Doctoral theses at NTNU, 2021:5

Haavard Haaskjold

# The Puzzle of Project Transaction Costs

## Optimising project transaction costs through client-contractor collaboration

Doctoral thesis

Haavard Haaskjold

ISBN 978-82-471-9788-2 (printed ver.)
ISBN 978-82-471-9712-7 (electronic ver.)
ISSN 1503-8181 (printed ver.)
ISSN 2703-8084 (online ver.)

Doctoral theses at NTNU, 2021:5

**NTNU**
Norwegian University of Science and Technology
Thesis for the Degree of
Philosophiae Doctor
Faculty of Engineering
Department of Mechanical and Industrial
Engineering

NTNU
Norwegian University of
Science and Technology

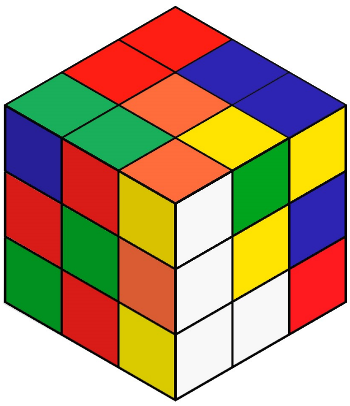
NTNU
Norwegian University of
Science and Technology

NTNU

Haavard Haaskjold

# The Puzzle of Project Transaction Costs

## Optimising project transaction costs through client-contractor collaboration



Thesis for the Degree of Philosophiae Doctor

Trondheim, January 2021

Norwegian University of Science and Technology
Faculty of Engineering
Department of Mechanical and Industrial Engineering

NTNU
Norwegian University of
Science and Technology

**NTNU**
Norwegian University of Science and Technology

Thesis for the Degree of Philosophiae Doctor

Faculty of Engineering
Department of Mechanical and Industrial Engineering

© Haavard Haaskjold

ISBN 978-82-471-9788-2 (printed ver.)
ISBN 978-82-471-9712-7 (electronic ver.)
ISSN 1503-8181 (printed ver.)
ISSN 2703-8084 (online ver.)

Doctoral theses at NTNU, 2021:5

Printed by NTNU Grafisk senter

*"Individuals can be forced to cooperate, but not forced to collaborate. Collaboration comes from the heart when the individuals want to reach a common goal"*

—Nils Arne Eggen, former head coach of Rosenborg Football Club—

# Preface

Through my professional career working with large offshore construction projects in the North Sea I became increasingly curious about why we sometimes ended up in disputes with our partners and had to spend significant resources to safeguard our interests. From the bridge on a pipe-laying ship in the North Sea, I noticed three different inspectors onboard the ship to monitor the installation of a pipe on the bottom of the sea. One inspector represented us (the client), the second represented the contractor, and the third represented an insurance company. Why do we need three inspectors to monitor the same task? We should be able to do better. The research in this thesis is motivated by the need for better understanding of project transaction costs, as this is an important topic that so far has received little attention. The audience for the research is both scholars and practitioners within the field of project management.

This dissertation describes the research that I conducted between March 2017 and September 2020 at the Norwegian University of Science and Technology for my doctoral thesis. I have no conflict of interests related to the research, which was funded by the non-profit organisation "Stiftelsen for etter- og videreutdanning ved NTNU" (SEVU).

During my last six months of work with this thesis, the Covid-19 virus dramatically changed the world around us. It also slightly affected how I could work with the final part of my thesis, as the University was closed. However, having a brother who works as a front-line doctor at the hospital reminds me how small the consequences were for my PhD research compared to the much more severe consequences so many others in society have faced from this pandemic. We all have to adjust to the new situation and in practical terms for completing my thesis, it was possible to conduct the final part working from home and to use digital solutions to collaborate with supervisors and colleagues.

In my personal life I have a deep fascination and interest in Arctic winter expeditions, where I travel on skis pulling a sledge behind me. Temperatures can be cold, sometimes below minus 35 degrees Celsius. Navigating safely with only a map and compass in these conditions is one of the most intense experiences I have, as the consequences are so real. Everything is white, through the blizzard, follow the compass needle. Stop, scan the terrain, study the map, identify the best route to the next waypoint. What are the risks? Where might there be treacherous ice, steep slopes or avalanche traps? I live in this bubble for a few weeks crossing the wilderness of Northern Norway.  Part of the work with this thesis was also conducted inside this bubble, as I took the work with me on four winter expeditions. As papers were read from the sleeping bag with the *aurora borealis* dancing outside my tent, inspirational and creative thoughts were triggered. In this thesis, I will use some metaphors from my personal interest in arctic winter expeditions, as I believe some of these can provide useful illustrations to operationalise terms and concepts.

***Fig. I: Working from my sleeping bag (left), following the compass through the harsh Arctic winter (right)***

# Acknowledgements

I would like to thank every one of you who has supported me in my PhD project. First, I would like to express my gratitude to my main supervisor, Professor Bjørn Andersen, and my two co-supervisors, Professor Wenche Aarseth and Associate Professor Jan Alexander Langlo. Thank you for your support, your guidance and your ability to raise critical questions. In particular, I would like to emphasise how you have helped to expand my mindset and introduced me to the academic world from a professional career.

I would also like to thank co-author of paper 1, Associate Professor Ola Lædre for valuable discussions and contributions.

I am grateful to all those individuals and organisations who have participated in the research. In particular, I would like to thank the interview respondents. Thank you for sharing information and spending valuable time with me. Without your input, there would not have been any research to present. I would also like to thank the companies that participate in the Nordic 10-10 programme for making data available for academic research. Thanks to Dr. Stephen Mulva, Director of Construction Industry Institute (CII), for interesting discussions related to the 10-10 benchmarking tool while visiting Norway.

Colleagues and friends, thanks for all those discussions at the coffee machine, in the cafeteria and in the classrooms: Professor Nils Olsson, Associate Professor Bassam Hussein, Professor Antoine Rauzy, Associate Professor Nora Johanne Klungseth, Dr. Knut Robert Fossum, Kristina Nevstad, Anne Strand Larsen, Bertha J. Ngereja, Kristin J. Hafseld, Jon Martin Fordal and Tom Ivar Pedersen.

Furthermore, I would like to thank the administrative staff for your help and assistance: Kari Elise Dahle, Monica Høgsten, Magnus Lyslo Haugskott, Nina Lødøen and Øyvind Andersen. I would also like to thank Margaret Forbes at

"Forbes Translation and Text" for professional proof-reading of all four articles as well as this thesis manuscript.

I am grateful to my parents who taught me the importance of hard work and stamina during my youth. These are invaluable skills while working with a PhD project.

Finally, I would like to thank my most important supporters. My wife, soul mate and love of my live, Liv Hilde and our three children: Aurora, Ellinor and Leonard. Thank you all for your love support and patience!


*Fig. II: Thanks for your support!*

**Trondheim, 24 September 2020** **Haavard Haaskjold**

# Scientific Summary


The total cost of a project consists of the sum of its production costs and its transaction costs. Project transaction costs are the costs of running the project and these are commonly split into *pre-contract* transaction costs and *post-contract* transaction costs. Pre-contract transaction costs refer to the costs before the contract with a contractor is signed. For clients, these costs include the costs associated with preparing feasibility studies, preparing tender documentation and evaluating bids, while contractors have similar costs when preparing their bid to the client. Post-contract transaction costs refer to the cost of monitoring, administrating, and controlling the project during its execution. This also includes potential costs from disputes and litigation.

However, little is known about the size of such project transaction costs and how they are related to the level of collaboration between a client and its contractor(s). The objective of this thesis is to address this research gap and increase the understanding of how project transaction costs can be optimised through better collaboration and how this can contribute to improved performance in future projects. The thesis combines the research field of project transaction cost with the research field of the collaborative relationship between a client and its contractor. The thesis addresses the following research questions:

- **RQ I:** What is the magnitude of transaction costs in construction projects?
- **RQ II**: What is the relationship between transaction costs and client-contractor collaboration in projects?
- **RQ III**: How can connecting the research field of project transaction costs with the research field of client-contractor collaboration contribute to improved performance in future projects?

This thesis consists of two parts. Part 1 consists of an overview of the conducted research and synthesizes the theoretical background and main findings. Part 2 consists of four scientific papers that are based on two different data sets. The first data set is qualitative and contains 38 interviews that were conducted by the author of this thesis with project managers from different industries in Norway. The second data set is quantitative and contains data from Norwegian construction projects registered in a common database through the Nordic 10-10 Programme for benchmarking, which uses the 10-10 tool that has been developed by the Construction Industry Institute (CII) in the United States.

The key contribution from Paper 1 is that it establishes the connection between project transaction costs and client-contractor collaboration. The key contribution from Paper 2 is that it establishes the relationship between client-contractor collaboration and the quality of the project deliverables. The key contribution from Paper 3 is the introduction of the C*ollaboration Compass*, which is a tool that project managers can apply to identify which specific mechanisms are most relevant to use for a project based on characteristics of the specific project. The key contribution from Paper 4 is that it quantifies the size of transaction costs in construction projects.

### The size of project transaction costs

In terms of quantification of project transaction costs (RQ I) the finding from this thesis is presented in Fig. III, which shows that the transaction costs of the client and its contractor are on average at least 18% of the total project cost in 134 Norwegian construction projects. This shows that a substantial amount of the total money spent on construction projects, some of which are funded by taxpayers, are transaction costs related to managing and administrating the project. This 18% only covers the client-contractor relationship in the project supply chain and the total transaction cost will increase further depending on the make/buy ratio and level of fragmentation of the project supply chain.

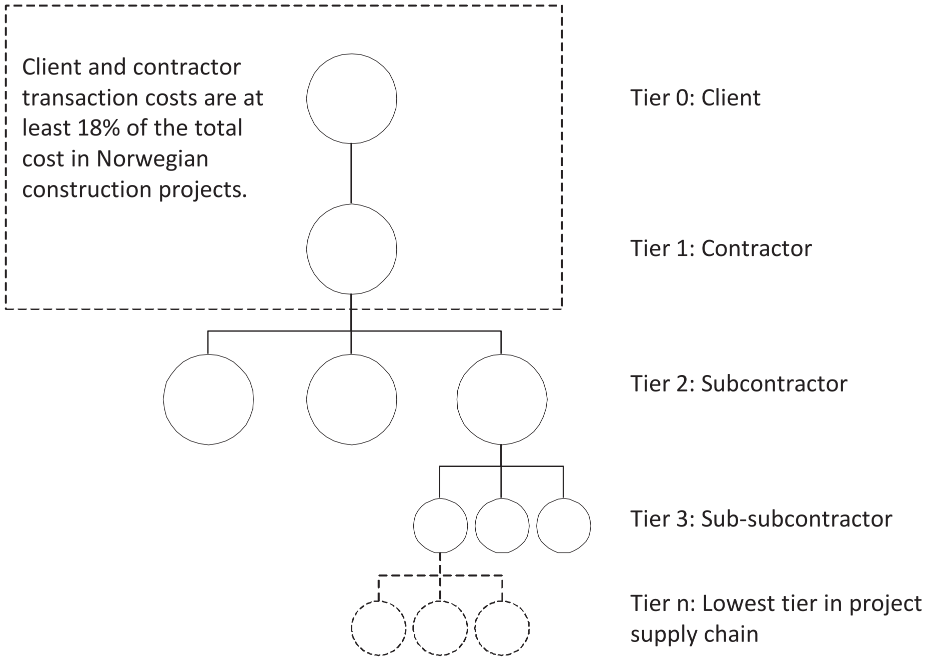



***Fig. III: Answer to RQ I: Client and contractor transaction costs found from study of 134 Norwegian construction projects***

### Describing the relationship between project transaction costs and collaboration

Moving on to RQ II, this thesis found that applying mechanisms that enable collaboration has a positive effect on a project's transaction costs, as synthesised in Fig. IV. Increased collaboration generates several positive effects such as better solutions, better communication, less uncertainty, fewer change orders and more trust. Hence, the need for detailed specifications and extensive monitoring and control is reduced and the number of conflicts and disputes is reduced. At the same time, many mechanisms that are used to foster collaboration requires some kind of investment in terms of time or money. A paradox can therefore occur if a project manager spends more money on mechanisms than the value of the benefits harvested. A sweet spot is found at the point where the total benefits and investments are balanced to give the lowest total transaction costs, as shown in Fig. IV. To optimise the balance between cost vs benefits, this thesis provides project managers with a Collaboration Compass that can be used to identify which collaboration mechanisms are most appropriate to invest in for projects with different characteristics.

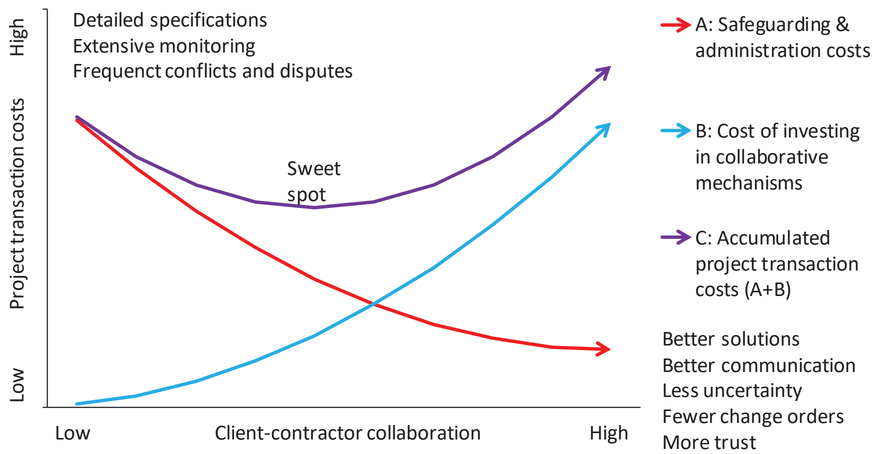



*Fig. IV: Answer to RQ II - Relationship between project transaction costs and client-contractor collaboration*

### Using a holistic approach for better project performance

Regarding RQ III, this thesis proposes a three-dimensional model expressing the relationship between project transaction costs, client-contractor collaboration and quality of project deliverables. This three-dimensional model is shown in Fig. V and called *The Puzzle of Project Transaction Costs*. Changes made to one dimension affect the other two dimensions and the aim is to solve the puzzle and position the project in the optimal place in the model where project transaction costs are low, while quality performance and collaboration remain high at the same time. Using this model, project managers can assess the status of their project and monitor the effect of initiatives taken to improve performance by measuring indicators in all three dimensions.

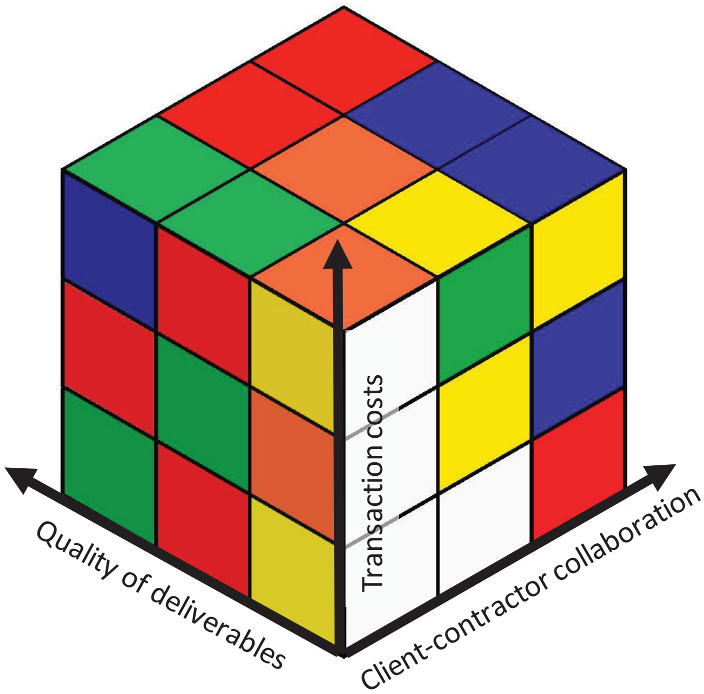



***Fig. V: Answer to RQ III - The Puzzle of Project Transaction Costs***

The main contributions of this thesis can be summarised as follows:

- Connecting the research stream of project transaction costs with the research stream of client-contractor collaboration
- Introducing the P*uzzle of Project Transaction Costs:* A three-dimensional performance model expressing the relationship between project transaction costs, quality of deliverables and client-contractor collaboration

- Providing increased understanding of the monetary size of transaction costs in construction projects
- Introducing the concept of project *head-to-body ratio* to illustrate the size of a project's transaction costs compared to its production costs
- Introducing the C*ollaboration Compass,* which can be used to identify which collaborative mechanisms are best suited for projects with different characteristics

# Executive Summary in Norwegian

Kostnadsoverskridelser er et gjentakende problem i bygg- og anleggsnæringen, både nasjonalt og internasjonalt. Totalkostnad i et prosjekt er summen av prosjektets produksjons- og transaksjonskostnader. Med produksjonskostnader menes de oppgaver som direkte bidrar til å skape en sluttleveranse. Eksempler på slike oppgaver er prosjektering og aktivitet på byggeplass. Transaksjonskostnader derimot er knyttet til de resterende oppgaver som ikke direkte bidrar til produksjonen, men som er nødvendig for å styre prosjektet. Eksempler på dette er prosjektledelse, tilbudsarbeid, møtevirksomhet, reisekostnader, inspeksjoner, konflikthåndtering m.fl.

