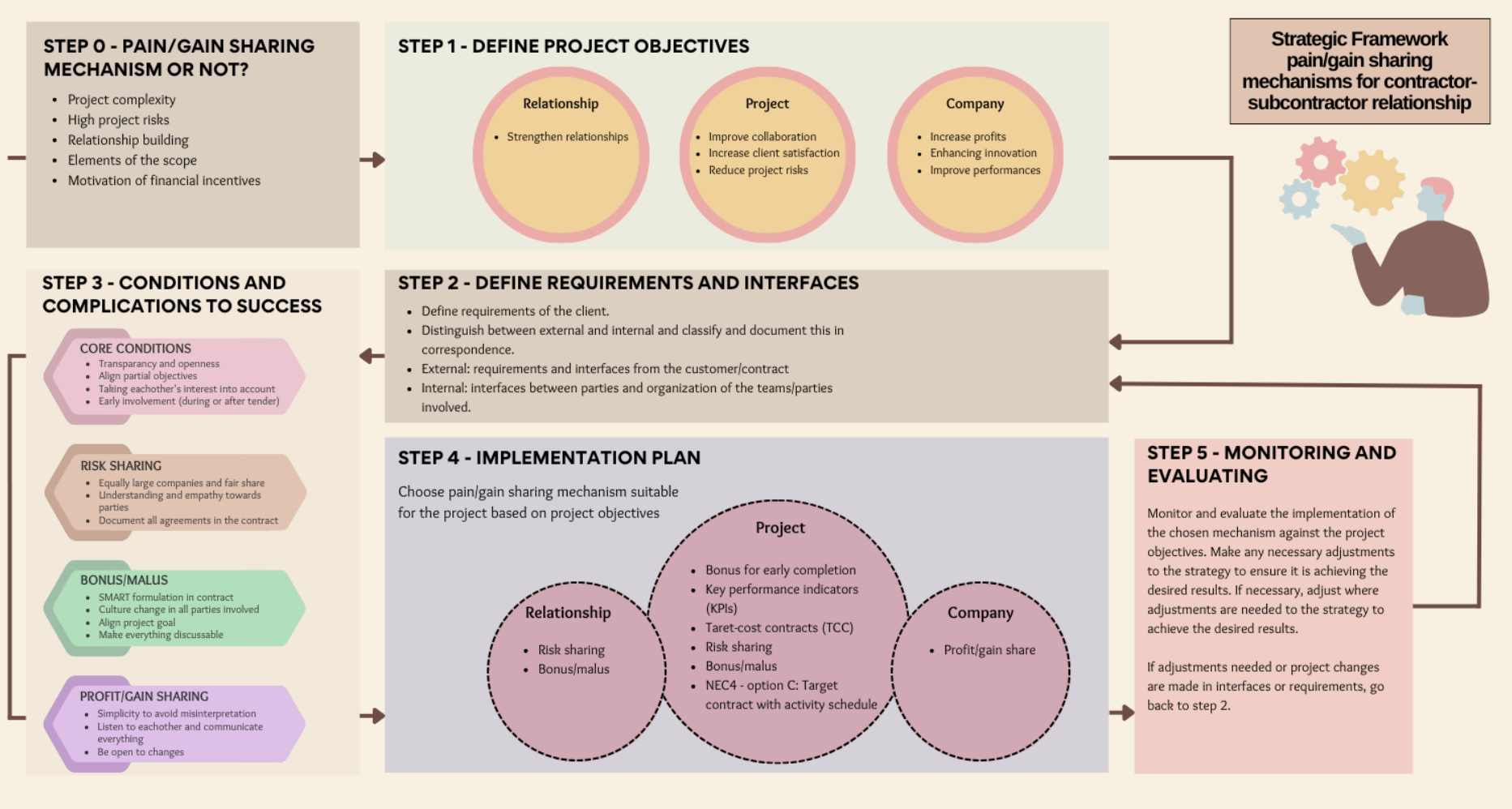

Figure 6, Strategic Framework for implementing pain/gain sharing mechanisms

6.2 Using the framework

This framework is designed for the main contractor, to be used to decide whether or not to implement a pain/gain sharing mechanism in a project/contract. The aim of this reader was to be easily read and as intuitive as possible, so that even individuals with less technical knowledge of pain/gain sharing mechanism can pick it up and study it easily.

It is aimed to be used before agreeing terms with a contractor/subcontractor and can be used when disagreements/concerns are voiced by either one of the parties during the planning process of the project/contract.

6.2.1 Reader for the strategic framework

This chapter contains the reader for the strategic framework for using pain/gain sharing mechanisms. This reader belongs to the framework. The reader consists of steps 0 to 5 of the framework. Below is the elaboration of these steps.

Step 0 - Determine the Need for a Pain/Gain Sharing Mechanism

Before the strategic framework, it's important to evaluate as to whether or not a pain/gain sharing mechanism could be beneficial to the project. The previous chapter showed that it was apparent that in order for a pain/gain sharing mechanism to be implemented – there are a number of prerequisite conditions and potential complications that need to be addressed.
To determine the need for a pain/gain sharing mechanism, the following factors can and should be considered.

1. Complexity of Project – Often, projects are complexed with multiple stakeholders involved. The multitude of parties involved shows the need for all parties to be aligned towards the common goals/objectives. If the project becomes too complex, a pain/gain sharing mechanism may create conflict between the parties.
2. Risks Involved – Different projects have differing levels of risks, there may be an uncertainty in the scope or the design, one party may be financially liable for a higher amount, or there may be safety concerns. A pain/gain sharing mechanism can help mitigate the risks, and in turn can further incentivise parties to collaborate more effectively to overcome these challenges.
3. Relationship Building – Long-term relationship building is vital in the industry, if the parties are interesting in building a long-term relationship, then implementing a pain/gain sharing mechanism into contracts/projects can effectively encourage the initial trust and collaboration.
4. Elements of the scope – on which elements of the scope will pain/gain sharing mechanisms be incorporated. Pain/gain sharing mechanisms can be used for the whole scope, but in case of using it on a specific element of the scope, it needs to be clear and concise which element(s) and how it will be applied.
5. Financial Incentivisation – Financial benefits are a common incentive in the industry, by implementing a pain/gain sharing mechanism – a clear framework can be provided to evenly distribute risk and reward in accordance with the productivity/involvement between the parties.

These factors are elements that arose during the analysis of the cases in the previous chapter. These were particular elements that made Dura Vermeer decide to incorporate a pain/gain sharing mechanism in the project. If a pain/gain sharing mechanism has been determined to be

appropriate to apply to the project, then step 1 of the framework and begin to define the project objectives.

Step 1: Define Objectives

The project objectives need to be clearly defined in this step, whilst taking into consideration the project needs to be aligned the overall goals for all parties. Since the scope of this research focuses on the relationship between the main contractor and subcontractor, the objectives are categorised into three categories. The categorised objectives are "project", "relationship" and "company" objectives. In order for these objectives to be successful – they need to fit certain parameters – they are "specific, measurable, achievable, relevant and timebound.

1. Project Objectives category. These are objectives that are specific to the project and relate to its successful completion. Examples may include:
    a. Reduce project risks
    b. Increase client satisfaction
    c. Improve collaboration
2. Relationship Objectives category. These are objectives that relate to the main contractor/subcontractor relationship and is applicable for the whole supply chain. This may include:
    a. Strengthen relationship
    b. Improve collaboration
    c. Increase client satisfaction
3. Company Objectives category. These are objectives that relate to the overall goals of the organisation (as Dura Vermeer) and may include:
    a. Improve performances
    b. Increase profits
    c. Enhancing innovation

Categorising objectives in this manner and using these examples as a guideline, ensures that all objectives are kept at the forefront of aligning with the organisation's overall goals. This means, efforts and resources are focussed on supporting the completion of the project as efficiently and effective as possible.

Step 2: Define Requirements and Interfaces

Step 2 consists of identifying and documenting requirements. During the interviews it became apparent that objectives and goals are not aligned due to the lack of documentation of important requirements and interfaces (Appendix C part "documenteren afspraken"). Namely from the client and contract – after these are identified and documented, a thorough review of the documents related to the project such as the client contract, project scope and any other relevant agreements. In order to come to this conclusion, the following tasks should be completed.

1. Identify the main requirements from the client: review the client's project scope, primary goals and primary objectives, and document these concisely.
2. Identify the requirements from the contract: to do this review the contract, to identify any specific requirements or obligations the client has deemed the contractor must fulfil.
3. Identify the other relevant agreements, these are often agreed internally between the parties. To complete this, review any ad-hoc internal documents, internal policies/interfaces between parties and disciplines, any other relevant information should be documented and considered in this step.

Completing this step allows the project team to have a clear understanding of the requirements and interfaces that need to be considered within the project. Meaning they are able to execute decision in alignment with any contractual obligations and client expectations.

Step 3 - Conditions and Complications to Success

After all the requirements are clearly documented, the next step is to consider any conditions/complications that may affect the project detrimentally. This section shows the steps to combat any complications that may arise. They will be categorised so they are easily followable and can be considered for all pain/gain sharing mechanisms. Each different mechanism will have it's own category in order for transparency.

1. Core conditions that are necessary for the successful completion of the project. These conditions are vital to the successful implementation of pain/gain sharing mechanisms – all parties involved in these need to address these core conditions and come to an agreement on them. Some examples are:
    - Transparency and openness in all communication (Appendix C, 2:34, 2:24, 2:30, 2:35, 2:40, 4:8, 4:21, 4:22, 5:16, 8:11, 8:5, 9:10, 9:12);
    - Alignment of partial objectives to ensure all parties are working towards the same end goal (Appendix C, 7:14, 8:12, 2:35, 2:38);
    - Taking each other's interests into account to foster a mutually beneficial relationship (Appendix C, 2:38, 4:22);
    - Early involvement of all parties, either during or after the tender process, to ensure clear expectations and understanding of the project (Appendix C, 8:1, 9:20, 9:2, 2:4, 7:5, 7:6, 7:7, 7:15, 10:8, 10:9).

2. Risk-sharing mechanism conditions:
    - Equally sharing of risks and rewards between the parties involved, especially when the companies are or are not of similar size (Appendix C, 2:26, 2:37);
    - Equally large companies so the share is proportional to the size of the company and can safely take a risk without the risk of major losses for companies (Appendix C, 2:26, 2:37);
    - Developing an understanding and empathy towards all parties to ensure a fair and reasonable approach to risk-sharing (Appendix C, 1:22, 1:23, 1:25,1:24, 4:4, 4:14, 4:17);
    - Documenting all agreements in the contract to ensure transparency and clarity (Appendix C, 1:4, 1:11, 1:16, 1:17, 2:41).

3. Bonus/malus mechanism conditions:
    - Formulating specific, measurable, achievable, relevant, and time-bound (SMART) goals in the contract to incentivize all parties to work towards successful completion (Appendix C, 7:2, 7:8, 7:9, 7:12);
    - Encouraging a culture change among all parties involved to prioritize project success and collaboration (Appendix C, 7:16, 7:17);
    - Aligning project goals to ensure that all parties have a vested interest in achieving them (Appendix C, 7:14, 8:12, 2:35, 2:38);

- Ensuring that everything is discussable and ability to address any issues that may arise during the project (Appendix C, 10:10, 8:11).

4. Profit gain/sharing mechanism conditions:
    - Keeping the approach simple to avoid differences in interpretation and understandings (Appendix C, 5:12, 5:14, 9:6);
    - Encouraging open communication and active listening between all parties to ensure that everyone's interests are taken into account (Appendix C, 7:8, 8:11, 4:8, 4:5, 4:21, 4:22, 2:34, 2:35, 2:38, 2:30, 2:40);
    - Being open to changes in the approach as the project progresses, to ensure that it remains aligned with the overall objectives of the project (Appendix C, 9:11).

These conditions are derived directly from the interviews conducted during the case study. The direct quotations that were leading for setting these conditions are listed in Appendix C under part "conditions for pain/gain sharing mechanisms". Addressing these conditions and complications and having a transparent and honest working model can reduce the likelihood of the arising of issues that can complicate and impact the successful completion of the project.

Step 4 - Implementation Plan

This step details the framework behind a successful implementation plan of pain/gain sharing mechanisms. The pain/gain sharing mechanisms found in the literature in Chapter 3 are categorised into the objectives of step 2. The mechanisms are divided into the category, for which they are stimulatory according to the literature, as a guidance. An implementation plan in regard to this framework is defined as a clear and concise document that outline's a team's steps to accomplish the goal of incorporating pain/gain share mechanisms into projects.

1. Project Objectives:
    - Bonus for early completion;
    - Key performance indicators (KPIs);
    - Target-cost contracts (TCC);
    - Risk sharing;
    - Bonus/malus;
    - NEC4 - option C: Target contract with activity schedule.
2. Relationship Objectives:
    - Risk sharing;
    - Bonus/malus.
3. Company Objectives:
    - Profit/gain share.

In order to implement successfully, the selected mechanism needs to be included for a written transparency, further to this – the implementation needs to outline both the steps and timeline as to how and when the implementation of the chosen mechanism will occur. The final vital component of this is to include any necessary amendments that the parties have discussed.

Step 5 - Monitoring and Evaluating

The final step is to monitor and evaluate the success of the implementation of the chosen mechanism. This is essential and cannot be ignored, without careful and thorough monitoring and evaluating the pain/gain sharing mechanism may not achieve the desired results.