Det finnes i dag mye kunnskap om hvordan vi kan redusere produksjonskostnadene i bygg- og anleggsprosjekter gjennom mer effektiv prosjektering og bygging. Når det gjelder transaksjonskostnader derimot, vet vi forbausende lite om disse. Vi vet lite om hvor stor andel disse kostnadene utgjør av totalkostnaden i et prosjekt og vi vet lite om hvordan vi kan oppnå lavere transaksjonskostnader gjennom økt samhandling. Begrepet *samhandling* beskriver en høyere form for samarbeid hvor deltagerne har et sterkt ønske om å nå et felles mål. Høy grad av åpenhet og stor tillit er kjennetegn på relasjoner med god samhandling.

Målet med denne avhandlingen er å skape økt kunnskap om transaksjonskostnader i leveranseprosjekter og undersøke hvordan bedre samhandling i grensesnittet mellom byggherre og entreprenør kan bidra til å optimalisere transaksjonskostnader og gi flere vellykkede prosjekter i fremtiden. Konkret skal denne avhandlingen besvare følgende tre forskningsspørsmål:

- Hva er størrelsen på transaksjonskostnadene i bygg- og anleggsprosjekter?
- Hva er sammenhengen mellom transaksjonskostnader og samhandling i relasjonen mellom byggherre og entreprenør?
- Hvordan kan kunnskap om transaksjonskostnader kombineres med kunnskap om samhandling for å skape flere vellykkede prosjekter i fremtiden?

Denne avhandlingen består av to hoveddeler. Den første delen omfatter avhandlingens teoretiske bakteppe og sammenfatter avhandlingens hovedfunn og bidrag. Den andre delen av avhandlingen omfatter fire ulike vitenskapelige artikler.

Forskningen i denne avhandlingen er i hovedsak basert på analyse av to ulike datakilder hvor den ene er kvalitativ og den andre er kvantitativ. Den første datakilden består av 38 intervjuer med prosjektledere fra tre ulike næringer i Norge. Den andre datakilden består av tallmateriale fra 134 norske byggeprosjekter fra perioden 2010 til 2020.

Avhandlingens hovedfunn er som følger:

- Transaksjonskostnadene utgjør i gjennomsnitt minst 18% av de totale kostandene i norske byggeprosjekter.
- Økt samhandling mellom byggherre og entreprenør er positivt for transaksjonskostnadene i et prosjekt. Samtidig er det kostnader knyttet til å skape slik samhandling gjennom ulike virkemidler. Det er derfor viktig å velge de virkemidlene som gir best effekt for et prosjekt, da dette varierer mellom ulike typer prosjekter.
- Transaksjonskostnader og samhandling i et prosjekt påvirker også kvaliteten av leveransene. Disse tre dimensjonene må derfor sees i sammenheng når en jobber med forbedring av kostander i prosjekter og ikke vurderes isolert.

De viktigste bidragene fra avhandlingen er som følger:

- Knytter sammen to teoretiske fagfelt (transaksjonskostnader og samhandling) som i liten grad tidligere har vært sett i sammenheng.
- Lanserer en tre-dimensjonal modell som utrykker sammenhengen mellom transaksjonskostnader, kvalitet og samhandling.
- Gir økt forståelse av hvor stor andel transaksjonskostnader utgjør av de totale kostandene i bygg- og anleggsprosjekter.
- Lanserer begrepene *prosjektets hode* og *prosjektets kropp* for å illustrere forholdet mellom transaksjonskostnader og produksjonskostnader i et prosjekt.
- Lanserer *samhandlingskompasset* som er et verktøy prosjektledere kan bruke til å identifisere hvilke virkemidler som gir best effekt for å skape samhandling i sitt prosjekt.

# Abbreviations

| | |
|---|---|
| BIM | Building Information Modelling |
| CII | Construction Industry Institute |
| CMR | Construction Management at Risk |
| DB | Design-Build |
| DBB | Design-Bid-Build |
| EU | European Union |
| ICE | Integrated Concurrent Engineering |
| ICT | Information and Communications Technology |
| IJMPB | International Journal of Managing Projects in Business |
| IJPOM | International Journal of Project Organisation and Management |
| IPD | Integrated Project Delivery |
| IT | Information Technology |
| JMPM | Journal of Modern Project Management |
| NCTP | Novelty, Complexity, Technology, Pace |
| NOK | Norwegian Kroner |
| NSD | Norwegian Centre for Research Data |
| NTNU | Norwegian University of Science and Technology |
| PM | Project Management |
| PMBOK | Project Management Body of Knowledge |
| PMI | Project Management Institute |
| PPC | Production Planning & Control |
| RQ | Research Question |
| TC(E) | Transaction Cost (Economics) |
| UK | United Kingdom |
| US(D) | United States (Dollars) |
| VDC | Virtual Design Construction |

# Declaration of Authorship

| ID | Paper | Declaration of authorship |
|---|---|---|
| Paper 1 | Haaskjold, H., Andersen, B., Lædre, O. & Aarseth, W. 2019.<br>"Factors affecting transaction costs and collaboration in projects"<br>**Published in**: *International Journal of Managing Projects in Business*, Vol. 13(1), pp.197-230, (Haaskjold et al., 2019) | The PhD candidate is first author. The PhD candidate collected all data through 38 interviews. The PhD candidate analysed all data and wrote more than 90% of the paper. |
| Paper 2 | Haaskjold, H., Andersen, B. & Langlo, J.A. 2020<br>"In search of Empirical Evidence for The Relationship between Collaboration and Project Performance"<br>**Published in**: *The Journal of Modern Project Management*, Vol. 7(4), pp. 120-152, (Haaskjold et al., 2020b) | The PhD candidate is first author. Raw data was made available through the Nordic 10-10 project at NTNU. The PhD candidate processed and sorted data, registered all data into SPSS software and conducted all statistical analyses. The PhD candidate wrote more than 90% of the paper. |
| Paper 3 | Haaskjold, H., Andersen, B., Langlo, J.A. & Aarseth, W. 2020.<br>"Follow the Collaboration Compass"<br>**Accepted for publication** (in press) in: *International Journal of Project Organisation and Management,* (Haaskjold et al., 2020a) | The PhD candidate is first author. The PhD candidate collected all data through 38 interviews. The PhD candidate analysed all data and wrote more than 90% of the paper. |
| Paper 4 | Haaskjold, H., Andersen, B. & Langlo, J.A. 2020<br>"Dissecting the Project Anatomy: Understanding the cost of Managing Construction Projects"<br>**Revision submitted to**: *Production Planning and Control* | The PhD candidate is first author. Raw data was made available through the Nordic 10-10 project at NTNU. The PhD candidate processed and sorted data, registered all data into SPSS software and conducted all statistical analyses. The PhD candidate wrote more than 90% of the paper. |

# Part 1

# Theoretical Background and Main Findings

# Table of Contents

# List of Figures

# List of Tables

# 1 Introduction

## 1.1 Scientific background and motivation

On 19 May 2007, Chelsea footballer Didier Drogba scored the winning goal in the first FA Cup final played at the new Wembley stadium in London. If every one of the 90,000 spectators watching the game that day had donated £10 each, it would not be enough to even cover the cost of photocopying the legal documents of what became a notorious dispute between the main contractor responsible for building the stadium and one of its subcontractors. The case was finally settled in September 2008 after more than two years of hearings. At this point, the photocopying bill alone for printing case documents was £1 million, and the total legal costs paid by the involved parties had risen to £22 million. In the concluding section, Justice Jackson expresses his concern about the amount of resources spent.

> *"The final result of this litigation is such that, when costs are taken into account, neither party has gained any significant financial benefit. Instead large sums of costs and a large amount of management time have been expended on both sides for no useful purpose" (Jackson, 2008, p. 220)*

This is a reminder that the cost of taking disputes to court can be high, as the parties invest significant resources in preparations for the hearings. Money spent on dispute resolution is an example of project transaction costs that do not add value and should be avoided (Tang et al., 2020; da Fonseca et al., 2018; Lu et al., 2015; Rajeh et al., 2015; Lumineau and Quélin, 2012) and Williamson (1981) uses friction as a metaphor to explain transaction costs.

> *"In mechanical systems, we look for frictions: do the gears mesh, are the parts lubricated, is there needless slippage or other loss of energy? The economic counterpart of friction is transaction cost: do the parties to the exchange operate harmoniously, or are there frequent misunderstandings and conflicts that lead to delays, breakdowns and other malfunctions?" (Williamson, 1981, p. 552)*

The total cost of a project is the sum of its production costs and its transaction costs (Lee et al., 2009; Walker and Kwong Wing, 1999; Williamson, 1979). Here, production refers to those activities directly related to transforming inputs into valuable outputs for the project owner (da Fonseca et al., 2018) such as design and construction activities (Ballard and Howell, 2003). However, project transaction costs are costs that are not directly related to this production, but rather the costs associated with managing and controlling the project (da Fonseca et al., 2018; Li et al., 2015; Rajeh et al., 2013). Project management is an example of a project transaction cost (Lee et al., 2009; Walker and Kwong Wing, 1999), which includes activities such as preparing bid documents (De Schepper et al., 2015), project administration (Li et al., 2015), travelling (da Fonseca et al., 2018), managing changes (Guo et al., 2016), conflict resolution (Tang et al., 2020), verifications, site visits and meetings (Rajeh et al., 2015), etc.

Although transaction costs have received some attention from project management scholars, the number of contributions in the field is scarce (Pinto et al., 2009). Only a handful of studies exists worldwide where project transaction costs are quantified (Guo et al., 2016) and more research in the field is needed (da Fonseca et al., 2018; De Schepper et al., 2015; Li et al., 2015; Rajeh et al., 2015). For example, in the latest edition of *Project Management Body of Knowledge* (PMBOK), project transaction costs are not mentioned even once (PMI, 2017). The purpose of this thesis is therefore to contribute to closing this research gap by investigating both the actual size of project transaction costs and how these can be optimised through collaboration to achieve better performing projects.

Project transaction costs are not equivalent to waste that can simply be eliminated. For example, eliminating project management activities would increase the risk of higher production costs and projects failing to meet their objective. The aim is therefore to optimise the transaction costs in order to minimise the total sum of production and transaction costs in a project (Lee et al., 2009; Walker and Kwong Wing, 1999; Williamson, 1979).

> "*The object is to economize on the sum of production and transaction costs*"
> *(Williamson, 1979, p. 245)*

Those transaction costs that do not make a positive contribution to the project should be reduced and avoided. For example, significant savings could be achieved if costs related to managing disputes and conflicts are avoided or if time-consuming administrative process are improved. This may lead to several paradoxes. For example, costs associated with a client's visit to a construction site to verify work conducted by its contractor are a transaction cost (da Fonseca et al., 2018). Such travelling costs can easily be reduced if the client decides to reduce the number of site visits, However, as a consequence, there is a risk that poor quality in the construction work remains undetected and is not discovered until later. This may be particularly relevant if the contractor acts opportunistically and is tempted to select solutions with lower quality if the number of client-inspections are reduced. Hence, simply reducing the number of site visits may not be a favourable option for the client even though transaction costs can be saved through a reduced travel budget. This paradox becomes more interesting once *collaboration* is introduced. Through a collaborative relationship with the contractor, the client can reduce its number of site visits as its trust in its contractor increases. The ability to prevent and resolve potential conflicts efficiently is related to the level of collaboration between the actors in the project (Børve, 2019; Dietrich et al., 2010). The term *collaboration* has been defined by the Institute for Collaborative Working:

> *"Collaboration is a commitment between two or more parties to create value by striving to achieve shared competitive goals and operational benefit through a spirit of mutual trust and openness" (ICW, 2017, p. 29)*

Good collaboration between the client and its contractor(s) should lead to win-win situations for both parties (Bititci et al., 2007) and contribute to project success (Bond-Barnard et al., 2018; Kwofie et al., 2018). However, collaboration relies on the presence of both formal and behavioural issues and many projects are subject to problems related to the social dimensions of collaboration (Hietajärvi and Aaltonen, 2018; Nevstad et al., 2018). Collaboration has a positive effect on project performance (Bond-Barnard et al., 2018). Projects with a high level of client-contractor collaboration experience less ambiguity, fewer errors and deviations, more often meet requirements and more often have satisfied clients than projects with poor collaboration (Caniëls et al., 2019; Sarhan et al., 2017; Walker et al., 2017). This leads to fewer conflicts and disputes, less rework and less need for the client to spend resources on monitoring the detailed work conducted by its contractor. Achieving the right quality in the deliverables is an effective means to achieve better project performance. Improved collaboration in the relationship between a client and its contractor leads to increased trust (Bond-Barnard et al., 2018). Consequently, as a result of increased trust, the parties can spend less resources to safeguard their own interests against a potential opportunistic counterpart (Shi et al., 2018; Kadefors, 2004).

According to Statistics Norway (SSB, 2019), the turnover for the Norwegian construction industry in 2018 was 599 billion Norwegian kroner. Public projects funded by taxpayers account for a substantial proportion of this figure. For example, for the period 2018-2029, the Norwegian government plans to invest 933 billion Norwegian kroner in road and railway projects (NTP, 2018). A cost reduction of one percentage point would make more than 9 billion kroner available for the government to spend on other purposes for the benefit of society. In White Paper 22, the Norwegian government identifies significant potential savings for society if transaction costs are optimised (Norway, 2018). This is particularly relevant for construction projects, which often struggle with poor productivity (Todsen, 2018). On a global scale, the McKinsey Global Institute claims that 1.6 trillion United States dollars (USD) is lost each year due to poor productivity in the global construction industry and that construction lags behind other industries when it comes to productivity in most countries (Barbosa et al., 2017). The specific figures are open to debate, but in general, this productivity gap is recognised by many researchers (Zhang et al., 2018b; Fulford and Standing, 2014; Abdel-Wahab and Vogl, 2011).

This thesis is important because it addresses a research gap which can lead to significant savings for society through improved performance in projects. Research on project transaction cost is scarce and future research in this area may lead to valuable contributions (Pinto et al., 2009). Several researchers call for further research on project transaction costs (da Fonseca et al., 2018; De Schepper et al., 2015; Li et al., 2015; Rajeh et al., 2015) and it is an aim that the research in this thesis will contribute to finding solutions to how performance in construction projects can be improved, as that will generate significant savings for society.

## 1.2 Personal motivation

As a practitioner in large offshore construction projects in the North Sea, I often witnessed and wondered about how we spent significant resources to safeguard the company we were working for. Take for example the most recent project I worked with prior to conducting my PhD studies. This was a project with a total budget of 150 million US dollars where the task was to construct underwater pipelines between two oil platforms. I followed the project for four years, from start until end, working as a client representative in the client's project management team. The relationship with the main contractor for this job soon became challenging, with mistrust and disputes. As a client, we suspected that, to win the job, the contractor had bid a lump sum price that was too low, and that the contractor was speculating on recovering the loss by claiming extra payment through requests for change orders. For two years, I witnessed how we, as client, spent a vast amount of time and money in this project to challenge change order requests and ensure that we were not taken advantage of by our contractor. E-mails were carefully reviewed by solicitors before they were sent to the contractor to be sure that we were not providing information that could be misused. Soon, even simple technical clarifications with the contractor had to be communicated through formal letters signed by contract managers instead of a two-minute telephone call between two engineers exchanging information. More and more expert consultants were hired to monitor the contractor's daily work on the site as the level of trust vanished. The work environment was bad with mistrust and fear and significant resources were spent to safeguard our interests. The contractor no doubt experienced similar effects as the contractor also had to spend large resources to safeguard its interests regarding a client that it did not trust.