1. Define pain/gain sharing mechanism - Identify mechanism(s) that align with the project objectives.

2. Monitor performance - Regularly monitor the performance of the project against the defined mechanisms to determine if the chosen mechanism is achieving the desired results.
3. Evaluate results - Evaluate the results of the chosen mechanism against the project objectives. If the results are not meeting the objectives, make necessary adjustments to the strategy to ensure it is achieving the desired results.
4. Adjust strategy - If adjustments are needed, go back to Step 2, and reassess the requirements and interfaces, conditions, and complications to success. Identify a new pain/gain sharing mechanism and adjust the implementation plan accordingly.
5. Repeat - Continuously monitor and evaluate the chosen mechanism to ensure it is achieving the desired results and make any necessary adjustments to the strategy.

6.3 Conclusion

In order to determine the most effective pain/gain sharing mechanism for the project, this framework should be used.

As evidenced above, this framework is a concise and intuitive easy to follow flow diagram which lists all the required steps, conditions, and complications that need to be followed/considered when determining the most effective pain/gain sharing mechanism for the project. Once the framework is being used, clearly the decision has been made to implement a mechanism.

Further to this framework, discussions need to take place between the contractor and supply chain to ensure transparency throughout and to ensure that all parties are satisfied with the mechanism chosen.

These discussions should be held to discuss the motivations behind each of the parties, and how a pain/gain sharing mechanism can be best applied to the project for the parties sake.

7 EXPERT EVALUATION

In this chapter, the framework from chapter 6 was presented to a number of experts within Dura Vermeer. This expert evaluation is an important step in ensuring the reliability and effectiveness of the framework in practice. This chapter includes a description of how the expert evaluation was performed and the results will be described.

7.1 Expert meeting set up

The strategic framework was presented to a number of experts. Based on the feedback from the experts, the framework is adapted, supplemented, or evaluated for use in practice.

The experts received a short presentation about this research and the steps in the framework were explained to them. Based on this, feedback and opinions were collected through semi-structured interviews that contribute to the optimization of the framework. The evaluation focuses on reliability, effectiveness, and usability in practice. The theme of the interviews was divided into two categories:

- Evaluating the steps of the framework;
- Evaluating the use of the framework in practice.

7.2 Expert selection

For the reliability of the research it was important that the chosen experts are people with expertise in the field and select people who cover a large discipline within Dura Vermeer.

Selecting different experts ensures that the framework is viewed from different perspectives and the feedback can be collected by different disciplines within Dura Vermeer.

Eventually three experts were selected for this expert evaluation:

- Expert 1: Procurement director
- Expert 2: Director of projects
- Expert 3: Discipline leader LP/RP (national projects/regional projects)

By combining the different perspectives of the experts, a more complete picture was obtained of the possible obstacles to the implementation of the framework in different phases of a project, and obstacles to the implementation of the chosen pain/gain sharing mechanism used in the project. projects. It also allowed me to get a better idea of the practical applicability of the framework and how it could work in practice.

7.3 Evaluation of the framework

In this section the evaluation of the experts on the framework will be discussed. This is divided into two sections. First of all, it will be discussed what the input of the experts was on the steps of the framework and the implementation of the framework. Subsequently, the adjustments and recommendations to this framework will be discussed.

7.3.1 Steps in the framework

The steps were seen by the experts as clear and concise steps. The steps are easy to follow and it is clear what needs to be done per step. The steps in the framework can be followed by Dura Vermeer and various departments.

The experts were asked if they would be able to follow the steps in practice. Two experts highlighted that, in order for this to be used in practice, the step between 0 and 1 must be formulated more SMART. The experts have indicated that it was not clear if or when they want to proceed to step 1.

One of the three experts has also indicated that they want an escape plan. “Suppose we find out after the monitoring that we do not want this, there must always be a legal escape. I do not want to leave the party, but I want to go back to basics” (Expert 2, 2023). The other two experts have not indicated that they want an escape in the framework.

In general, the experts have indicated that they do not see any obstacles in the framework that lead to it not being applicable, but the steps 0 and 1 need to me formulated more SMART (Boogaard, 2021).

7.3.2 Implementation of the framework

Subsequently, the implementation of this framework in practice at Dura Vermeer was examined. The experts were asked whether this framework could be used in Dura Vermeer projects. Expert 1 and 3 indicated that they see that these steps can be followed by Dura Vermeer.

Expert 2 indicated that in order to be implemented in projects at Dura Vermeer, it must be made clear who is responsible for the framework and who will implement the framework. Someone should be designated who will be responsible for this framework. The steps will be performed by multiple departments, but there will need to be a person responsible for bringing this framework into projects (Expert 2, 2023).

Furthermore, experts 1 and 3 have indicated that this framework should be used for the tender. Incorporating pain/gain sharing mechanisms at an early stage (before or during the tender) has also been mentioned by many interviewees.

7.3.3 Amendments on the framework

Following the suggestions in the previous section, we will now explain the changes to the framework.

Experts have indicated that steps 0 and 1 should be more SMART if this will be used in practice. The step to determine whether pain/gain sharing mechanisms will be used depends on a number of factors at Dura Vermeer. First of all, it is important that the parties have a good understanding of a pain/gain sharing mechanism. The definition of pain/gain sharing mechanisms determined by the literature, exploratory study, case studies and interviews is “a mechanism or strategy that can be used to align goals, objectives and interests together by sharing pain and gain and using other incentives to encourage desired behaviour”.

When it is clear what can be achieved with pain/gain sharing mechanisms, consideration can be given to using the mechanism or not. This depends on the project interests, subcontractors of Dura Vermeer and the complexity of the project.

One of the experts explained that it is unclear who is ultimately responsible for the framework. Since many interviewees and experts have indicated that pain/gain sharing mechanisms should be implemented early, this framework will become part of the procurement process. Dura Vermeer must make a person from the procurement department responsible for implementing and guaranteeing this framework.

As discussed in the previous section, one of the experts has indicated that they would like to see an escape plan in the framework. Since only one of the three experts wants to see an escape plan for pain/gain sharing mechanisms, two options will be discussed here.

Option 1 – escaping pain/gain sharing mechanisms:
When Dura Vermeer wants to incorporate an escape plan into the framework, this will have to be done in step 4. In step 4, agreements will be made about how pain/gain sharing mechanisms are applied. In this step, agreements will also have to be made in advance about when pain/gain sharing mechanisms will no longer be used. Dura Vermeer can contractually incorporate an escape in advance. Dura Vermeer will have to lay down concretely and clearly under which conditions they will no longer apply pain/gain sharing mechanisms.

Example: “If the party engages in action X, then Y is the subsequent outcome”

X and Y will have to be defined by Dura Vermeer's legal department.

If they do not determine this in advance, Dura Vermeer can negotiate with the parties that they no longer want what they initially agreed with both parties. Unilateral decision to terminate the mechanism is not possible.

Keep into consideration if the escape plan is utilised under conditions X and consequences Y, it may affect the effectiveness of the pain/gain sharing mechanism.

Option 2 – committing to pain/gain sharing mechanisms:
Another option is not to include an escape and to jointly commit to the mechanism in advance. Dura Vermeer will go through all the steps together with the parties and make good agreements in the implementation plan. The moment that all parties express commitment to the use of pain/gain sharing mechanisms from the start, this can strengthen the cooperation and the parties can make better efforts during the project and the pain/gain sharing mechanism can be used optimally. Perhaps the pain/gain sharing mechanism works better without the implementation of an escape.

7.4 Strategic Framework after expert evaluation

The amendments of the experts after the evaluation are added to the framework. These amendments are the step to make the objectives more smart, implementing option 1 and 2 into step 4 of the framework. These amendments make the next figure the final version of the strategic framework.

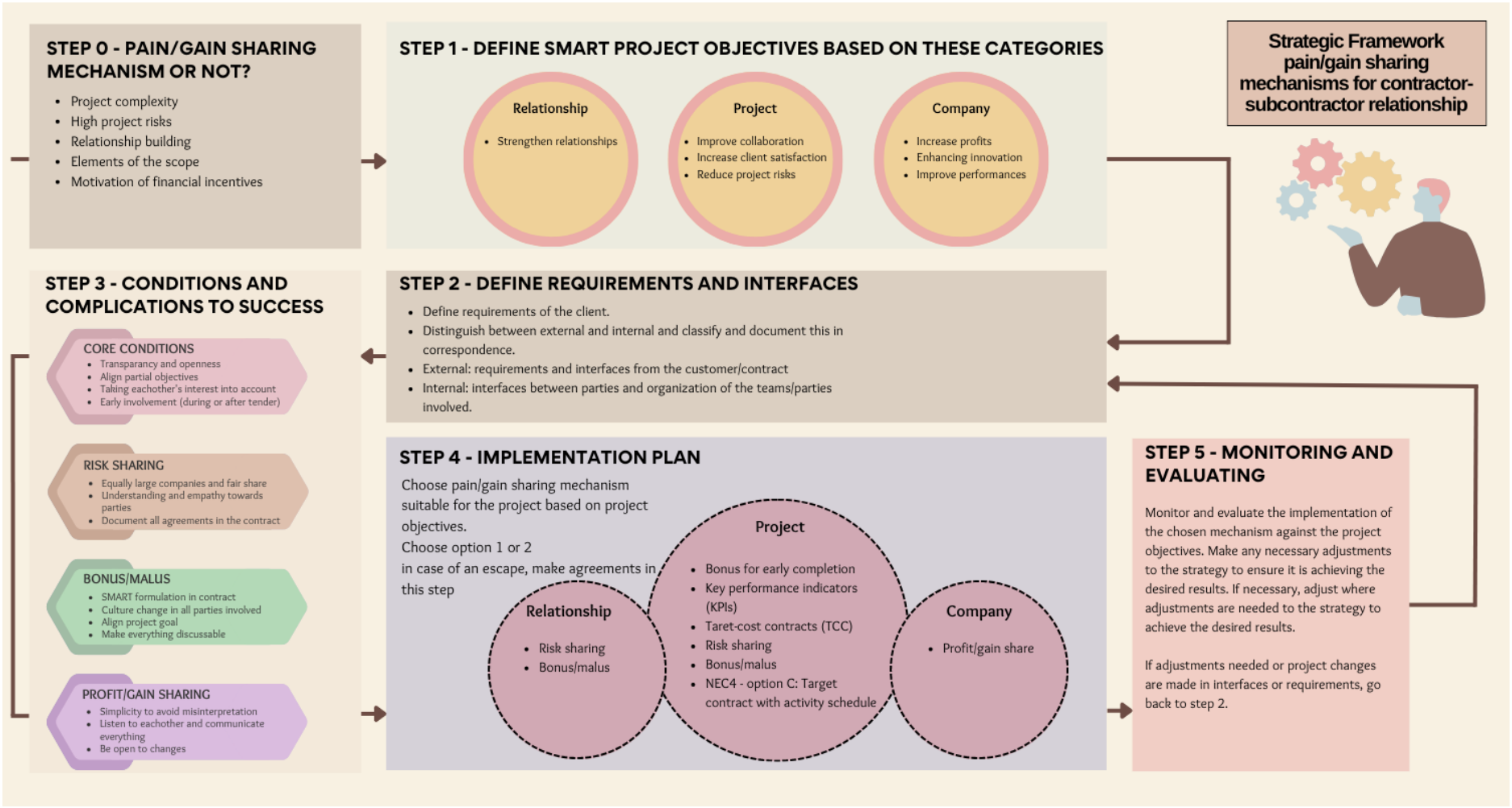

Figure 7, final strategic framework for implementing pain/gain sharing mechanisms

7.5 Conclusion

Based on the strategic framework designed in chapter 6 and this expert evaluation, the final sub question can now be answered. Sub question 4 states as follows:

How can one determine the most effective pain/gain sharing mechanism for the project?

The framework was developed for the main contractor to choose to implement an appropriate pain/gain sharing mechanism. Each different pain/gain sharing mechanism has different benefits and drawbacks in regard to the application of it to contracts.

Further to this, there are a number of factors that may influence whether or not a pain/gain sharing mechanism should be applied, and if so, which pain/gain sharing mechanism should be chosen?

First and foremost, it is important to consider whether a pain/gain sharing mechanism should be used or not factors such as the complexity of the project, the potential for the building of a long-term relationship, the risks involved, and the financial incentives should all be kept in mind when making this decision.

Additionally, factors, such as the size disparity between companies, the financial power disparity between companies and the urgency of completion of the project should all be considered when choosing whether or not, and if a pain/gain mechanism should be implemented at all in the first place.

Once these factors are considered, parties should move onto defining the key shared objectives that they hope to meet in the completion of this project. These key shared objectives should be specific, measurable, achievable, relevant and timebound (SMART). Each different pain/gain sharing mechanism can initially follow the same structure, by determining the projects overall goals and set outcomes that have been agreed upon.
After this, depending on which pain/gain sharing mechanism is being used then consider different factors. For example, the bonus/malus pain/gain sharing mechanism has different conditions when compared to the gain sharing mechanism – however all mechanisms will share some commonalities – such as trust and transparency being a vital factor in ensuring the mechanism performs successfully.

Once the objectives and goals are clearly set out and agreed upon, identify, and document the requirements from the client and the contract. Consider the client's scope, primary goal, and primary objectives – the requirements/obligations, and any other relevant agreements, such as agreements agreed internally between parties. During this step, also consider any complications to success, this will allow any potential contingencies to be prepared and explored, which can help prevent a potential breakdown in the contract.

After this, a thorough and comprehensive implementation plan should be developed, by including the project objectives, the relationship between the parties objectives and the company objectives. By creating an implementation plan, the idea is that there will be a written point of reference that can be studied and used to successfully manage the pain/gain sharing mechanism during the project's lifetime.