Eventually, after two years the conflict level peaked at a level where serious action had to be taken. Both parties realised that this spiral of increased mistrust could not go on and that it was harming both organisations. Significant efforts and tough decisions were made by both parties and a common plan was laid to de-escalate the conflict level and start to re-build trust. A neutral third party of professional organisational psychologists was hired to facilitate this process. Gradually, the lawyers disappeared, and the level of trust started to increase between individuals in the two organisations. Rules for behaviour were established and agreed through common workshops. Both parties agreed common rules, such as where and when contract matters should be addressed and where such matters should not be addressed. For example, a large part of the work for this project took place onboard the contractor's pipe-laying ships in the North Sea. Onboard ships, commercial discussions between the client and contractor were banned, and only technical and operational discussions were to be taken onboard. In fact, all commercial contract exhibits were left at the wharf when the ship sailed. The focus by all personnel onboard should be to find the best way to conduct the job as we were literally "all in the same boat". As the client's representative onboard the ship I could now discuss technical clarifications freely with the contractor's project engineers without having to consult with the contract manager in the office on a satellite telephone line for every little detail. Any commercial matters were only to be discussed between the two organisations' contract managers after the ship had returned to shore and completed the job.

Even though the outcome from this example was ultimately satisfactory the project transaction costs underway must have been substantial. Exactly how much money the two organisations spent to secure their interests and monitor each other is not known to me, but the numbers must have been high. This example is not unique. Talking to colleagues and practitioners in other projects and other industries, I heard similar stories. This made me curious and I started to wonder. I wanted to become a PhD student to understand more of this.

I wrote a short blog text on the professional LinkedIn community where I shared my curiosity on the topic. The feedback was overwhelming, and I was encouraged by many colleagues to investigate this topic. The conflict level in Norwegian construction projects is in general considered to be high, with significant safeguarding costs (Kvålshaugen and Sward, 2018). Still, I find that the term *transaction costs* is seldom used by project practitioners. In fact, throughout my almost 15 years as a practitioner in offshore construction projects, I do not believe I ever heard the term *transaction costs* being used more than a few times. At the same time, the term appears to be more frequently used in permanent production organisations with long-term supply-chain relations, as can be found in the automobile industry, for example. As transaction cost theory is also relevant for project management, I believe it is useful to operationalise the term and to "enlighten" project practitioners. A personal motivation for this thesis is to show project practitioners that transaction costs are highly relevant for their daily work in projects and to demonstrate how we can optimise them through improved collaboration.

***Figure 1-1: "All in the same boat" - achieving a collaborative climate at the end in a project that had a rough start (Photo: H. Haaskjold)***

## 1.3 Paper-based thesis

This thesis is based on four scientific papers submitted to international journals with a refereeing scheme. Each paper addresses an issue that is related to the research objective of the thesis. The purpose of the chapters in this thesis is to present how these papers are connected to each other and how these papers together make a contribution to the field that is larger than the sum of the contributions from each individual paper. Even though the thesis is paper based, the aim is that the reader will be able to read this thesis as a standalone manuscript without the need to keep switching back and forth between the thesis manuscript (part I) and the individual papers (part II). This thesis therefore provides an overview of both literature and the findings from the individual papers. Several text excerpts and figures from the individual papers are therefore also included in this thesis manuscript when appropriate to ensure that part I of the thesis can be read as a standalone manuscript. The main purpose of each individual paper can be seen in Table 1-1.

***Table 1-1: Paper-based thesis, purpose***

| Paper ID | Purpose |
| --- | --- |
| Paper 1 | Investigating which factors affect both transaction costs and collaboration in projects |
| Paper 2 | Investigating the relationship between the level of collaboration in projects and how well projects perform in terms of cost, time and quality |
| Paper 3 | Investigating which mechanisms are most used to achieve collaboration in projects with different characteristics |
| Paper 4 | Investigating what proportion of the total cost in a construction project is spent on project management by a client and its contractor |

In terms of the number of publications, the formal requirement from the Faculty of Engineering (IV) at NTNU for a paper-based PhD thesis is as follows.

> "*A paper-based thesis should consist of a minimum of 3 journal articles sent to an internationally recognised journal with a referee scheme. The PhD candidate must be the main author of at least two of the journal articles. At least one of the journal articles, with the PhD candidate as the main author, must be accepted for publishing when the thesis is delivered for assessment*" *(NTNU-IVT, 2020)*

All four papers in this thesis have been submitted to internationally recognised journals with a refereeing scheme. A summary of the status for each paper is shown in Table 1-2. The second column in the table contains the name of the journal where the papers were submitted. Column 3 provides information about the journal as listed in the Norwegian Register for Scientific Journals, Series and Publishers, which is published by the *Norwegian Centre for Research Data* (NSD, 2020). This information contains an assessment about the refereeing scheme applied by the journal as well as its scientific level. The scientific level is rated from 0 (lowest) to 2 (highest). The fourth column describes the PhD candidate's author role while the fifth column shows the current publication status for each paper at time when this thesis was submitted.

***Table 1-2: Paper-based thesis, publication summary***

| Paper ID | Journal name | NSD assessment | PhD candidate is main author | Publication status |
|---|---|---|---|---|
| Paper 1 | International Journal of Managing Projects in Business (IJMPB) | Peer-reviewed, Level 1 | Yes | Published |
| Paper 2 | Journal of Modern Project Management (JMPM) | Peer-reviewed, Level 1 | Yes | Published |

| | | | | |
|---|---|---|---|---|
| Paper 3 | International Journal of Project Organisation and Management (IJPOM) | Peer-reviewed, Level 1 | Yes | Accepted for publication |
| Paper 4 | Production Planning & Control (PPC) | Peer-reviewed, Level 1 | Yes | Revision submitted |

## 1.4 Overview of thesis structure

The overview of the structure of this thesis is presented in Table 1-3. In the first chapter, the background and motivation for the objective of the thesis are presented. Chapter 2 presents the state of the art of existing research in the field and identifies a research gap. Based on the research gap, research questions are developed and presented in Chapter 3, where the research methods used in the thesis are also described. In Chapter 4, the findings from each paper are presented and discussed. Chapter 5 connects the findings from the individual papers and provides a holistic presentation of the main findings in the thesis, while these findings are discussed in Chapter 6. In Chapter 7, conclusions are drawn, contributions are highlighted and avenues for further research are presented. Chapter 8 contains a list of cited sources in the thesis while Chapter 9 contains appendices with additional information such as the detailed interview guide.

*Table 1-3: Overview of thesis structure*

| Chapter | Content |
|---|---|
| **Chapter 1** Introduction | • Background and context<br>• Motivation<br>• Objective<br>• Scope and limitations |
| **Chapter 2** Theoretical Background | • Literature review and presentation of state of the art<br>• Research gap |
| **Chapter 3** Research Method | • Research questions<br>• Research methods |
| **Chapter 4** Findings from Individual Papers | • Specific findings and discussions from each of the four individual papers |
| **Chapter 5** Thesis Main Findings | • Presentation of main findings from thesis |
| **Chapter 6** Discussion of Findings | • Holistic discussion of thesis findings |
| **Chapter 7** Conclusions | • Answer to research questions<br>• Highlight main contributions<br>• Proposal for further research |
| **Chapter 8** References | • Reference list of cited literature |
| **Chapter 9** Appendices | • Interview guide<br>• Link to Nordic 10-10 questionnaire |

## 1.5 Research objective, scope and limitations

The objective of this thesis is to investigate project transaction costs and the potential to optimise them through client-contractor collaboration in order to achieve better performing projects in the future. The research objective has been studied from different perspectives. More specifically, all four papers have studied both the client and the contractor perspective. In terms of industry sector, papers 2 and 4 only study projects within the construction industry, while papers 1 and 3 also include perspectives from projects in the information and communications technology (ICT) industry and the offshore oil and gas industry.

The scope of this thesis is illustrated in the Venn diagram in Figure 1-2. This diagram shows that the contribution from this thesis is in the intersection between the research domains of transaction cost economics, project management and client-contractor collaboration.

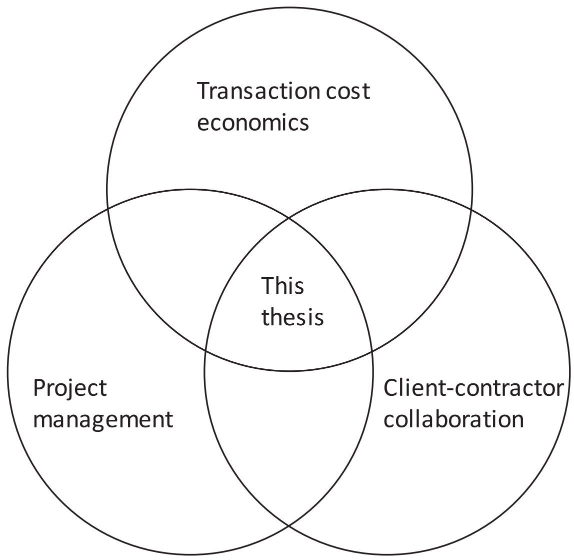



***Figure 1-2: Theoretical framework for the thesis***

In terms of elements that are considered to be outside the scope of work, there are some areas that are particularly relevant to mention as they lay close to the scope. The first limitation is that the thesis does not cover Lean processes. Although some elements of Lean processes are mentioned in this thesis, they are not considered a key part of the scope. In terms of project cost performance, the aim is to minimise the total project costs. This total cost of a project is the sum of its production costs and its transaction costs (Lee et al., 2009; Walker and Kwong Wing, 1999). Regarding cost performance, this thesis focuses on the task of optimising the transaction costs side of the equation, with less attention to optimisation of production costs. This thesis has some limitations related to project performance, as mainly cost, quality and schedule aspects are considered. Most researchers today agree that an approach restricted to performance inside the iron triangle is too narrow in terms of whether a project is successful or not (Müller and Jugdev, 2012). This view is also shared by the author. Hence, this limitation is a consequence of narrowing down the scope of the thesis and does not mean that the author considers other dimensions of project success to be unimportant.

In order to build collaboration, both hard and soft mechanisms may be applied. Examples of "hard" mechanisms are contract incentives and contractor selection processes. Softer mechanisms are those related to building and managing relationships on a more day-to-day basis (Bresnen and Marshall, 2000). Collaborative project delivery methods such as the use of Integrated Project Delivery (IPD), partnering or alliances can be used to foster collaboration between client and contractor. Different procurement and delivery methods are discussed, but they are not considered a core topic within the scope of this thesis. Day-to-day mechanisms and practical tools applied by project managers to achieve collaborative behaviour have been studied less than contracting methods by existing researchers (Suprapto et al., 2015a; Aarseth, 2014; Bresnen and Marshall, 2002).

This thesis will narrow its focus area to the intersection between the research domains of transaction cost economics and client-contractor collaboration, and the thesis addresses the following three research questions (RQ):

- **RQ I:** What is the magnitude of transaction costs in construction projects?
- **RQ II**: What is the relationship between transaction costs and client-contractor collaboration in projects?
- **RQ III**: How can connecting the research field of project transaction costs with the research field of client-contractor collaboration contribute to improved performance in future projects?

The following chapter describes the theoretical background for this thesis. This leads to a research gap and the rationale behind the research questions that are further developed in Chapter 3.1.

# 2 Theoretical Background

This chapter contains the theoretical background based on a literature review of the following main knowledge domains that this thesis is built on:

- Project management theory
- Project transaction costs
- Client-contractor collaboration

The first part of this chapter describes some elements from general project management theory that are particularly relevant to this thesis. This is followed by a summary of theory on project transaction costs and client contractor-contractor collaboration. In the final section of this chapter a research gap is identified based on the findings from this literature review. Details about how the literature review was conducted (the method) are described in chapter 3.3 of this thesis.

## 2.1 Project management theory

In the latest version of PMBOK, the Project Management Institute defines a project as "*A project is a temporary endeavour undertaken to create a unique product, service or result*" (PMI, 2017, p. 4). In this section, elements from classical project management theory that are particularly relevant to this thesis are presented. The purpose is not to cover all aspects of project management theory but to introduce elements from project management theory that are particularly relevant to the topic of this thesis.

## 2.1.1 Project life cycles

Every project has a start and an end and is normally divided into different life cycle phases (ISO, 2012). These phases follow a logical sequence, which may vary between different types of projects as synthesised in Figure 2-1. In the latest edition of PMBOK, the Project Management Institute (PMI) describes how projects can, in general, be organised into a typical life cycle structure of the following four phases: starting the project, organising and preparing, carrying out the work and ending the project.  A similar model is proposed by Pinto (2010), who divides a typical project's life cycle into four stages: conceptualisation, planning, execution and termination.

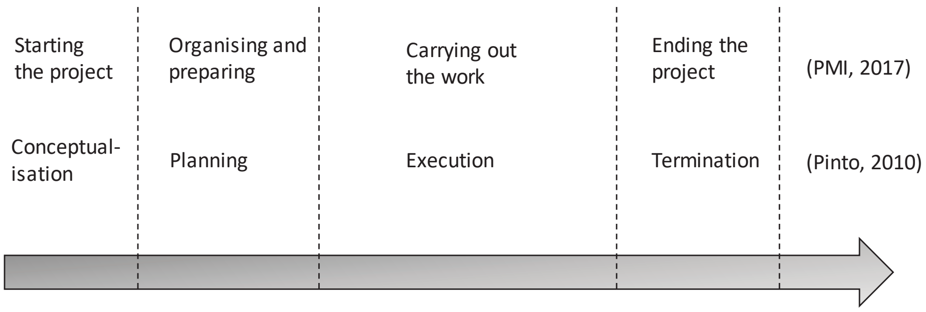



***Figure 2-1: Generic description of project life cycles***

## 2.1.2 Project performance and the Iron Triangle

Measuring project success in terms of the extent to which it meets its target within the dimensions of  cost, time and quality is commonly known as the "Iron Triangle" (Rezvani and Khosravi, 2018) or the "Triple Constraint" (Pinto, 2010).

Most researchers today agree that the iron triangle  is too limited as a definition of project success (Müller and Jugdev, 2012). The Iron Triangle focusses on internal productivity measures and describes the efficiency of how the project was executed. However, even though a project is delivered on time, within its budget and in accordance with its specifications it may not be considered a success if the client or the user does not get the desired effect from the project (Samset, 2014). To determine whether a project is successful or not, the objectives of all the project's stakeholders should be considered (De Wit, 1988). Pinto and Slevin (1988) suggested expanding the Iron Triangle with a fourth dimension that measures client satisfaction. Through a literature review, Eriksson and Westerberg (2011) identify three additional aspects that are crucial to sustainable project success. They remind us that the environmental impact, work environment and innovation must also be assessed in order to determine if a project is successful.

Quality is defined by PMI (2017) p. 718 as "the degree to which a set of inherent characteristics fulfils requirements". Indicators of quality level typically evaluate: number of changes, errors, and omissions, the cost of quality (PMI, 2017), fulfilment of functional and regulatory requirements (Arditi and Gunaydin, 1997), level of non-conformances and deviations (Yeung et al., 2013), conformity to expectations (Molenaar et al., 1999) and client satisfaction (Oakland, 2012; Juran and Godfrey, 1999). Juran and Godfrey (1999) and Oakland (2012) remind us that quality is also associated with meeting customers' needs beyond purely conforming to specifications and requirements. Afterall, the project should create value for the owner (Haddadi and Johansen, 2019).

### 2.1.3 Productivity in construction projects

In general terms, the term *productivity* in a project simply describes the ratio between input and output, i.e. the ratio between how much value is gained compared with the amount of resources spent (Abdel-Wahab and Vogl, 2011; Dozzi and Abourizk, 1993). Examples of different types of such productivity include capital productivity, measuring the ratio between money spent and gained output, or Average Labour Productivity (ALP), measuring output per hour worked (Vogl and Abdel-Wahab, 2015). These are examples of single factor productivity measures describing the input/output ratio of one factor such as cost or labour. Simply measuring the labour productivity in a construction project is narrow and does not capture the real productivity of a construction project (Ahmad et al., 2018). To get a more holistic description it is therefore common to describe productivity in terms of multi-factor productivity measures, which consist of a combination of multiple factors to better capture the magnitude of a construction project (Vogl and Abdel-Wahab, 2015). Many existing studies of productivity in construction projects apply Total Factor Productivity (TFP), which considers multiple inputs such as labour, equipment, materials and capital (Park, 2006).

The McKinsey Global Institute claims that USD 1.6 trillion is lost each year due to poor productivity in the construction industry (Barbosa et al., 2017). When one reads existing research on productivity trends, it is important to be aware of which elements of productivity have been measured. Several studies are based on statistics from national databases that are not necessarily comparable (Ahmad et al., 2018; Vogl and Abdel-Wahab, 2015). However, existing studies on the productivity of construction projects still appear to reach the same conclusion: that the construction industry is lagging behind other industries in most countries in terms of productivity, and that this productivity gap is widely recognised by most researchers even though specific numbers are debated (Zhang et al., 2018b; Vogl and Abdel-Wahab, 2015; Fulford and Standing, 2014). For example, Abdel-Wahab and Vogl (2011) investigated both Average Labour Productivity (ALP) and Total Factor Productivity (TFP) for construction projects in Germany, France, UK, USA and Japan and found that construction productivity was lagging behind other industries in all countries. For Germany and Japan, the study found that construction productivity was gradually declining. A more recent study by Todsen (2018) showed similar results for

Norwegian construction projects. According to this study, based on national data from Statistics Norway, productivity in Norwegian construction projects has declined by 10% since year 2000 while other industries in Norway in general have increased their productivity by 30% during the same period.

In terms of factors affecting productivity, these are not simply limited to production related factors but also include other aspects such as project and quality management, human factors, change orders and environmental factors (Park, 2006). The framework developed by Dozzi and Abourizk (1993) describes how different aspects of management practices, labour effectiveness and material timeliness all affect productivity in a construction project.

### 2.1.4 Taxonomy for project classification

Several existing frameworks and models can be used as a taxonomy to classify different types of projects. For example, projects can be differentiated based on the extent the work scope, type of industry or duration, to mention a few. More generic models also exist, such as the Cynefin framework (Snowden and Boone, 2007), which can be used to differentiate between projects with different complexity. The generic NCTP framework (Shenhar and Dvir, 2004) differentiates between projects in four different dimensions and is widely recognised in the project management research field (De Rezende et al., 2018). In this framework, shown in Figure 2-2, projects are categorised according to their level of novelty (N), complexity (C), technology (T) and pace (P). The novelty dimension describes how new a product delivered by a project is on a scale from 1-3. The lowest score (derivative) indicates that the product is well known in the market as opposed to the highest (breakthrough), which describes products that are new to the world. The complexity dimension ranges from 1-3, where low complexity (assembly) describes a scope of work isolated to a single function as opposed to the highest complexity (array), which would include projects with a high level of interfaces such as a city's highway system or the development of an offshore oil field. The technology dimension is used to describe the uncertainty related to the technology applied in the project and ranges from 1(low tech) to 4 (super high-tech). The fourth, and final, dimension is pace, which describes the urgency with which the project needs to be executed, ranging from 1 (regular) to 3 (blitz critical) (Shenhar and Dvir, 2004).

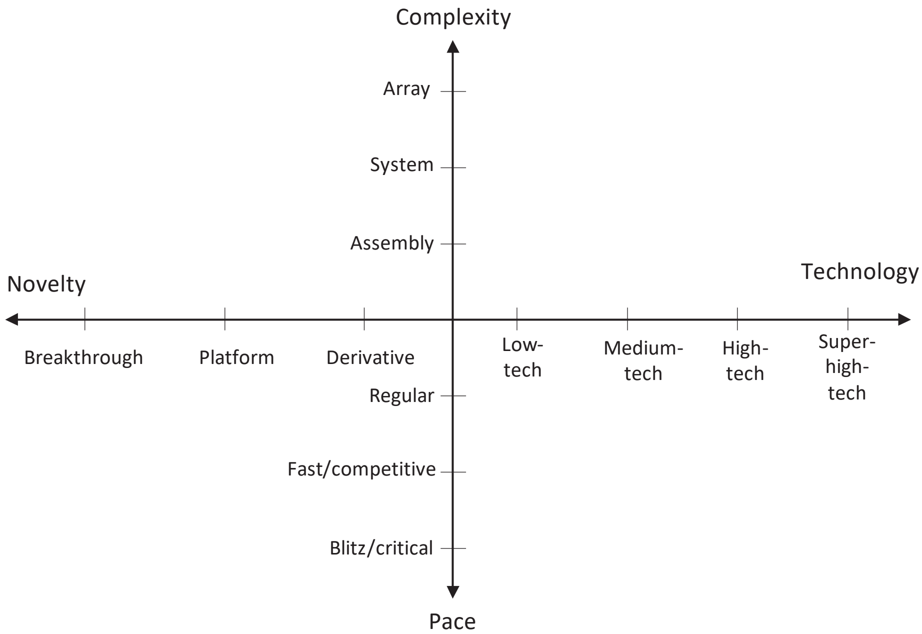



***Figure 2-2: The NCTP framework, redrawn from (Shenhar and Dvir, 2004, p. 1270)***

### 2.1.5 Governance of project management

The distinction between the terms *project management* and *project governance* deserves some clarification as both terms are mentioned in this thesis.

The International Organization for Standardisation (ISO) defines *project management* as "…*the application of methods, tools, techniques and competencies to a project*" (ISO, 2012, p. 4). A similar definition is provided by the Project

Management Institute, who state that "*Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements*" (PMI, 2017, p. 10). While *project management* is accomplished through application of methods, tools, techniques, etc. to ensure that the project is successful in terms of meeting its requirements, project governance refers to the framework that guides these project management activities (PMI, 2017; ISO, 2012).

Governance comes from the Latin word *gubernare,* which means "to steer" (Muller, 2009) and is the framework by which an organisation is directed and controlled. By applying such governance, the quality of the project management activities is improved (Muller, 2009). Typically, such governance includes defining management structures, policies, roles and responsibilities etc. (ISO, 2012). It affects projects in terms of how people in the project organisation behave and the actions they take (Muller, 2009). This is illustrated in Figure 2-3. Here, project governance is placed within the project environment but outside the project organisation. Typically, the responsibly for maintaining project governance is assigned to the project sponsor or the steering committee (ISO, 2012). In transaction cost economic theory, governance is a key element, as an organisation seeks the optimal governance structure that offers the lowest transaction costs (Williamson, 1996). Transaction cost theory will be addressed further in the following sub-chapter.

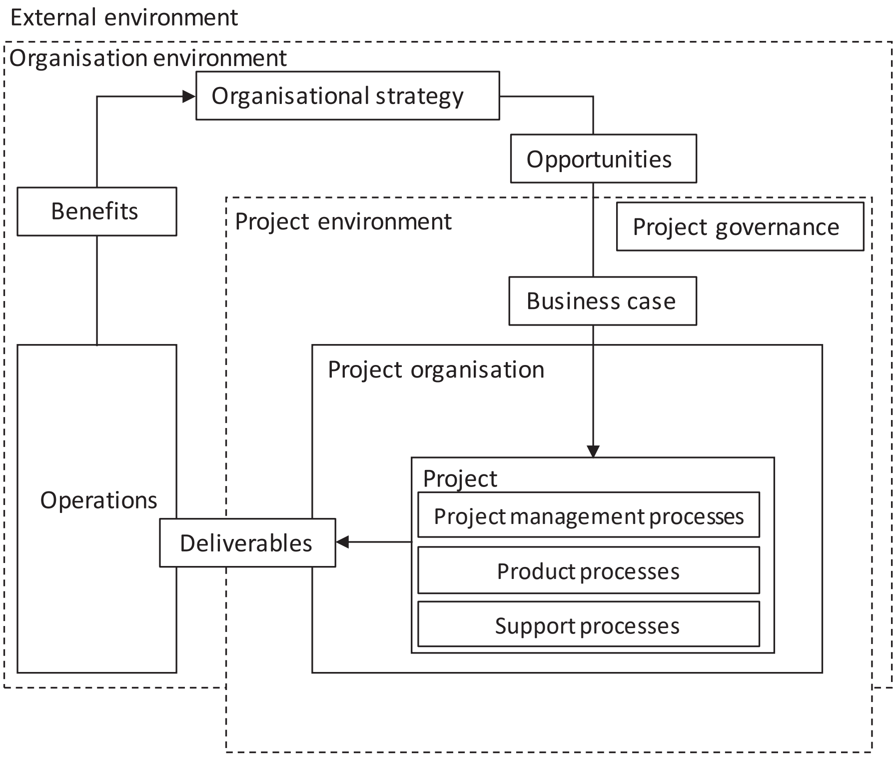



***Figure 2-3: Overview of project management concepts and their relationships, redrawn from (ISO, 2012, p. 3)***

## 2.2 Project transaction costs

In economics, transaction costs are the “costs of running the economic system” (Arrow, 1969, p. 48), and Williamson (1981) describes this as friction.

> *“In mechanical systems, we look for frictions: do the gears mesh, are the parts lubricated, is there needless slippage or other loss of energy? The economic counterpart of friction is transaction cost: do the parties to the exchange operate harmoniously, or are there frequent misunderstandings and conflicts that lead to delays, breakdowns and other malfunctions?” (Williamson, 1981, p. 552)*

The total cost of a project is the sum of its production costs and its transaction costs (Lee et al., 2009; Walker and Kwong Wing, 1999). Here, production refers to those activities directly related to transforming inputs into valuable outputs for the client (da Fonseca et al., 2018) such as design and construction activities (Ballard and Howell, 2003). However, transaction costs are costs that are not directly related to this production, but rather the costs associated with managing and controlling the project (da Fonseca et al., 2018; Li et al., 2015; Rajeh et al., 2013; Walker and Kwong Wing, 1999).

In the following sub-chapters, the theoretical background and the key concepts for project transaction costs are presented: first, going back to its origin in the *New Institutional Economics* and then tracing its path forward. Here, the transaction cost framework has expanded from its origin within the fields of economics and supply chain management into recent times where it has also received some attention in the field of project management research.

### 2.2.1 Transaction cost economics – The essentials and key concepts

The term transaction cost was originally introduced by Coase (1937) in *The Nature of the Firm.* Coase (1937) argued that using the free market economic system has a cost. Even in a free market, there would still be costs associated with obtaining information and administration of contracts, and the magnitude of these transaction cost affects the make-or-buy decision. If the transaction costs are low, it is favourable to buy a product from the open market. However, if the transaction costs are high, it is better to produce the product in-house. A firm can exist when the cost of carrying out the transactions within its organisation is lower than the cost of carrying out the same transactions in the free market. On the other hand, it is not profitable to establish a firm if its internal transaction costs are higher than what it would cost to perform the transactions in the free market. Coase's work opposed the mainstream neoclassical economic theory at the time, which assumed that the market can be coordinated without any cost and where institutional phenomena received little attention (Richter, 2005; Walker and Kwong Wing, 1999).

> *"All that was needed was to recognize that there were costs of carrying out market transactions and to incorporate them into the analysis, something which economists had failed to do" (Coase, 1988, p. 19)*

Coase's work received little attention at the time, but the impact of *The Nature of The Firm* gradually improved during the 1970s and the number of citations increased (Cheung, 1983). Eventually, this laid the foundation for the *New Institutional Economics* paradigm where "the transaction" itself is the core unit of analysis (Richter, 2005) through major contributions by authors such as Alchian and Demsetz (1972), Williamson (1971) and Arrow (1969). Four decades earlier, Coase (1937) had pointed out that whether a transaction would be carried out within a firm or by contracting it to the market depended on if it is cheaper to carry out market transactions or if it is cheaper to carry out the transactions within the firm. However, Coase had not discussed in detail what causes these transaction costs. The research thread was picked up when researchers such as Arrow (1969) and Williamson (1971) discussed market failure mechanisms and choice of governance structures. Williamson (1975) pointed out that opportunism in combination with bounded rationality, uncertainty or high asset specificity leads to transaction costs as the parties invest in mechanisms to secure their own interests. The elements that determine the cost of conducting a specific transaction are synthesised in Figure 2-4. These are based on a set of human factors and a set of environmental factors which are referred to as behavioural assumptions and transaction dimensions (Rindfleisch and Heide, 1997; Williamson, 1985).

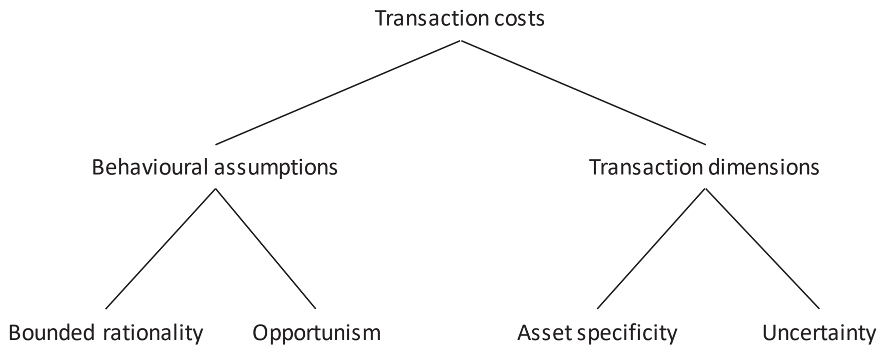



***Figure 2-4: Transaction cost framework, adopted from (Rindfleisch and Heide, 1997; Williamson, 1985)***

Asset specificity describes the uniqueness, i.e. to which extent investments are locked and specific to a certain transaction (Williamson, 1981; Klein et al., 1978). Bounded rationality relates to the limited capacity the human mind has to process information and solve complex problems (Simon, 1957). Opportunism is defined as *"…Self-interest seeking with guile: agents who are skilled at dissembling realize transactional advantages"* (Williamson, 1971, p. 255). If bounded rationality and uncertainty are linked with opportunism, problems occur. Opportunistic agents can then exploit this uncertainty to deceive others while pursuing their own interest (Williamson, 1996; 1985; 1975) by, for example:

- Providing incomplete information
- Disclosure of information
- Calculated efforts to mislead, distort or confuse

One should safeguard transactions against the threats from opportunism, and Williamson (1996) clarifies the assumption of opportunistic behaviour by stating that:

> *"To assume, moreover, that human agents are opportunistic does not mean that all are continually given to opportunism. Rather, the assumption is that*

> *some individuals are opportunistic some of the time and that it is costly to ascertain differential trustworthiness ex ante" (Williamson, 1996, p. 48)*

In order to avoid harm from a possible opportunistic agent, the principal may choose to monitor and control its agent by the use of various measures and governance. Such measures may typically include observation of the agent's behaviour, establishing operating rules and writing detailed specifications and contract documents (Pratt and Zeckhauser, 1991; Eisenhardt, 1985; Jensen, 1983; Jensen and Meckling, 1976).

Transaction cost economics has gradually evolved from its origins firmly anchored in the field of economics to application in other fields, such as for example supply chain management. Transaction costs economics has also more recently been applied by some project management researchers (Li et al., 2014; Rajeh et al., 2013; Turner, 2004). In a typical project, uncertainty is high in the beginning and gradually reduced as the project proceeds (Pinto, 2010). At the same time, the asset specificity increases as the client becomes more and more locked to its contractors and the cost of replacing contractors increases as the project proceeds (Winch, 2001). The client may be faced with opportunism in both these phases. In the first phase, when uncertainty is high, contractors may use their superior knowledge by, for example, opportunistic bidding where they speculate in the high uncertainty and offer a lower price with the aim of claiming extra payment later through issuing variation order requests. Similarly, an opportunistic client may try to speculate in uncertainty by, for example, sneaking changes into a work scope that was originally agreed with the contractor. In the later project phases, where uncertainty is lower, opportunistic contractors may speculate in the fact that the asset specificity is high and that it is difficult for the client to replace its contractor. This asset specificity may also be exploited by the client, as the contractor is also locked into the project and it is difficult for a contractor to leave the project once the contract is signed.

### Asset specificity and selection of governance structure

> *"Asset specificity is both the most important dimension for describing transactions and the most neglected attribute in prior studies of organizations" (Williamson, 1981, p. 555)*

The concept of asset specificity deserves further elaboration, as it is a key element in transaction cost theory. It is used to describe the extent to which investments are specific to a certain transaction (Williamson, 1981; Klein et al., 1978). The concept of such asset specificity originates from the concept of quasi-rent value that was introduced in the *Principles of Economics* in 1890 by Alfred Marshall to describe a situation where a producer, due to increased market demand for his goods, could claim a higher price than he needed to cover his investment and operating cost (Marshall, 1890). A commonly cited definition of the term *quasi-rent value* is provided by (Klein et al., 1978, p. 298) as follows:

> *"The quasi-rent value of the asset is the excess of its value over its salvage value, that is, its value in its next best use to another renter. The potentially appropriable specialized portion of the quasi rent is that portion, if any, in excess of its value to the second highest-valuing user." (Klein et al., 1978, p. 298)*

Williamson (1971) pointed out that certain assets are specific (and often locked) to a certain transaction and that quasi rents then can be exploited by an opportunistic counterpart (Shi et al., 2018). For example, a supplier may be asked to double its current production of very specialised parts to a client. After the supplier has installed several more machines in its factory to meet this demand, the client may be tempted to re-negotiate the price for these parts, knowing that the supplier has already installed the new specialised machines in the factory to make these parts, and that it would take substantial extra costs (quasi rents) for the supplier to adjust its production to produce other parts that they can sell to another client. Such *asset specificities* fall into six categories: site specificity, physical asset specificity, human asset specificity, dedicated assets, brand name capital and temporal specificity (Williamson, 1991). The different asset specificities are further described in Table 2-1.