By following all of these steps, one is able to determine the most effective pain/gain sharing mechanism for the project. In essence, it takes a lot of study, reflection and analysis of the client needs, any parties involved in the supply chain needs and finally the relevancy and usefulness of the pain/gain sharing mechanism to the project.

The experts received a short presentation about the framework and it was explained to them how to use the framework and the steps were explained. The experts were then asked whether the framework can be used in their practice and what their expert opinion is on the steps. In general, they found the steps clear and concise and that the framework fits in practice. The experts recommended steps 0 and 1 to define SMART more. The experts have also indicated that they want an escape plan in the framework. For this, 2 options are given in this chapter that Dura Vermeer could consider for the research. The options are as follows:

- **Option 1 – escaping pain/gain sharing mechanisms**
- **Option 2 – committing to pain/gain sharing mechanisms**

Option 1 can be done by writing an escape plan and make agreements on ending the pain/gain sharing mechanism beforehand. Option 2 is committing to the pain/gain sharing mechanism. Perhaps the pain/gain sharing mechanism works better without an escape plan.

8 DISCUSSION

In this chapter the research criteria are tested and the contributions to science are discussed. Subsequently, the limitations for this study are discussed.

8.1 Validity of the research

In this section, validity of the research is described. When conducting research, it is important to ensure the research is of good quality and reliable (Kumar, 2023).

Reliability

There are two main types of reliability in regards to research – external reliability and internal reliability. Internal reliability is mainly focussed on two things – consistency and dependability within the internal research team. External reliability focuses on the reliability for external parties to be able to replicate this research.

This research was conducted by myself, so no internal reliability was relevant for this project. However, throughout the course of this topic, professionals from Dura Vermeer and from TU Delft tested and feedback on this, so some form of internal reliability was present – despite it not being needed.

External reliability in this thesis as previously stated, is based upon the idea that this research can be repeated by other professionals/students. The difficulty in this is that qualitative research is highly open to interpretation, and suffers in the sense that, if you were to interview different people involved in the project, then a different set of responses/results may be obtained.

The way this project solved this issue was by having a stringent and strict interview protocol, by following this to the letter – another researcher has a higher chance of replicating these results.

Ethical considerations

All research will face ethical considerations/challenges. Ethical considerations refer to the idea of protecting participants throughout the research process and ensuring that all research conducted is above board and ethical.

During this research process, informed consent was gained from all participants. Every participant was sent an email detailing basic information about the project and what the interview would entail. However, the decision was made to not give a full explanation, to keep the research objective – the fear was that the interviewers would talk amongst themselves and give biased responses.

Transparency was also an important ethical issue to consider during the process, the interviewers were given a documented written copy of the transcript to authenticate as being themselves speaking, in order to keep authenticity and transparency, and to not make false information pertaining to certain individuals.

Privacy and confidentiality was also an important ethical factor to consider in this research. After the transcripts were collated, they were all stored in a password protected laptop, and further kept secure by being kept in a protected folder with a different password in the laptop.

8.2 Contributions to science

Contributing to science was difficult on this topic due to the niche topic and limited research on pain/gain sharing mechanisms. However, in my research I have built upon the existing research about pain/gain sharing mechanisms in the field of the contractor/subcontractor relationship and expanded the recommendations put forward by previous studies. By doing this I have contributed to a deeper understanding of the dynamic between contractors and subcontractors and identified practical steps by developing a strategic framework that can be taken to improve their collaboration.

Furthermore, I have also done more than just exploratory research and developed a strategic framework that is designed to be real-world applicable to projects. This means that the recommendations of this research are not only theoretical, but also practical. This framework can be implemented by contractors and subcontractors in their day-to-day job. The framework gives clear steps to follow and improve their collaboration in order to achieve better outcomes.

8.3 Limitations of the research

A number of situations occurred during the study that may have had an effect on the results and conclusions of the study. These limitations are listed below.

- In the interviews for one of the cases, an interview was finally conducted in which both members of the subcontractor were present. Both were asked to give a time so that the interviews could be conducted 1 on 1. The reason that during the interview it was important that the persons answer the questions separately from each other is because they may feel inhibited in the answering of the questions by the person present. This could have an effect on the final results of the interview.
- In one of the cases I only interviewed 1 person during the interviews from Dura Vermeer. I asked to interview 2 members of Dura Vermeer who were involved in the project. The members I found were not involved in the project and no one knew who the involved members were or if they were still employed at Dura Vermeer. Unfortunately, due to the limited time frame for this thesis I had to move on and could only interview one person at Dura Vermeer's side. This could have possibly influenced the results, because interviewing two people paints a clearer picture than one person. With 1 person everything that person says is true, with several people finding connections and differences is clearer.
- In the case studies I was only able to analyse 3 cases. This is little, a larger sample size can give a more reliable end result of the results and conclusions.
- The responses I got from Dura Vermeer regarding the pain/gain sharing mechanisms reference projects was low. Out of the 18 employees I asked to send me 2 references each, I received a total of 10 references. The response rate was high, I received 5 additional emails where people apologised for not knowing a reference project.
- Another limitation of the research is based on the scope of the research. My research focused on the contractor-subcontractor relationship, where Dura Vermeer acts as the client. Dura Vermeer also works a lot as a contractor. Pain/gain sharing mechanisms can also be applied for client-contractor relationships. Outcomes could have been different had I extended my scope to the client-contractor-subcontractor.

- The limited time for collecting data in this research is another limitation. More data could have been collected had I had more time to carry out this research. Insufficient time could have led to rushing the research.
- Finally, the strategic framework has not been tested in practice. The effectiveness and reliability of the framework has been evaluated by the experts during the evaluation, but in order for the framework to be verified on effectiveness and applicability it needs to be tested in practice.
- Another limitation of this study is the scope of the contracts in the Dutch construction industry and Dura Vermeer. Pain/gain sharing mechanisms are applied to NEC contracts. However, the use of NEC contractors does not apply in The Netherlands.

9 CONCLUSION AND RECOMMENDATIONS

This chapter contains the conclusion of this research. The main question of this research will be answered in this chapter.

9.1 Conclusion

Before the main research question can be answered, the 4 sub questions need to be answered first.

Sub question 1 reads as:

"What are the pain/gain sharing mechanisms in theory?".

As previously touched upon, the current literature shows that as of right now, the pain/gain sharing mechanisms that are most commonly implemented in NEC4 contracts are the Target Cost Contract (CCC) which is a mechanism in which contractors and subcontractors throughout the supply chain, absorb losses and share the cost savings together in harmony. In addition to this, further metrics, and Key Performance Indicators (KPIs) and bonuses for early completion may also be added to the contracts.