***Table 2-1: Asset specificities***

| Type of asset specificity | Reference |
|---|---|
| **Site specificity** (costly or impossible to re-locate)<br><br>Example: The location of a coal mine is specific to the location of the coal deposit and cannot be moved. | (Klein et al., 1978)<br>(Williamson, 1991; Williamson, 1981) |
| **Physical asset specificity** (specialised equipment)<br><br>Example: A ship constructed to transport liquefied natural gas cannot be used to transport other goods.<br><br>Materials purchased for construction of a specific building cannot be transferred to another project without additional costs. | (Klein et al., 1978)<br>(Shi et al., 2018; Williamson, 1991; Williamson, 1981) |
| **Human asset specificity** (learning by doing)<br><br>Example: Skills that are only valuable within a specific organisation. For example, having learned to use the company's internal quality system. | (Williamson, 1991; Williamson, 1981) |

| | |
|---|---|
| **Dedicated assets** (reserved capacity)<br><br>Example: A factory that increases its capacity in order to sell a significant number of products to a specific customer. | (Williamson, 1991; Williamson, 1983) |
| **Brand name capital** (reputation effect)<br><br>Example: It is important for a company that is famous for producing high quality cars that all components have sufficient quality. If not, the company could lose its reputation. | (Williamson, 1991; Klein et al., 1978) |
| **Temporal specificity** (available when needed)<br><br>Example: it is important for a newspaper that a printing press is available at the right time to ensure the next day's newspapers are delivered in the morning. | (Williamson, 1991) (Masten et al., 1991) |

Vertical integration, as opposed to market procurement and outsourcing, is a commonly used term in economics. For a definition one can look to Riordan (1995p. 356) who states that: "*Vertical integration is the organization of two successive production processes by a single firm*". A commonly used illustration of vertical integration is the "Fisher Body – General Motors case" where General Motors in 1926 acquired Fisher Body, a company that supplied auto bodies to General Motors (Klein, 1988; Klein et al., 1978). A more modern example of vertical integration is when Google acquired Motorola in 2011 in order to develop its own mobile phone (Chiu et al., 2016). In transaction cost economics, the type of investments affects the choice of whether to vertically integrate or utilise the market. Investments that are specific and locked to a specific transaction will typically favour vertical integration due to the high quasi rent value that could be subject to hold-up by another party with opportunistic behaviour, leading to increased governance cost (Williamson, 1996; Williamson, 1991; Klein et al., 1978). The relationship between asset specificity and governance costs is illustrated in Figure 2-5. Transactions with low asset specificity have low governance costs and are therefore most efficiently carried out in the free market, while transactions with high asset specificity require more governance and are therefore most efficiently carried out by vertical integration (hierarchy).

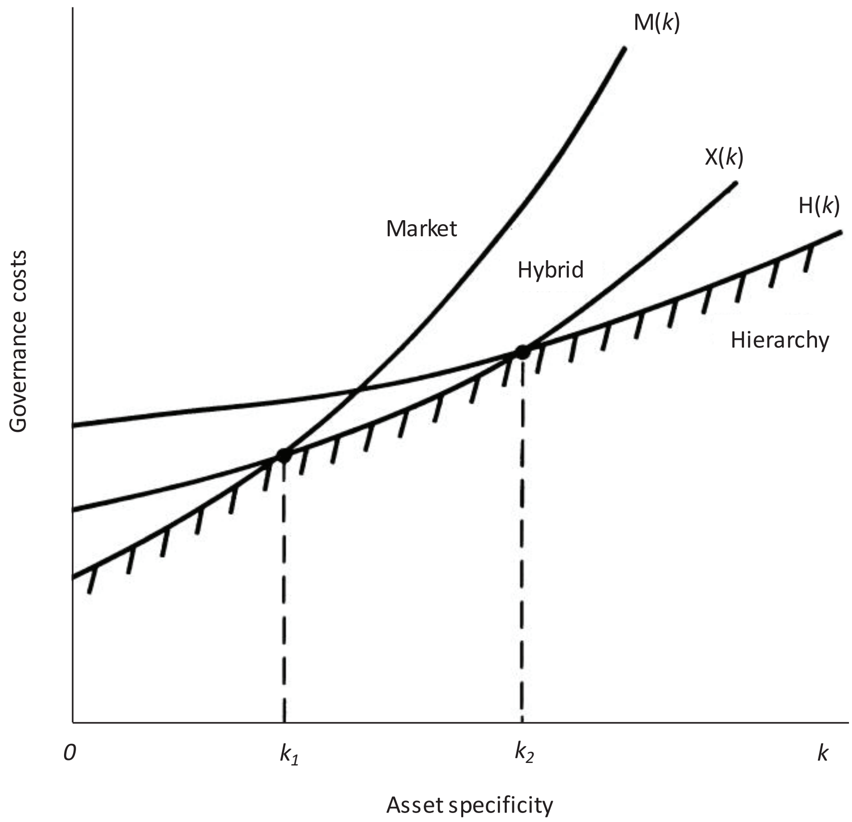



***Figure 2-5: Governance costs as a function of asset specificity, redrawn from (Williamson, 1991, p. 284)***

### Principal-agent problems

Principal-agent problems refer to various situations in the relationship between the principal (the client) and its agent (the contractor doing work on behalf of the client) where one of the parties uses its superior knowledge to exploit the other party (Arrow, 1991; Jensen and Meckling, 1976; Mitnick, 1973; Ross, 1973). The principal's problem is to motivate the agent to act in a way that is in alignment with reaching the principal's goals rather than the agent's own goals, (Jensen and Meckling, 1976; Mitnick, 1973; Ross, 1973). Situations where one party in a transaction possesses more information or knowledge than the other party are often referred to as situations of *asymmetric information* (Akerlof, 1970; Arrow, 1963). The agent who will perform the work on behalf of the principal may have more knowledge about the details and risks involved with the work to be carried out than the principal who hired him. To safeguard its interests, the principal invests in control mechanisms.

The term *adverse selection* is commonly used to describe the situation where information asymmetry between a principal and its agent leads to decisions that do not give the optimal result (Akerlof, 1970; Arrow, 1969). In agency relationships, the agent normally has more detailed knowledge about the subject than the principal that he serves (Pratt and Zeckhauser, 1991). Such information asymmetry in a project may lead the client (principal) to choose a contractor (agent) that may in fact not turn out to be the best contractor for the job (Forsythe et al., 2015; Müller and Turner, 2005). Often the contractor offering the lowest price is not the most favourable contractor for the client to choose in the long run (Lædre, 2014). In order to select the best contractor, both the organisational culture and the trustworthiness of potential bidders must be considered (Kadefors et al., 2007). Another example of a situation where the client may need to safeguard its interests is *small number bargaining.* If the number of alternative contractors is low, a contractor may choose to utilise its bargaining power to claim a higher price (Levy, 1985; Klein et al., 1978). Once a relationship between two parties exists, *hold-up problems* can occur as the contractor may try to hold up the client and re-negotiate a better deal (Klein et al., 1978). Goldberg (1976) illustrates this with the mechanic who takes apart your car and then demand three times the agreed price to put it back together. *Moral hazard* describes the situation where one party is depending on the behaviour of the other (Alchian and Woodward, 1988). A commonly used example is how an individual after purchasing insurance against an unwanted event may act more carelessly, and thus increase the probability of the event occurring. Since the cost from this event is paid for by the insurance company and not by the person itself, the person does not any longer have an incentive to act with care to prevent the event from occurring (Rothschild and Stiglitz, 1976; Arrow, 1963). If the negative consequences of an event only affect the principal, an agent, because of self-interest, may have an incentive to take a higher risk than what is beneficial for the principal (Alchian and Woodward, 1988). An example of moral hazard in construction projects is a contractor who chooses to use low quality materials when designing a building to reduce the construction cost. This may cause negative consequences for the owner of the building in the future, but not for the contractor who designed the building, (Xiang et al., 2015).

Furthermore, incomplete contracts where the principal is not able to specify all details may lead to *haggling problems* with the contractor (Williamson, 1996). To safeguard its interest against a contactor that underperforms or conducts work with poor quality, the client may need to monitor the execution of the contractor's work closely. This leads to *shirking costs* (Alchian and Demsetz, 1972).

### Critics and evidence for transaction cost economics

One should be aware that there have been some critics of transaction cost economics since the 1980s. Transaction costs economics has been accused of neglecting how social relations affect behaviour and institutions (Granovetter, 1985) and criticised for a lack of empirical support for the theory (Ghoshal and Moran, 1996; Simon, 1991). This view was opposed by Shelanski and Klein (1995), who studied the findings from more than 100 empirical studies and found these to be consistent with predictions from the transaction cost framework. Another study of 45 articles concluded that there was mixed empirical support for the theory (Rindfleisch and Heide, 1997). In 2004, a systematic review was performed with the purpose of providing more facts to inform the debate related to empirical support for transaction cost economics. From 308 statistical tests performed on 63 articles, David and Han (2004) found that 47% of the tests supported the transaction costs economics theory, 43% were inconclusive and 10% refuted the theory. Later, several reviews of empirical studies suggest that there is strong evidence that the empirical research is consistent with transaction cost predictions (Macher and Richman, 2008; Lafontaine and Slade, 2007; Geyskens et al., 2006).

> *"The weight of evidence is overwhelming. Indeed virtually all predictions from transaction-cost analysis appear to be borne out by the data" (Lafontaine and Slade, 2007, p. 658) .*

> *"...today transaction cost theory stands on a remarkably broad empirical foundation" (Geyskens et al., 2006, p. 531)*

In his Nobel Prize lecture in 2009, Williamson pointed out that transaction cost economics has been strengthened through a large number of empirical tests, where the total number of tests exceeded 800 in 2006 (Williamson, 2009). In the statement given by the Nobel Prize committee, they highlight the high amount of evidence supporting transaction cost economics (Kunglege-vetenskaps-akademien, 2009).

The framework of transaction cost economics has also been applied by some researchers within the field of project management (Li et al., 2014; Rajeh et al., 2013) and it can be combined with project management theory (Walker, 1999). Transaction costs explain the governance structure applied in a project (Muller, 2009). For example, if the client has low trust in its contractor and suspects that the contractor may be opportunistic, the client may need to incorporate more control to safeguard its interests (Kadefors, 2004).

### 2.2.2 Opportunistic behaviour between clients and contractors

A summary of identified research on opportunistic behaviour in projects after year 2000 is presented in Table 2-2. Opportunistic behaviour has a negative effect on collaboration (Ning, 2018) and causes transaction costs (Ho et al., 2015). Some contractors may choose to prepare opportunistic bids to win a job only to file a high number of claims to the client later (Mohamed et al., 2011; Rooke et al., 2004).

A low level of trust was found by Kadefors (2004) in client-contractor relationships in Swedish construction projects. These contractors were often found to be opportunistic and took advantage of mistakes, changes and omissions in contract documents in order to claim additional payment from the client. To prevent contractor opportunism, clients prepared detailed specifications in contract documents and closely monitored contractors during the execution of the project. This led to high transaction costs for the client. Similar findings are also presented by Pinto et al. (2009) who performed an empirical study of large construction projects in Canada and found that trust between actors contributes to reduced transaction costs.

***Table 2-2: Research published since year 2000 on opportunistic behaviour in client-contractor relations in projects***

| Opportunistic behaviour | Discussed by |
|---|---|
| **Opportunistic bidding**<br><br>Reduce margins in bids and seek profit recovery by claims.<br><br>Submit unbalanced bids by exploiting information asymmetry. | (Nyström, 2015)<br>(Mohamed et al., 2011)<br>(Arditi and Chotibhongs, 2009)<br>(Tan et al., 2008)<br>(Lo et al., 2007)<br>(Ho and Liu, 2004)<br>(Rooke et al., 2004)<br>(Ngai et al., 2002) |
| **Take advantage of uncertainty or mistakes by others**<br>Search for mistakes and omissions in principal's documentation to build claim.<br>Take advantage of changes and variations to scope. | (You et al., 2018)<br>(Ho et al., 2015)<br>(Manu et al., 2015)<br>(Mandell and Nyström, 2013)<br>(Pinto et al., 2009)<br>(Kadefors, 2004) |
| **Strategic misrepresentation**<br>Use of false or misleading information to get acceptance for project.<br>Withhold information on purpose. | (Andersen et al., 2016)<br>(Pinto, 2013)<br>(Flyvbjerg, 2009)<br>(Flyvbjerg, 2005)<br>(Flyvbjerg et al., 2002) |
| **Strategic time overruns**<br>Delay production on purpose to optimise use of production facility | (D'Alpaos et al., 2013) |

### Opportunistic bidding

In competition with others, contractors may choose to lower their margins and reduce their price in order to increase their chances of winning the contract with a client (Mohamed et al., 2011; Arditi and Chotibhongs, 2009; Tan et al., 2008; Ngai et al., 2002). In some cases a contractor may even choose to bid a price with negative margin (lower than his own cost) and speculate that he will recover the loss later through claims against the client (Lo et al., 2007). The overall project cost for the client may then turn out to be significantly higher in the end than the price offered by the bidder prior to contract award.

A bid that does not reflect the actual costs for the units in unit price contracts is often referred to as an unbalanced bid (Arditi and Chotibhongs, 2009). If contractors have better knowledge than the client does about the actual quantities needed, they may exploit this situation of asymmetric information to skew their unit prices and bid strategically. This is typically done by lowering the price for items where the client has overestimated the quantity and raising the price on items where the client has underestimated the total quantity needed (Mandell and Nyström, 2013).

A mathematical model is proposed by Arditi and Chotibhongs (2009) to assist clients to detect bids that do not reflect a reasonable price. A preventive approach is suggested by Hyari (2016) where clients can re-balance bids to reduce the negative effects from bids that do not reflect a reasonable price and are skewed. However, Nyström (2015) tested the hypothesis of unbalanced bidding in 15 Swedish road projects and did not find evidence of unbalanced bidding.

### Take advantage of uncertainty or mistakes by others

Research on client-contractor relations in Swedish construction projects is presented by Kadefors (2004). She studied the influence of trust and found a low level of trust between client and contractors in traditional projects. Contractors are often opportunistic and take advantage of mistakes, changes and omissions in contract documents in order to claim additional payment from the client. To prevent contractor opportunism, Kadefors (2004) found that clients prepare detailed specifications in contract documents and closely monitor contractors during the execution of the projects. Similar findings are also presented by Pinto et al. (2009), who performed an empirical study of large construction projects in Canada.

In a case study of four construction projects, Manu et al. (2015) studied the relationships between the main contractor and its subcontractors. They found that changes to work scope was a major source of conflict and disputes as it was not always practically possible to handle these changes in accordance with the change management procedures. Under these circumstances, the contractor had to trust that the subcontractor would not act opportunistically. However, some subcontractors took advantage of the situation and claimed variations that were not reasonable. For the subcontractors it was important that the contractor was fair and reasonable when negotiating payment for variations that had been made based on verbal instructions.

### Strategic misrepresentation

The term *strategic misrepresentation* was used by Flyvbjerg et al. (2002) to describe the situation where costs for projects are underestimated to make it easier to gain approval for the project. It is argued by Flyvbjerg et al. (2009) that self-interest and asymmetric information are among the causes of strategic deception in the relationship between the principal and his agent in any level of principal-agent relationship.

In a study of the politics of megaproject approval, Flyvbjerg (2005) found that costs were underestimated in 9 out of 10 projects and found evidence of manipulation. "*Again, many forecasters deliberately manipulate costs and benefits to* *help projects get approved*" (Flyvbjerg, 2005, p. 57). Research on cost overruns for the Olympic Games (Flyvbjerg and Stewart, 2012) and IT projects (Flyvbjerg and Budzier, 2011) suggests that strategic misrepresentation is present in several industries and a worldwide phenomenon. The research by Flyvbjerg has received criticism from Eliasson and Fosgerau (2013), who argue that although Flyvbjerg identifies significant cost overruns his research does not provide sufficient evidence to claim that this is caused by deception or lies. The research by Flyvbjerg mainly compares the actual project cost with the estimate at the time of project approval (Kreiner, 2020).