A different type of TCC is also found in theory, these TCCs are applicable to the client/contractor relationships, and they focus on alliances and risk-sharing in contrast to the NEC4 contracts which focus on cost-sharing. Although these are currently applied to client/contractor relationships, these can be adapted and implemented into the contractor/subcontractor supply chain relationships.

The difficulties in short are: lack of understanding TCC and its purpose, resistance to change traditional work practices, absence of standardised TCC contracts leading to errors and confusion and lastly, unfamiliarity with TCC concept in certain regions. In order to implement TCC successful these are the important conditions: willingness and cooperation from both parties, mutual trust and close working relationships, joint agreements on risk sharing between clients and contractor, fair evaluation of fees and risk sharing to keep contractors motivated and lastly, alignment of aims and objectives of all parties to maximise project goals.

A further pain/gain sharing mechanism identified in theory is the bonus/malus systems and delay damages (found in the NEC4 secondary option clauses Option X7). These can be classed as pain/gain sharing mechanisms if parties with a common goal implement these into a contract.

The mechanisms are found in theory, and are easily applicable to existing contract forms, as financial bonuses/rewards are commonplace within contracts already, they are easily applied and can be a source of motivation throughout the supply chain.

As shown by analysing the available literature, it is evident that the lack of knowledge and understanding regarding pain/gain sharing mechanisms is a cause for concern. Little is known about these mechanisms, showing a significant disparity between the theoretical knowledge of pain/gain sharing mechanisms and the practical implementation of these mechanisms.

In order to gain these deeper insights into the real-world application of pain/gain sharing mechanisms, a real-world investigation needed to be conducted. This information was elicited by conducting semi-structured interviews and holding expert-meetings with relevant industry stakeholders/professionals such as Dura Vermeer and the associated subcontractors. This allowed the understanding of the pain/gain sharing mechanisms known in theory to be discovered.

Question 2 which is linked to sub question 1 reads:

"What are the different types of pain/gain sharing mechanisms in practice?".

The literature review and the conclusions drawn from sub question 1 reveal a clear lack of pain/gain sharing mechanisms, both in theory and practice. While there is some understanding of the methodology behind these mechanisms among the involved parties, there seems to be a general lack of awareness regarding the specific details and implications of the mechanisms.

This has led to a lack of implementation of pain/gain sharing mechanisms into real-world practice. Despite some of the conditions and factors being met, as these mechanisms are not formally being put into practice, they are not being used correctly.

In regard to who is more likely to use a pain/gain sharing mechanism in practice, the literature and the interviews have shown that the subcontractor are more likely to want to implement a mechanism as the benefits often outweigh it on their side than the main contractor. However, this isn't to say that the client doesn't think they are useful, Dura Vermeer see the benefits of implementing these, and the interview participants have mentioned the usefulness of applying them practically when there are time constraints.

The pain/gain mechanisms most commonly used are bonuses and fines, these benefit subcontractors throughout the supply chain if they are of a smaller size, as financial rewards/penalties are more important to them.

Some other mechanisms that are implemented into practice but are not as common as bonuses and fines are the risk/sharing and gain/sharing mechanisms. These are difficult to implement at times, if there is a lack of transparency as there is no set formula to follow.

Sub question 3 is

"What are the essential conditions of implementing a pain/gain sharing mechanism?"

Semi-structured interviews following a qualitative approach were conducted to answer this question.

Based on the interviews it was concluded that there are a number of essential conditions, and these need to be agreeable for both the contractor and subcontractor.

Transparency is the most important condition to be met, this is evidenced by the three cases. The two cases in where transparency was clear and there was a level of honesty between all parties shown – the mechanism was implemented successfully. However, in case 3 where there was a lack of transparency, the mechanism failed to meet its objectives.

If transparency is not kept as a primary factor, then the mechanisms will fail. This is evidenced by the case of large airport infrastructure airport, the lack of transparency led to confusion, and discontent amongst the parties. The consequences of a lack of transparency can range from one party suffering financial/productivity losses, to a complete relationship breakdown if one party feels they have been disadvantaged by the other.

Another important condition is having easy to follow quality outcomes/meeting objectives. All interview participants on both the contractor and subcontractor sides believed that having these easy-to-follow quality outcomes would allow a higher level of success as there is something to aim towards.

Having a clear focus, allows quality outcomes to be met, and this point of reference allows clarity behind the project goals, and overall reason for implementing the mechanism and will eliminate any abstractness in the crossover of goals between contractor and subcontractor.

The final essential condition that was identified by the comparative case study and semi-structure interviews was a need for satisfactory performance and happiness of implementing it. Despite the performance of the mechanism itself, if the parties were not satisfied and pleased with the result, the environment is not suitable for the mechanism – henceforth the need of satisfaction is paramount in deciding whether or not to implement the mechanism.

The final sub question is:

“How can one determine the most effective pain/gain sharing mechanism for the project?”

In order to determine the most effective pain/gain sharing mechanism, the strategic framework shown should be used. The framework was developer so that parties can choose to implement an appropriate mechanism. Each of the different pain/gain sharing mechanisms evidenced in the framework’s conditions for implementation and potential complications are shown.

This framework has been evaluated by experts in the topic, for example, the experts agreed that the steps were clear and concise and that the steps were easy to follow. Technical experts and non-technical professionals are able to understand and follow this framework due to its intuitiveness.

The feedback given by the experts was that the transition between step 0 and 1 needed to be more SMART. This was later rectified and now the framework is a reliable document to decide which is the most effective pain/gain sharing mechanism.
Other feedback included one of the three indicating that an escape plan should be implemented, in order for parties to save face after deciding the mechanism is probably not best implemented.

However, a consensus was reached amongst the experts that the framework is reliable, valid, and applicable to real-life contracts and is a tool in deciding which is the most effective pain/gain sharing mechanism to be implemented to the project.

The main research question is as follows:

How can a pain/gain sharing mechanism be implemented so that the contract prerequisites are met by all parties in the supply chain?

First and foremost, to answer the main research question, the definition of pain/gain sharing mechanisms will be repeated.

The definition of pain/gain sharing mechanisms determined by the literature, exploratory study, case studies and interviews is “a mechanism or strategy that can be used to align goals, objectives and interests together by sharing pain and gain and using other incentives to encourage desired behaviour”.

By pain/gain sharing mechanisms we mean different mechanisms that we have learned from the literature and the exploratory study at Dura Vermeer.

In the current literature, the contract form in which the pain/gain sharing mechanism has been implemented is the NEC4 contract ECS4 Option C. This contract is a target cost contract (TCC) in which the pain/gain sharing mechanism occurs, namely the option whereby the contractor and subcontractor share the benefits of cost savings as well as accept some losses together.

The literature also identifies some other pain/gain sharing mechanisms. The Target Cost Contract (TCC) of alliances, risk sharing are forms that fall under pain/gain sharing mechanisms in the literature for alliances or Client-Contractor relationships. However, these mechanisms alone can be used for Contractor-Subcontractor relationships, if used in the correct way.

Along with the aforementioned mechanisms, some other pain/gain sharing mechanism have been found in the literature, only they are classified in this thesis as “potential pain/gain sharing mechanisms”. These are bonus/malus and NEC4's secondary option clause option X7: Delay damages. These have the potential to act as 'sharing' mechanisms in contracts if they are used this way between parties with a common goal.

The pain/gain sharing mechanisms from Dura Vermeer's practice were less common. At first Dura Vermeer did not realize that pain/gain sharing mechanisms were being used as the term was unknown. After further questioning, they found out that this was a pain/gain sharing mechanism.

After analysing the cases, it was concluded that certain steps were missing in Dura Vermeer and the implementation of pain/gain sharing mechanisms. Important preconditions have been drawn up by both parties for the specific cases. These preconditions are seen as conditions for the success of implementing the pain/gain sharing mechanisms.

Pain/gain sharing mechanisms are implemented using the strategic framework that was developed based on the collected results of the interviews. Using this framework, a pain/gain sharing mechanism can be chosen that most effectively fits the project. With the help of this framework, the conditions can be determined and agreements, requirements and interfaces can be properly documented. in step 4 of the strategic framework, the contract prerequisites can be determined and must be signed by all parties.

It is important to make agreements about what and when to share. In the event of scope, requirement and project changes, the parties must jointly share the consequences of these changes. By agreement of all parties, it is important that agreements are respected and guaranteed in order to utilise the optimal effectiveness of pain/gain sharing mechanisms.

9.2 Recommendations for further research

In this section the recommendations for further research will be discussed. In this investigation, matters came to the fore that fell outside the scope of my investigation and that I was not able to investigate. However, these are recommendations that need further investigation to measure the true effectiveness of the implementation of pain/gain sharing mechanisms.

- Investigating more pain/gain sharing mechanisms. In this study, 3 mechanisms have been investigated in the case studies. More research into different mechanisms is recommended.
- This study has done a comparative case analysis due to the presence of different mechanisms in the cases. Further research would be to examine cases with similar mechanisms and to do a cross-case analysis for pain/gain sharing mechanisms.
- More research on parts of sharing “pains” in the Civil Engineering industry.
- This research is an exploratory research. It is recommended to investigate certain mechanisms in practice.
- The number of cases in the case study was small, it is recommended to study more cases.
- The framework has been evaluated by experts. A follow-up study would be to investigate this framework in practice and measure the effectiveness of the framework on the implementation of the system in practice.
- This study focused on the side of the main contractor and the supply chain. More research needs to be done on the contractor side in relation to the client.
- This study focused on several contract types, however, it is recommended that research should be conducted on pain/gain sharing mechanisms in 2-phase contracts.

9.3 Recommendations for Dura Vermeer

In addition to these recommendations, there are also recommendations for Dura Vermeer.

- Implement pain/gain sharing mechanisms and incentives in small project. This way Dura Vermeer and subcontractors will get familiar with the concept and people will gain experience before applying it to larger complex projects.
- Emphasize transparency throughout the project in all departments. “Open book” policy is important as evidenced in this research. Being transparent will foster trust and collaboration with the parties involved and the implementation of pain/gain sharing mechanisms will become more successful in the long run
- Test and refine the framework before full implementation. Start by experimenting with pain/gain sharing mechanisms in a controlled environment. Evaluate their effectiveness and make adjustments if necessary. This iterative approach helps optimising the mechanisms for future projects.
- Dura Vermeer can implement an escape plan in step 4 of the strategy framework. They can also determine whether only the main contractor may use the escape, or whether the subcontractor can also use the escape to terminate the mechanism. The effect of using a (unilateral) escape can influence the collaborations of the parties or the pain/gain sharing mechanism in general. This effect was not part of my scope, but is recommended for further investigation.

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APPENDICES

APPENDIX A – INTERVIEW PROTOCOL

PART 1 – INTRODUCTION	PURPOSE
- **Korte introductie en toestemming vragen om het interview op te nemen** **Introduceer kort mijn scriptie en leg uit waar het interview over gaat** - Uitleggen hoe ik de vragen ga stellen.	De inleiding is belangrijk voor het interview, omdat zo duidelijk wordt wat er van beide partijen wordt verwacht en er gerichte antwoorden kunnen worden gegeven en waardevolle data worden verzameld.

PART 2 – PAIN/GAIN SHARING MECHANISMS	PURPOSE
Bonus/malus	
1. Kan je mij in jouw eigen woorden vertellen hoe bonus-malus is toegepast in dit project?	Beeld krijgen over wat er in het project is gebeurd, dit kan daarna geanalyseerd worden met de mechanismes uit de literatuur.
2. Welke prestatie-indicatoren waren bepaald als belangrijk en waarom waren deze belangrijk?	Deze informatie kan inzicht geven in de effectiviteit van het bonus-malus systeem bij het stimuleren of bestraffen van prestaties, evenals de impact van het systeem op projectresultaten. Het begrijpen van het denkproces achter de selectie van prestatie-indicatoren kan ook helpen bij het identificeren van mogelijke verbeterpunten bij de implementatie van toekomstige bonus-malus systemen.
3. Waarom is er gekozen voor een bonus/malus regeling?	Identificeren waarom en wat er verwacht wordt, wat is de aanleiding
4. Had het opnemen van de bonus-malus een significant effect op de productiviteit in het project? - Zo ja, hoe? - Zo nee, welke effecten vielen er wel op?	Als het bonus-malus systeem een significant effect had op de productiviteit, kan de civiel ingenieur details geven over hoe het systeem was opgebouwd en hoe het projectteam gemotiveerd werd om de prestaties te verbeteren. Deze informatie kan waardevol zijn om te begrijpen hoe bonus-malus systemen effectief kunnen worden geïmplementeerd in toekomstige projecten om de productiviteit te verbeteren en projectdoelen te bereiken. Als het bonus-malus systeem geen significant effect had op de productiviteit, kan de civiel ingenieur inzicht geven in waarom het systeem niet werkte en alternatieve strategieën voorstellen om de prestaties te verbeteren.