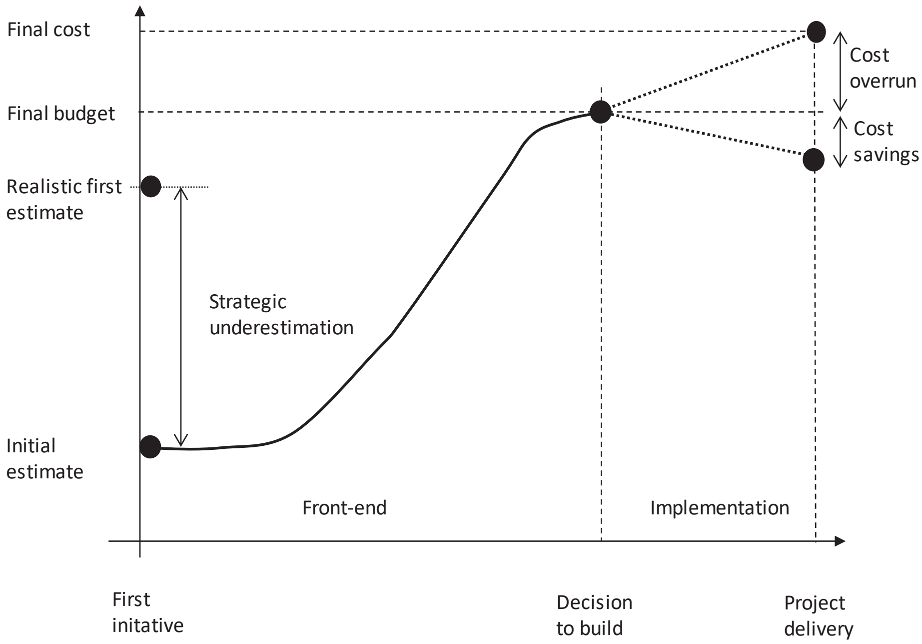



***Figure 2-6: Upfront underestimation, redrawn from (Andersen et al., 2016, p. 175)***

This is taken further by Andersen et al. (2016), who expanded the research to include the front-end phase based on their suspicion that the change in cost estimates in this phase may also be significant. They studied the change in cost estimates from the first initial estimates in 12 high profile projects in Norway and the findings are synthesised in Figure 2-6. They found significant underestimation, especially in the front-end phase, and that strategic underestimation was one of several dominant causes for this.

#### Strategic time overruns

Strategic time overruns describe the situation where a contractor chooses to delay the production or the delivery of the works to the client in order to optimise the use of its production facility. To prevent this, clients often includes penalties in the contract linked to delivery date. Depending on the magnitude of the penalty, a contractor may still choose to delay delivery if his benefits from this exceed the imposed penalty (D'Alpaos et al., 2013).

### 2.2.3 The size of transaction costs in projects

When describing transaction costs in projects it is common to split transaction costs into *pre-contract* transaction costs and *post-contract* transaction costs (Li et al., 2015). Pre-contract transaction costs refer to the costs before the contract with a contractor is signed. Typically, these include the costs associated with preparing feasibility studies, preparing tender documentation and negotiating the contract with bidders. Post-contract transaction costs refer to the cost of monitoring and controlling the project during its execution and also includes potential costs from disputes (Li et al., 2015).

Based on a review of existing literature, Li et al. (2015) present factors that determine potential project transaction costs. These are grouped in four categories, which are: the role of the owner, the role of the contractor, the transaction environment and project management efficiency. In total, these four categories consist of 26 different factors that affect transaction costs in projects, as can be seen in Figure 2-7.

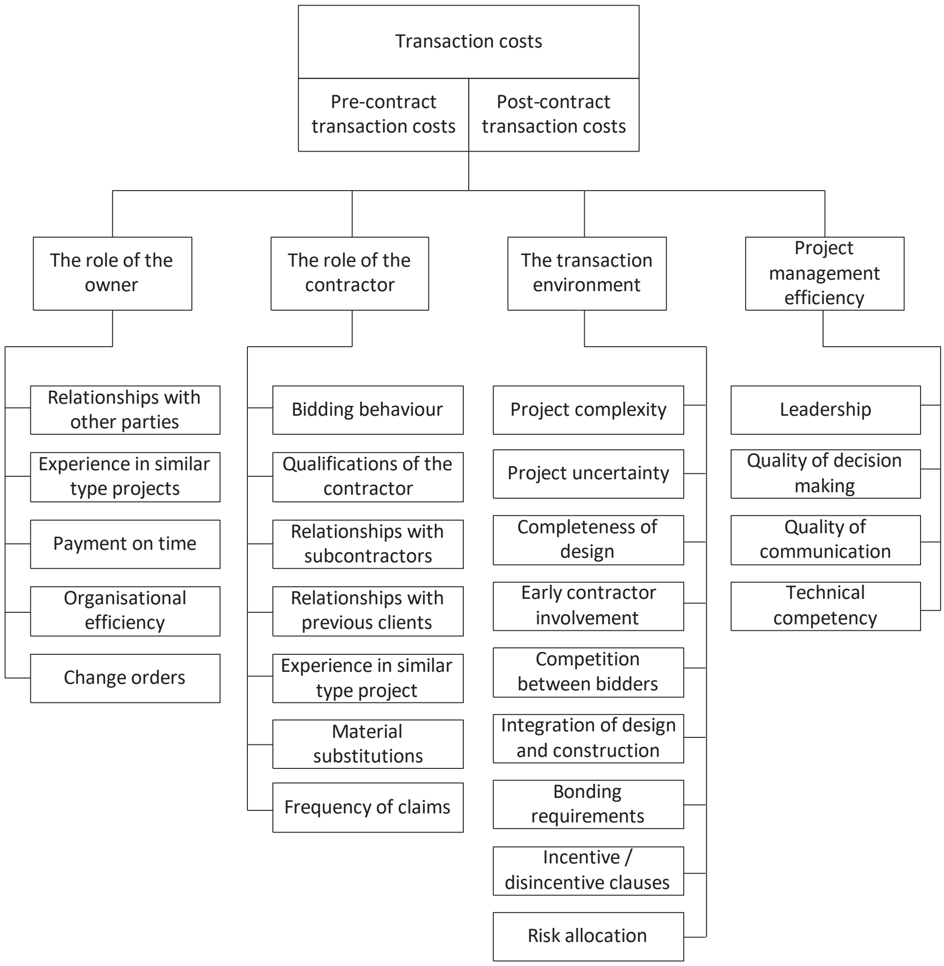



***Figure 2-7: Determinants of transaction costs in projects, redrawn from (Li et al., 2015, p. 550)***

The owner's behaviour affects the direct transaction costs but also has an indirect effect, as it has an impact on the uncertainty in the transaction environment. By involving contractors early, clearly defining the work scope, harmonising relationships and making sure that risk allocation is fair between the parties, project transaction costs can be reduced (Guo et al., 2016; Li et al., 2013). The contractor's behaviour when bidding and executing the work is also found to impact such project transaction costs (Li et al., 2013). Furthermore, high project management efficiency through leadership, good decision making, effective communication, proper conflict management and a high degree of technical competence helps to reduce these project transaction costs (Li et al., 2013).

### Project management - a transaction cost

Project transaction costs are those costs that are not directly related to production, but costs associated with managing and controlling the project (da Fonseca et al., 2018; Li et al., 2015; Rajeh et al., 2013). Such activities include: preparing bid documents (De Schepper et al., 2015), project administration (Li et al., 2015), travelling (da Fonseca et al., 2018), managing changes (Guo et al., 2016), conflict resolution (Tang et al., 2020), verifications, site visits and meetings (Rajeh et al., 2015), etc.

Based on a literature study, Rajeh et al. (2013) developed a conceptual framework to measure transaction costs in construction projects by measuring project management activities. This framework describes different activities that should be measured in order to quantify a project's transaction costs, and it is shown in Table 2-3. The various measures for transaction costs presented here are all examples of activities from the five process groups in PMBOK, activities related to managing the project (PMI, 2017). Walker and Kwong Wing (1999) argue that project management is entirely a transaction cost, a view that is supported by more recent research by others such as (da Fonseca et al., 2018; Li et al., 2015; Lee et al., 2009).

***Table 2-3: Constructs and initial measures of transaction costs, adopted from (Rajeh et al., 2013, p. 249)***

| **Transaction cost measure** | **Description and examples** |
|---|---|
| Information gathering | Getting information about contractors, behaviour, market, prices and materials |
| Communication | Communicating with stakeholders to identify uncertainties |
| Attending meetings | Bid clarification meetings, pre-construction meetings |
| Translation of client's needs | Writing specifications and functional requirements that describe the scope of work for the contractor |
| Project preliminary design | First phase of the design process, coordinating design teams |
| Transition observation | Change to procedures and roles of responsibilities |
| Training | Training to improve performance |
| Site visits | Site visits are typically used for coordination, inspection, resolving disputes, or clarifications |
| Contract administration | Administration of contract documents and process change orders and claims |
| Conflict resolution | Negotiation and mediation with an aim to resolve and find effective resolutions to disputes |
| Decision making | Handling of problems, making policies and coordinating with stakeholders |
| Contract enforcement | Monitoring and controlling the work and carrying out enforcement mechanisms |
| Verifying compliances | Conducting inspections and control to verify that deliverables are in compliance with client's needs |

Following the above argumentation that project management is a transaction cost, one may reach a premature conclusion that since project management activities are transaction costs they should be eliminated. However, one should be aware that transaction costs are not equivalent to "waste" but rather the necessary cost associated with operating the economic systems (Williamson, 1996). In fact, Williamson (1979) emphasises that this is rather an optimisation problem where the aim is to find the optimal balance between production and transaction costs:

> "*The object is to economize on the sum of production and transaction costs*" *(Williamson, 1979, p. 245)*

The aim is to maximise value (Ballard and Howell, 2003) by minimising the total sum of production- and transaction costs as expressed in Equation 1. If reducing transaction costs leads to higher production costs, the total costs of a project may increase. In a project context, simply eliminating project management activities would lead to poor performance and failing projects. Project management is a necessary transaction cost to ensure successful projects (Haq et al., 2018; Walker and Kwong Wing, 1999).

***Equation 1: (Ikuabe et al., 2020; Lee et al., 2009; Walker and Kwong Wing, 1999; Williamson, 1979)***

$$Total\ project\ cost = Production\ costs + Transaction\ costs$$

### 2.2.4 Existing studies that quantify project transaction costs

There are few existing empirical studies that quantify and measure the transaction costs in projects (da Fonseca et al., 2018; Guo et al., 2016; Li et al., 2014). Table 2-4 shows a summary of the existing research that was found in a literature search on studies that have attempted to measure and quantify project transaction costs. In general, the purpose of several of these existing studies has been to compare transaction costs between projects that used different procurement methods or different contract arrangements.

*Table 2-4: Quantitative research on project transaction costs since year 2000*

| Reference | Quantified transaction costs in projects |
|---|---|
| (Dudkin and Välilä, 2006) | Contractor's pre-contract transaction costs<br>Pre-contract, 55 EU construction projects<br>>10% of total project cost |
| (Li et al., 2014) | Client's transaction costs<br>1-3% of total project cost in pre-contract phase<br>3-7% of total project cost in post-contract phase |
| (Farajian, 2010) | Contractor's pre-contract transaction costs<br>Two case studies of US highway projects<br>0.3%-1.1% of total project cost in procurement phase |
| (De Schepper et al., 2015) | Pre-contract, Belgian infrastructure projects, Contractors<br>1.7% of total project cost for public-private partnership (PPP) projects<br>0.7% of total project cost for traditional public procurement (TPP) projects |
| (Soliño and Gago de Santos, 2010) | Contractor's pre-contract transaction costs<br>EU infrastructure projects:<br>3-10% of project cost depending on procurement procedure |
| (Whittington, 2008) | Case study of client's transaction costs in six US highway projects with different delivery methods.<br>Design-bid-build: 15% of total project cost<br>Design-build: 12% of total project cost |
| (Petersen et al., 2018) | Contractor's transaction cost in the pre-contract phase is 5% of the total project cost |

Some of the research covers both pre-contract and post-contract transaction costs (Li et al., 2014; Soliño and Gago de Santos, 2010; Whittington, 2008) while the research by (Petersen et al., 2018; De Schepper et al., 2015; Farajian, 2010; Dudkin and Välilä, 2006) covers only the pre-contract transaction costs. The quantified numbers vary significantly between the studies. For example, Dudkin and Välilä

(2006) found that pre-contract transaction costs accounted for more than 10% of the total project value as opposed to De Schepper et al. (2015) who find pre-contract transaction costs to be lower than 2%.

The quantified numbers in Table 2-4 are not directly comparable, as the studies cover different project phases and are limited to different perspectives. For example, some studies are limited to either the pre-contract or post-contract transaction costs while other studies are limited to the client or the contractor perspective.

In addition, there is a variety of which elements of transaction costs that have been studied. For example, the study by Farajian (2010) is based only on the transaction costs that are actually categorised and recorded as transaction costs by the project team during the procurement phase of two projects. Farajian (2010) argues that the actual transaction costs most likely are significantly higher, since there are several transaction activities that are not covered in the study.

De Schepper et al. (2015) studied transaction costs in Belgian infrastructure projects. They found that transaction costs were significant higher in public-private partnership (PPP) arrangements than in traditional public procurement (TPP) arrangements. Also, the specific investments made by contractors during the tendering process were significantly higher in PPP arrangements.

In her doctoral dissertation, Whittington (2008) studied transaction costs in six highway projects in the United States to see if there were significant differences in transaction costs depending on which project delivery method was used. She found that transaction costs in the projects that used design-bid-build were on average 15% of the total value compared with 12% for the projects that used design-build.

In two articles, Li, Arditi and Wang (Li et al., 2014; Li et al., 2013) also study the factors that affect project transaction cost. They conducted a questionnaire survey aimed at various construction clients and found that factors such as uncertainty in the project environment, project management efficiency and the behaviour of contractors affected the transaction costs. They also found that transaction costs were significantly higher in the post-contract phase and that projects with unit-price compensation format suffered higher transaction costs than projects that utilised a lump sum or cost-plus compensation format. Furthermore, they found that public projects suffered higher transaction costs than private projects. They found post-contract transaction costs in unit-price contracts to be 6.8%. In a study of infrastructure projects in the EU, Soliño and Gago de Santos (2010) found that transaction costs varied between 3% and 10% of the total project value depending on which procurement procedure was used.

The existing studies also vary between perspectives. From the seven studies that are listed in Table 2-4, five are limited to studying contractors' transaction costs (Petersen et al., 2018; De Schepper et al., 2015; Farajian, 2010; Soliño and Gago de Santos, 2010; Dudkin and Välilä, 2006). Li et al. (2014) and Whittington (2008) limit their studies to the client's transaction costs.

In summary, findings from the existing studies that attempt to quantify project transaction costs vary and most of the studies listed in Table 2-4 focus on the pre-contract phase. Only a few of the studies attempt to quantify post-contract project transaction costs. In addition, the existing studies vary between different perspectives. None of the studies listed above include both pre-contract and post-contract transaction costs as well as covering both the client and contractor perspectives.

## 2.3 Client-contractor collaboration

The term *collaboration* has been defined by the Institute for Collaborative Working as:

> *"Collaboration is a commitment between two or more parties to create value by striving to achieve shared competitive goals and operational benefit through a spirit of mutual trust and openness". (ICW, 2017, p. 29).*

In the following sub-chapters, the state-of-the-art research within the research field of collaboration in the relationship between a client and its contractor is presented.

### 2.3.1 Benefits from collaboration

Projects more often fail due to conflicts and cooperation issues than due to technical issues (Aarseth, 2014). The importance of organisational relations in projects has also been identified by others, such as (Ning and Ling, 2015; Young, 2015; Pinto, 2010; Davies et al., 2009; Winter et al., 2006). According to the synergy model by Bititci et al. (2007), the collaborating parties need to have a sufficient maturity level in order to be able to collaborate successfully and achieve win-win situations. Recent research on client-contractor relations has found that success factors are cooperation, sharing of knowledge, mutual ability to adapt and learn, openness and trust (Biong et al., 2016). In addition, soft elements such as trust, long-term commitment, cooperation and communication are important to achieve a high extent of collaboration (Yeung et al., 2007).

The importance of carrying out self-assessment to verify an organisation's readiness for collaboration with another company is highlighted in the "ISO 44001 Collaborative business relationships management systems" standard, which was launched in 2017. This is the first international standard that addresses collaborative business relationships, and it supersedes the previous British standard "BS 11000 Collaborative Business Relations" (ICW, 2017). Empirical research presented by Chakkol et al. (2018) reveals how using such collaborative standards is useful to formalise the collaboration practices between clients and contractors in complex projects.

### 2.3.2 Collaboration quality

A summary of elements that researchers have found to describe the quality of collaboration in the client-contractor relationship is presented in Table 2-5. Each of the following four elements will be further described: trust, communication, teamwork and coordination.

***Table 2-5: Elements describing collaboration quality, research after year 2000***

| Collaboration element | Reference |
|---|---|
| Trust | (Walker and Lloyd-Walker, 2016b)<br>(Chan et al., 2004)<br>(von Danwitz, 2018)<br>(Bond-Barnard et al., 2018)<br>(Pinto et al., 2009)<br>(Kadefors, 2004)<br>(Nevstad et al., 2018)<br>(Suprapto et al., 2015b)<br>(Ling et al., 2013)<br>(Yeung et al., 2007)<br>(Dietrich et al., 2010) |
| Communication | (Walker and Lloyd-Walker, 2016b)<br>(Dietrich et al., 2010)<br>(Chan et al., 2004)<br>(Badi and Pryke, 2015) |

| | |
|---|---|
| | (Aliakbarlou et al., 2018)<br>(Simatupang and Sridharan, 2005)<br>(Nevstad et al., 2018)<br>(Suprapto et al., 2015b)<br>(Yap et al., 2017)<br>(Hoegl and Gemuenden, 2001)<br>(Yeung et al., 2007) |
| Teamwork | (Aliakbarlou et al., 2018)<br>(Caniëls et al., 2019)<br>(Suprapto et al., 2016)<br>(Walker and Lloyd-Walker, 2016b)<br>(Hoegl and Gemuenden, 2001)<br>(von Danwitz, 2018)<br>(Ling et al., 2013) |
| Coordination | (Walker and Lloyd-Walker, 2016b)<br>(Dietrich et al., 2010)<br>(Chan et al., 2004)<br>(von Danwitz, 2018)<br>(Hoegl and Gemuenden, 2001)<br>(Ling et al., 2013)<br>(Dietrich et al., 2010) |

**Trust**

There is a positive relationship between trust and collaboration (Bond-Barnard et al., 2018; Pinto et al., 2009; Kadefors, 2004). Trust is defined by (Rousseau et al., 1998, p. 395) as follows: "*Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another*". Furthermore, trust can have different forms. Calculative trust follows rational choices (Rousseau et al., 1998) and can be tangible in terms of, for example, certificates (Kadefors, 2004). Relational trust is less tangible and develops over time based on previous behaviour, while institutional trust describes how circumstances necessary for trust are created through, for example, legal systems (Rousseau et al., 1998).

Openness that encourages sharing of both bad and good news is positively associated with trust (Suprapto et al., 2015b; McAllister, 1995). Having effective mechanisms to resolve issues is one of several factors that contribute to trust (Manu et al., 2015). Other elements of trust include role clarity (Henderson et al., 2016; Buvik and Rolfsen, 2015) and empowering team members and contractors with sufficient authority (Schoorman et al., 2007).

### Communication

Effective communication plays an important role in the collaborative relationship between clients and contractors (Aliakbarlou et al., 2018). It is important that that all parties communicate and understand the project's objectives and goals (Yeung et al., 2007). Poor communication can lead to misunderstandings and conflicts (Lædre, 2009; Young, 2006). The quality of communication is often best when there is a balance between formal and informal communication (Turner and Müller, 2004). Geographical co-location often leads to better communication and higher collaboration levels among the parties (Walker and Lloyd-Walker, 2015). Another example is how the use of shared workspaces facilitates better communication between different professions on construction sites (Christensen, 2008).

### Teamwork

Teamwork quality influences how well client and contractor teams collaborate (Hoegl and Gemuenden, 2001). Parties that achieve a high order of collaboration often demonstrate strong elements of a no-blame culture, consensus when making decisions, and a culture where the team members act for the best of the project instead of pursuing personal gains (Walker and Lloyd-Walker, 2015). Having team members with the right experience (Park and Lee, 2014; Patel et al., 2012) who are motivated by good leadership (Caniëls et al., 2019) contributes to a high-performing collaborative climate.

**Coordination**

Coordination describes the extent to which the parties have a common understanding of the goals and what activities need to be taken to achieve these (Dietrich et al., 2010). In order to collaborate, the parties must manage the interfaces between stakeholders effectively and ensure that resources are allocated where they are needed most (Chan et al., 2004). Having effective work processes to manage and coordinate activities and changes also contributes to improved collaboration (Simatupang and Sridharan, 2005).

### 2.3.3 Collaborative project delivery methods

In general terms, the process where a contractor is hired to perform work on behalf of a client can be separated into two main routes: towards integration or towards separation (Lædre, 2014). An outline of classical procurement routes for a project is synthesised in Figure 2-8. Choices that mean that the project is leaning towards a high degree of integration between the client and the contractor are shown towards the left side of the figure while choices leaning towards a higher degree of separation are shown to the right.

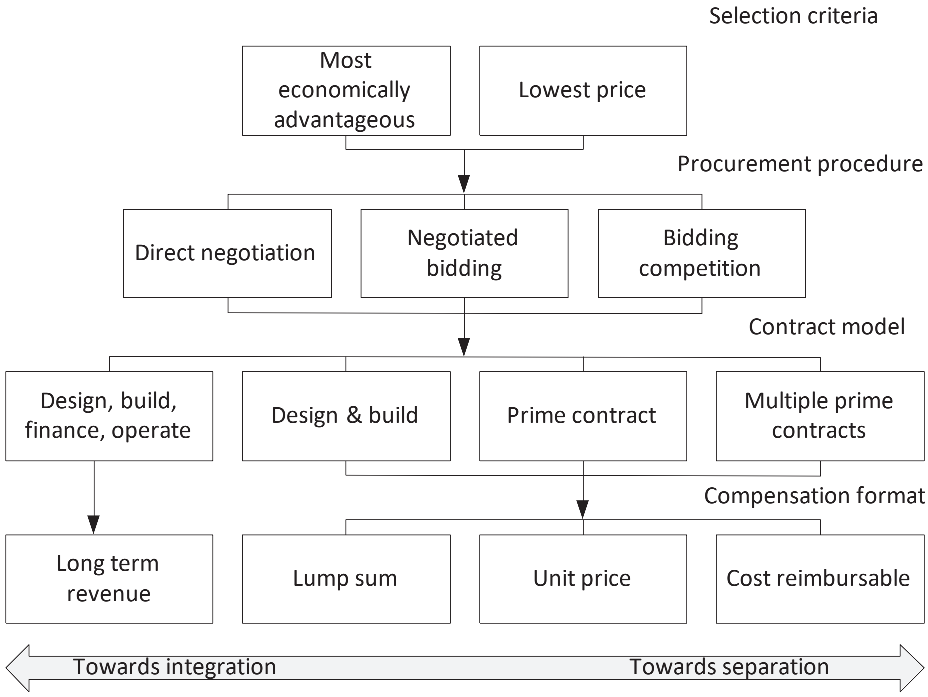



***Figure 2-8: Traditional procurement routes in construction, adopted from (Lædre, 2014, p. 50).***

However, as projects move even further towards integration, they may utilise collaborative project delivery methods. In a frequently cited literature review on collaborative delivery methods in construction, Lahdenperä (2012) found that such methods generally are split into three approaches that have much in common: partnering, alliancing and Integrated Project Delivery (IPD). Similarly, a more recent literature review by Engebø et al. (2020b) also found the same three to be the predominant collaborative delivery methods. Among these approaches, alliancing is the most extreme form of relational contracting (Walker and Lloyd-Walker, 2015; Lahdenperä, 2012). The categorisation shown in Figure 2-9 indicates that project alliances have a high level of both pain-share/gain-share incentives and early contractor involvement. In addition to these hard elements, soft elements such as trust, long-term commitment, cooperation and communication are also important to achieve a high extent of collaboration (Yeung et al., 2007).

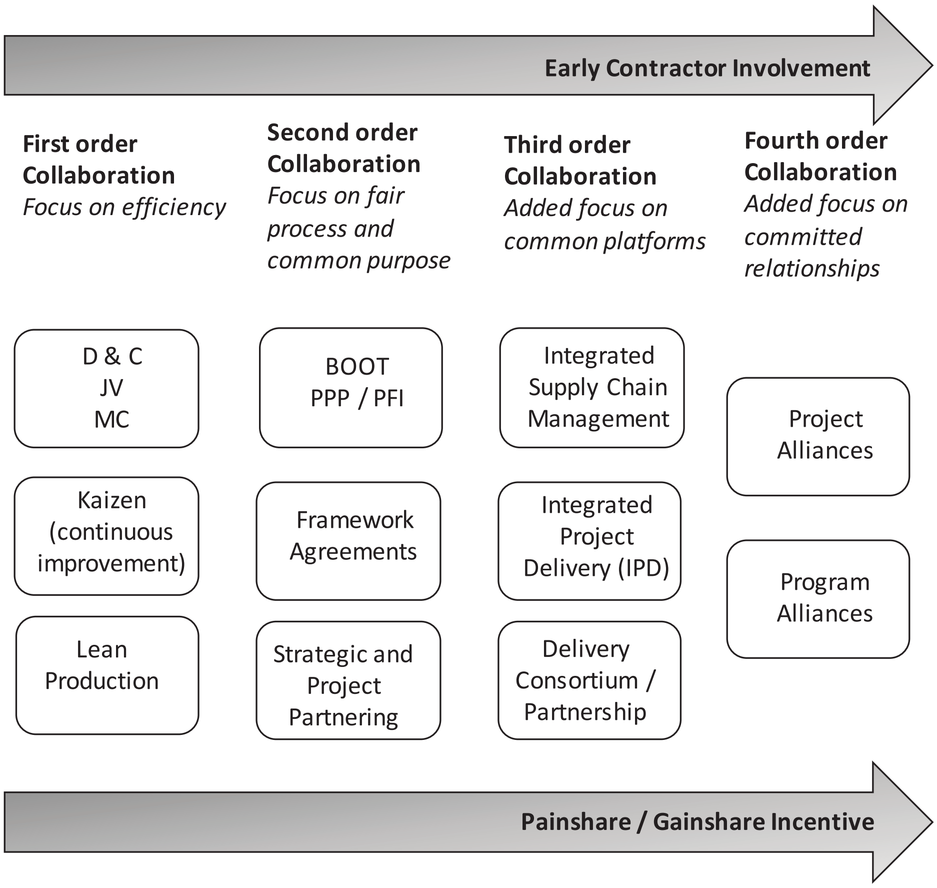



***Figure 2-9: Categorizing collaboration forms of project management delivery, redrawn from (Walker and Lloyd-Walker, 2015, p. 108)***

Contracts should be designed so that the interests of the client and the contractor are aligned in order to prevent opportunism (Eisenhardt, 1985). Contracts with fixed-price or cost-plus mechanism often have a negative impact on project collaboration between a principal and its agent (Müller and Turner, 2005). To foster cooperative behaviour from its contractor(s), the client should use contract mechanisms that also take into account what contractors need and not only focus on what is best for themselves, (Zhang et al., 2018a).

Collaboration should create win-win situations and ensure that all the parties gain economic advantages by participating (Bititci et al., 2004). There are several positive outcomes when client and contractors collaborate that enhance project success (Nevstad et al., 2018; Suprapto et al., 2016) and many of these are synthesised in Figure 2-10. For example, such outcomes includes: improved change order and issue resolution, more open and better understood communications reducing the potential of claims (Bygballe and Swärd, 2019; Børve, 2019).

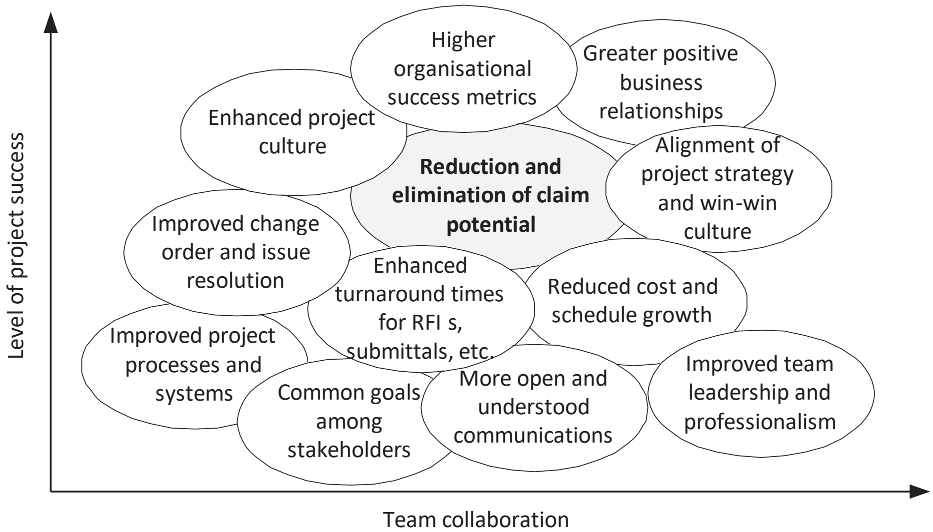



*Figure 2-10: Project partnering outcomes, redrawn from (Børve, 2019, p. 48)*

### 2.3.4 Collaboration mechanisms

The term *collaboration mechanisms* is used to describe actions that are taken to enhance collaborative behaviour (Dietrich et al., 2010). A summary that synthesises the main findings from a literature search on the topic collaboration mechanisms is presented in Table 2-6.

***Table 2-6: Collaboration mechanisms, findings from literature search***

| **Supporting Literature** | (Dietrich et al., 2010) | (Christensen, 2008) | (Eriksson et al., 2009) | (Kokkonen and Vaagaasar, 2018) | (Bosch-Sijtsema and Tjell, 2017) | (Ahola et al., 2017) | (Hosseini et al., 2016) | (Bresnen and Marshall, 2000) | (Bygballe and Swärd, 2019) | (Turner et al., 2019) | (Lloyd-walker et al., 2014) | (Walker and Lloyd-Walker, 2015) | (Bayliss et al., 2004) | (Aarseth et al., 2016) | (Wilkinson, 2005) | (Harley, 2011) | (Matthews et al., 2018) | (Erdogan et al., 2008) | (Smits and van Marrewijk, 2012) | (Karis et al., 2016) | (Cho and Ballard, 2011) | (Bond-Barnard et al., 2013) | (Singh et al., 2011) | (Sebastian, 2011) | (Porwal and Hewage, 2013) | (Merschbrock and Munkvold, 2015) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ID** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | ✓ | | | | | | |
| B | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | |
| C | ✓ | | ✓ | | | | | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| D | | | ✓ | | | | | ✓ | | | | | ✓ | ✓ | | | | | | | | | | | | |
| E | ✓ | | | | | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| F | | | | | | | ✓ | | ✓ | ✓ | | | ✓ | | | | | | | | ✓ | | ✓ | | | |
| G | ✓ | | | | | ✓ | | | | | | | | | | | | | ✓ | | | | | | | |
| H | | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | ✓ | | | | | |
| I | ✓ | | | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | | | | | ✓ | | | | | |
| J | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | | |
| K | | | ✓ | | | | | | | | | ✓ | | | | | | | | ✓ | | | | | | |
| L | | | | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | | |

| |
|---|
| **A**: Co-locate teams, adjust the physical workspace |
| **B:** Hold kick-off meeting to clarify expectations and establish ground rules for collaboration |
| **C**: Share IT solutions |
| **D:** Frequent use of social activities and teambuilding |
| **E**: Spend time with key decision makers and stakeholders |
| **F:** Hold regular multidisciplinary work sessions |
| **G**: Use external collaboration facilitators - Chaperoning |
| **H**: Involve contractors and users early in planning |
| **I**:  Use collaborative procurement methods |
| **J:** Open up books and share both bad and good news |
| **K**: Encourage frequent travelling to work sites and meetings. Increase travel budget |
| **L**: Use advanced communication tools and video conferencing systems |

Co-locating the teams from the client and contractor increases informal communication (Eriksson et al., 2009; Christensen, 2008). Through regular contact and meetings, the contractor can better understand the client's true problem, and establishing common rules helps to build trust (Turner et al., 2019). In a Danish case study Christensen (2008) found that establishing a common building and work shed for all the people on a construction site improved the learning and social relations between the workers from different contractors. In addition to the co-location itself, adjusting the physical workspace in the building where teams work together improves informal communication and fosters collaboration (Kokkonen and Vaagaasar, 2018). Adjusting the physical workspace in the project and creating open spaces that allow for increased face-to-face communication are other examples of methods that contribute to collaborative behaviour (Bosch-Sijtsema and Tjell, 2017).

In their case study, Eriksson et al. (2009) described how a Swedish construction project used several different mechanisms to overcome collaborative barriers. The collaborative mechanisms that they identified included sharing IT systems, arranging social teambuilding events and collaboration workshops, and co-locating the project office to the construction site. In another case study, Ahola et al. (2017) describe several mechanisms that were used to improve the collaboration between the contractors and the client in a complex oil and gas delivery project. These mechanisms included frequent coordination meetings, early involvement of contractors, relation-specific investments and the frequent use of co-location. Similar mechanisms are also identified in a recently published study of infrastructure partnering projects by Hosseini et al. (2016).