5. In welke specifieke gebieden van het contract zijn bonussen en malussen opgenomen en hoe werden deze gebieden geïdentificeerd?	Het helpt om de gebieden in het project te identificeren die als kritiek worden beschouwd voor het bereiken van projectdoelen, wat vervolgens zou kunnen leiden tot de incorporatie van bonus/malus in andere contracten.
6. Wat zijn de belangrijkste overwegingen bij het ontwerpen van een effectief bonus-malussysteem voor een bouwproject, en hoe zorg je ervoor dat het systeem eerlijk is en het juiste gedrag in de hele keten aanmoedigt?	Het stellen van deze vraag aan een civiel ingenieur kan helpen bij het identificeren van eventuele beperkingen of uitdagingen bij het gebruik van bonus-malus, en kan ook inzicht geven in alternatieve mechanismen die beter geschikt kunnen zijn voor toekomstige projecten. Het antwoord kan ook een meer genuanceerd begrip bieden van de besluitvormingsprocessen achter de selectie van pain/gain sharing mechanismen in verschillende projecten.
7. Wat voor prikkels worden gestimuleerd door het toepassen van bonus/malus regelingen? - Zowel positieve als perverse prikkels	Deze informatie kan helpen om het bonus-malussysteem in toekomstige projecten te optimaliseren en de belangrijkste prikkels om het volgen en stimuleren van prestaties te identificeren.
8. a) Kan je mij ten slotte vertellen wat jouw algemene ervaring was met het gebruik van bonus-malus? b) Had het gebruik van het mechanisme ook nadelen? c) Zou je het in de toekomst opnieuw gebruiken? Waarom wel of waarom niet?	Om een laatste overzicht te geven van het onderwerp bonus-malus en of het al dan niet nuttig is.
Risk sharing	
1. Waarom is er gekozen voor risk sharing? (in het geval dit niet van toepassing is: vraag had er ook gekozen kunnen worden voor risk sharing?)	Identificeren waarom en wat er verwacht wordt, wat is de aanleiding
2. Wat voor risico's zijn er gedeeld? - Heeft dit geleid tot behalen van doelen? - Heeft dit de samenwerking gestimuleerd? Zo ja, hoe en zo nee, waarom niet? - Wie was er in de lead bij deze afspraken?	Identificeren wat voor risico's delen zorgen voor welke resultaten.
3. Waarom is er niet meer gedeeld?	(deel van dynniq is veel groter dan wat ze nu in dit contract hebben gedeeld)

4. Wat is het grootste voordeel voor jouw partij door het gebruik van risk sharing?	Identificeren wat de voordelen kunnen zijn voor partijen om risk sharing toe te passen in projecten.
5. Wat voor prikkels worden gestimuleerd door het toepassen van risk sharing regelingen? - Zowel positieve als perverse prikkels	Identificeren van knelpunten of positieve punten die zijn opgetreden.
6. a) Kan je mij ten slotte vertellen wat jouw algemene ervaring was met het gebruik van risk sharing? b) Had het gebruik van het mechanisme ook nadelen? c) Zou je het in de toekomst opnieuw gebruiken? Waarom wel of waarom niet?	Om een laatste overzicht te geven van het onderwerp risk sharing en of het al dan niet nuttig is.
Gain sharing	
1. Hoe is het delen van een gain in dit project toegepast? - in welk geval werd er wel of niet gedeeld? - welke afspraken zijn er gemaakt?	Identificeren waarom en wat er verwacht wordt, wat is de aanleiding
2. Waarom is er gekozen voor gain sharing? (in het geval dit niet van toepassing is: vraag had er ook gekozen kunnen worden voor gain sharing?)	Identificeren wat de voordelen zijn en wat mogelijke valkuilen zijn.
3. Wat zijn de voor- en nadelen geweest bij het gebruiken van dit mechanisme?	
4. Wat voor prikkels worden gestimuleerd door het toepassen van gain sharing regelingen? - Zowel positieve als perverse prikkels	
5. a) Kan je mij ten slotte vertellen wat jouw algemene ervaring was met het gebruik van gain sharing? b) Had het gebruik van het mechanisme ook nadelen? c) Zou je het in de toekomst opnieuw gebruiken? Waarom wel of waarom niet?	Om een laatste overzicht te geven van het onderwerp gain sharing en of het al dan niet nuttig is.

PART 3 – COLLABORATION BETWEEN CONTRACTOR AND SUBCONTRACTOR	**PURPOSE**
1. Hoe heeft dat mechanisme jullie samenwerking beïnvloed? - Wat ging er goed? Wat kon er beter?	Beeld krijgen van de positieve en negatieve bevindingen bij deze samenwerkingsrelatie.

2. Wat verwacht je bij dit soort (aannemer-onderaannemer) samenwerkingen van de andere partij? - Wat zou je graag willen van de andere partij?	Beeld krijgen wat beide partijen willen en/of verwachten van elkaar.
3. Welke methodes zijn er gebruikt om de samenwerking soepel te laten verlopen?	Beeld krijgen van werkwijze, methode en afspraken die voorhand gemaakt worden
4. Hoe kan de samenwerking in het vervolg beter gestimuleerd worden?	Beeld krijgen wat de wensen zijn voor beide partijen voor de toekomst.

PART 4 – DISCUSSION	**PURPOSE**
1. Heeft het gebruik van het mechanisme tot ander gedrag geleid?	Kan positief of negatief zijn, erachter komen wat voor positieve of perverse prikkels er zijn ontstaan.
2. Hoe heeft het gebruik van dit mechanisme geleid tot gedrag dat je wilde?	Specificatie, was dit ook het gedrag dat je wilde vanaf het begin.
3. Heeft dit mechanisme de gewenste uitkomst opgeleverd?	Heeft dit dan ook het resultaat opgeleverd wat je wilde bereiken.
4. Zijn er andere mechanismes (financiële en non financiële prikkels) die gebruikt zijn of kunnen worden om jouw doelen als partij te behalen?	Inzicht krijgen in andere mechanismes / prikkels voor de partijen die in projecten gebruikt kunnen worden.

PART 5 – END OF THE INTERVIEW	**PURPOSE**
- Afronden interview - Anonimiteit waarborgen - Interview uittypen en opsturen ter verificatie	Afronden interview en rond maken overige zaken

APPENDIX B – EXPERT MEETING

PART 1 – INTRODUCTION	PURPOSE
- Korte introductie en toestemming vragen om het interview op te nemen Introduceer kort mijn scriptie en leg uit waar het interview over gaat - Uitleggen hoe ik de vragen ga stellen.	De inleiding is belangrijk voor het interview, omdat zo duidelijk wordt wat er van beide partijen wordt verwacht en er gerichte antwoorden kunnen worden gegeven en waardevolle data worden verzameld.

PART 2 – INHOUD	PURPOSE
- Zouden jullie dit kunnen gebruiken? o Zo nee, waarom niet?	Erachter komen of dit framework real-life applicable is en door Dura Vermeer gebruikt kan worden.
- Waar zou je dit in jullie projecten kunnen gebruiken? o Waarom niet?	Achterkomen wat mogelijke beperkingen zijn en waar aanpassingen gemaakt moeten worden.
- Welke obstakels zien jullie voor de toepassing van pain/gain sharing mechanismes?	Beeld krijgen of en welke aanpassingen of toevoegingen in het framework

PART 3 – END OF THE INTERVIEW	PURPOSE
- Afronden interview - Anonimiteit waarborgen - Interview uittypen en opsturen ter verificatie	Afronden interview en rond maken overige zaken

APPENDIX C – CODING OF THE INTERVIEWS

APPENDIX D – SUMMARY OF THE EXPERT MEETINGS