In an often cited article, Bresnen and Marshall (2000) present several tools to build collaboration. These include both hard and soft tools. Examples of hard tools are contract incentives and contractor selection processes. Softer tools are related to building and managing relationships and include co-location of teams, teambuilding and opening the books to share information. Similar mechanisms are presented by Turner et al. (2019), who also describe the importance of having regular workshops as a means to improve the communication in the relationship. It is better to arrange frequent simple teambuilding events that include all staff rather than to hold fewer, and more expensive, events limited to key personnel (Eriksson et al., 2009; Bresnen and Marshall, 2000).

Establishing a clear set of routines and rules and establishing a joint code of conduct that describes the accepted behaviour between the parties is commonly used as a mechanism to build collaborative behaviour with a no-blame culture (Hans and Mnkandla, 2019; Lloyd-walker et al., 2014). Having a kick-off or workshop session early in the project to establish ground rules for collaboration is important in order to achieve a no-blame culture (Lloyd-walker et al., 2014). In fact, kick-off meetings were found to be the tool most frequently used by project managers in a study that investigated how frequently 20 different project management tools were used by project managers (Tereso et al., 2019). In the book titled *Collaborative Procurement Arrangement*s, Walker and Lloyd-Walker (2015) categorise various procurement methods from first-order collaboration to fourth-order collaboration as a function of increased level of early contractor involvement and use of pain/gain share incentives (see Figure 2-9 on page 89). In order to reach the fourth order of collaboration, several different mechanisms can be used such as combining IT solutions, co-location and frequent site visits. A common denominator for such methods is that they have substantial elements of pain/gain share incentives (Walker and Lloyd-Walker, 2015).

Involving contractors early in the project has shown a positive effect on collaborative behaviour (Rahmani et al., 2018; Hosseini et al., 2016). Early involvement of contractors where they can contribute with their detailed competence at the concept stage enhances the collaboration level in the project (Ahola et al., 2017; Wondimu et al., 2016). Similarly, early involvement of users and other important stakeholders improves collaboration (Badi and Pryke, 2015). Tendering in public projects must comply with public procurement regulations, which sometimes makes it difficult for clients to involve contractors as early as they ideally would have liked to (Bygballe and Swärd, 2019).

In a case study of a Hong Kong partnering project, workshops, social activities, newsletters and use of incentives were identified as important mechanisms to improve collaboration (Bayliss et al., 2004). It has also been suggested that establishing a common project call centre is a practical way to establish the right balance between informal and formal communication in a project and reduce mistrust (Bond-Barnard et al., 2013).

By sharing IT systems, the project managers in the various companies that participate in the project can more easily exchange information with each other (Engström and Stehn, 2016; Harley, 2011). The use of Internet has changed our capacity to communicate and online collaboration tools make it easy for project participants to access and share data (Harley, 2011; Wilkinson, 2005), Building Information Modelling (BIM) (Matthews et al., 2018), and to conduct online meetings that reduce the need for travelling (Erdogan et al., 2008). However, even with modern video portals with live video streams between locations, travelling is still needed to achieve good collaboration quality. After one face-to-face meeting, the quality of remote collaboration is multiplied by 10 as a result of trust achieved from a first face-to-face meeting (Karis et al., 2016). In a recent study, Aljuwaiber (2019) found that although face-to-face meetings are superior in terms of communication richness, video meetings can often be a pragmatic solution in projects where high workload and tight schedules limit the possibilities to travel and meet face-to-face. However, top management support is crucial when establishing the video conference system and it is important to have available resources to quickly resolve any technical issues. In their study of US defence projects, Blenke et al. (2017) found that less than 4% of the respondents preferred virtual communication over face-to-face meetings.

In order to maintain more efficient information sharing between the contractors working in a project, a dedicated role may be established as interface coordinator. This person is responsible for coordinating interfaces between the actors (Ahola et al., 2017). In the Panama Canal expansion project, specialised consultants were used in the project to teach the actors and monitor their collaborative behaviour, a mechanism known as “chaperoning" (Smits and van Marrewijk, 2012).

### 2.3.5 Empirical relationship between collaboration and project performance

Collaboration generally has a positive effect on project performance (Bond-Barnard et al., 2018; Um and Kim, 2018; Cicmil and Marshall, 2005; Turner and Müller, 2003). It should lead to win-win situations for all parties (Bititci et al., 2007; Yeung et al., 2007) and the value of the relationship between customers and suppliers in supply chains is enhanced if there is a high degree of collaboration (Vaaland and Håkansson, 2003).

Table 2-7 shows a summary of a literature search of existing research that investigates the relationship between collaboration and project performance with regard to cost, time and quality. In other words, the performance measures within the traditional Iron Triangle of project efficiency constraints (Rezvani and Khosravi, 2018). In this table, a (+) symbol indicates where authors have found a correlation between collaboration and each of the three dimensions of the iron triangle, as opposed to a (-) symbol indicating that the authors studied this relation but found no correlation. A blank cell indicates that the authors did not study the relation between collaboration and the specific dimension.

***Table 2-7: Research after year 2000 on relationship between collaboration and project performance in terms of cost, time and quality***

| Author | Unit of analysis | Data collection method | Performance dimension | | |
|---|---|---|---|---|---|
| | | | Cost | Time | Quality |
| (Eriksson and Westerberg, 2011) | Factors affecting project performance | Conceptual framework based on literature | (+) | (+) | (+) |
| (Iyer and Jha, 2005) | Cost performance success factors | Survey, 112 practitioners in India | (+) | | |
| (Chan et al., 2003) | Partnering benefits | Survey<br>78 respondents in Hong Kong | (+) | (+) | (+) |
| (Silva and Harper, 2018) | Correlation between team integration and performance (cost/time) | Survey<br>26 projects in the US | (+) | (-) | |
| (Ibrahim et al., 2018) | Difference in performance between IPD projects and non-IPD | Survey, 109 projects | (+) | (+) | (+) |

| | | | | | |
|---|---|---|---|---|---|
| (Franz et al., 2017) | Difference in performance between contract types | Survey, 204 projects in the US | (+) | (+) | (+) |
| (Suprapto et al., 2016) | Difference in performance between contract types | Survey, 119 practitioners from various industries in the Netherlands | (+) | (+) | (+) |
| (Dietrich et al., 2010) | Collaboration antecedents and outcomes | Conceptual framework based on literature | (+) | (+) | (+) |
| (Cho and Ballard, 2011) | Difference in performance between IPD projects and non-IPD | 49 construction projects | (+) | (+) | |
| (Asmar et al., 2013) | Difference in performance between IPD projects and non-IPD | Survey, 35 US construction projects | (-) | (+) | (+) |
| (Hanna, 2016) | Difference in performance between IPD projects and non-IPD | Survey, 12 projects, 42 practitioners | (-) | (+) | (-) |
| (Bond-Barnard et al., 2018) | Link between collaboration and project success | Online survey, 151 respondents from various industries | (+) | (+) | (+) |
| **Note:** | | | | | |
| (+) authors suggest that there is a relationship with collaboration | | | | | |
| (-) authors suggest that there is no relationship with collaboration | | | | | |
| Blank cell: author did not discuss relationship with collaboration | | | | | |

Eriksson and Westerberg (2011) proposed a conceptual framework with a positive relationship between collaboration level and project performance in terms of cost, time, and quality. In addition, they proposed a positive relationship between collaboration and success in terms of environmental impact, work environment and innovation. Similar findings were also reported by Dietrich et al. (2010), who through an extensive literature review found a relationship between collaboration quality and project success in general. Iyer and Jha (2005) conducted a survey among Indian construction projects where they identified coordination as the most significant factor that influenced project cost performance. Chan et al. (2003) conducted a survey among 78 practitioners working with partnering projects in Hong Kong and found that collaboration was positively related to all three sides of the iron triangle.

Based on a survey of US public transportation projects, Silva and Harper (2018) investigated correlations between how well integrated teams were in projects and how well these projects performed with regard to cost and schedule. They found that project organisations that experience high levels of collaboration in general perform better with regard to cost performance, while there was no clear correlation with schedule performance. However, in their survey, only 26 projects had registered cost and schedule performance and the authors have encouraged other researchers to collect more project data and perform similar studies. Recently Bond-Barnard et al. (2018) published results from a survey where they found empirical evidence of a positive relationship between collaboration and project management success in terms of cost, time and quality.

Several studies compare how projects using different delivery methods or contract types perform with regard to cost, time and quality. Sullivan et al. (2017) provide a summary of 30 existing studies performed by researchers on projects using either design-build (DB), construction management at risk (CMR) or design-bid-build (DBB) delivery methods. However, none of these 30 studies included projects that utilised high-order collaborative delivery methods.

Recently, some empirical studies have been published with a focus on the performance of higher order collaborative delivery methods. For example, Ibrahim et al. (2018) analysed 109 projects and found that projects that utilised Integrated Project Delivery (IPD) arrangements generally outperformed the remaining projects that used less collaborative methods. Similar findings are reported by Asmar et al. (2013), who compared 12 IPD projects with 23 non-IPD projects in the US and found that there were no significant differences in cost performance between these projects but that there was a small difference in schedule growth. However, they found that IPD projects were superior in quality performance compared with non-IPD projects. Regarding quality performance, Hanna (2016) came to a different conclusion and found no difference in quality performance between IPD and non-IPD projects.

Furthermore, Franz et al. (2017) collected data from 204 projects and found generally positive correlations between collaboration and project performance in terms of cost, time and quality. They found some differences between various delivery methods but highlighted that choosing a collaborative delivery method did not automatically lead to improved performance. Similar conclusions were reached by Suprapto et al. (2016), who studied project performance based on survey responses from 119 practitioners in the Netherlands and compared how projects (mainly oil and gas) that used various contract types performed. Their main finding was that relational attitude and level of teamwork were more important than the type of contract used.

## 2.4 Research gap

The previous sections have described the theoretical background for research on transaction costs in projects as well as the theoretical background for collaboration in the relationship between a client and its contractor(s). Even though these are interesting areas of research in themselves, combining these two fields of research may lead to new solutions.

The literature review presented in chapter 2.2 showed that transaction costs have received limited attention among project management scholars. The number of contributions in the field is scarce and future research in the area may lead to valuable contributions (Pinto et al., 2009). However, only a handful of studies exists worldwide where project transaction costs are quantified (Guo et al., 2016) and more research in the field is needed (De Schepper et al., 2015; Li et al., 2015; Rajeh et al., 2015). A common feature of the existing studies that quantify project transaction costs (see Table 2-4 on page 80) is that they are mainly limited to transaction costs related to conducting the procurement itself in terms of bidding and contract negotiation (pre-contract phase) but exclude post-contract transaction costs related to controlling the work during the construction and operational phase of the project (Li et al., 2015). Through the literature review it was found that existing studies are either limited to a certain phase (pre-contract or post-contract) or to a certain perspective (client or contractor). None of the existing research that was presented in chapter 2.2.4 covered both phases and both perspectives. Hence, there is a need for research that covers both phases and both perspectives in order to get a more holistic understanding of the size of project transaction costs. In the latest edition of *Project Management Body of Knowledge* (PMBOK), transaction costs are not mentioned once (PMI, 2017). It is a paradox that so little is known about project transaction costs, and this is a field that deserves more attention (da Fonseca et al., 2018).

Existing research indicates that there are several potential positive outcomes (synthesised in Figure 2-10 on page 90) from improved client-contractor collaboration. Many of the positive outcomes that have been identified through research on client-collaboration relations appear to be corresponding with factors that have been identified as affecting project transaction costs. For example, more collaboration leads to a reduction in claims and opportunistic change orders

(Børve, 2019; Dietrich et al., 2010). Collaborative behaviour between a client and its contractor builds trust (Bond-Barnard et al., 2018), which should have a positive effect on project transaction costs (Kadefors, 2004). However, more research in this field is needed (Pinto et al., 2009).

Combining the two research streams of project transaction costs and client-contractor collaboration could lead to valuable contributions in the field. Existing research in the field suggests that several of the positive outcomes from collaboration may also have a positive effect on a project's transaction cost and this relationship should be investigated further. However, the literature search conducted in this thesis identified a research gap, as no existing studies were found that investigated this relationship between project transaction costs and client-contractor collaboration. A research gap has therefore been identified where this explicit relationship between project transaction costs and client-contractor collaboration is studied in more detail.

As illustrated in Figure 2-11, transaction costs may be considered as a "colder" domain compared to the "warmer" domain of collaboration, as the first domain is related to money and economics while the latter relates to relations between humans. Bridging the gap and mixing the cold and warm research stream can potentially lead to valuable contributions within the domain of project management research and contribute to finding solutions to improve project performance.

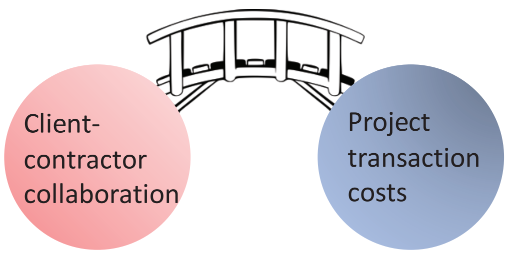



***Figure 2-11: Bridging the gap by connecting two research streams***

# 3 Research Method

In this chapter, the research questions for the thesis and the rationale behind them are presented. This is followed by a description of the method used to conduct the literature review. Next, using the taxonomy of the research onion (Saunders et al., 2019), each layer of the research methods applied in the thesis is dissected from the philosophical position to specific techniques and procedures used for data collection and analysis. The final part of this chapter contains reflections and criticism related to the applied research methods in the thesis.

Figure 3-1 shows a timeline that presents an overview of the research process for the PhD project. Above the timeline, the main tasks are described, while the main deliverables from the project are shown below the timeline.

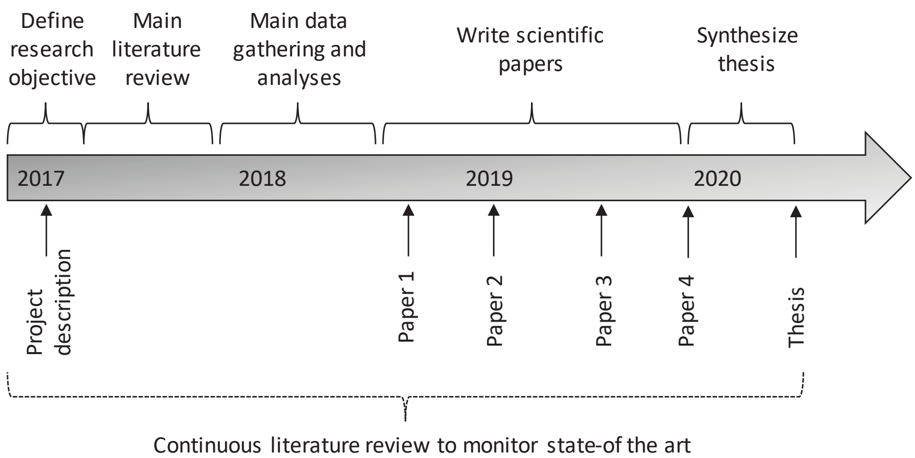



***Figure 3-1: Research process for the PhD project***

The first deliverable from the PhD project is the project description. This document contains a justification of the research objective as well as suggesting further directions for the literature review and a milestone schedule for the PhD project. Also, ethical considerations and proposed research methods are described. This project description is issued for approval by the Doctoral Degree Committee at NTNU within the three first months after the start of the PhD project.

Following the approval of the project description, the main literature review phase started. This phase is further described in Chapter 3.3. At this stage, the research objective and research questions were refined based on research gaps that emerged from the literature review. Next was a phase where data were gathered and analysed, followed by writing papers. The outcome from this phase was four scientific papers that were submitted to peer-reviewed international journals. The final phase of the PhD project was to synthesise this thesis manuscript.

Although the timeline in Figure 3-1 indicates that this was a sequential process, the reality is that there were significant elements of overlap and iterative loops along the way. For example, although the main literature review was conducted mainly during one phase, a continuous monitoring of literature was ongoing for the entire duration of the PhD project to monitor the state of the art and to identify any relevant literature that had been published after the main literature review was conducted in 2017. In addition, more specific literature reviews were conducted for each of the four separate papers.

## 3.1 Developing thesis research questions through design science

The normative approach, where a researcher develops solutions and recommendations to solve problems in a field, is commonly described as *design science* or *design research* (Van Aken, 2005).

Design science was introduced by Fuller (1963) as a systematic form of designing research. This was expanded by Simon (1969) through development of systematic and formalised design methods for different domains such as architecture, engineering, urban planning, medicine, computer science and management. This led to development of design research as an approach for researchers to structure and develop findings from their research based on a combination of sources and analysis in order to find normative solutions and recommendations that can be applied in the field. The results from a research project should contribute to the body of knowledge and expand knowledge in the specific field (Nunamaker Jr et al., 1990). Argyris (1995) stresses the importance of producing knowledge for action that can be used in contexts other than where the research took place and Van Aken (2005) highlights how management research should lead to knowledge production.

> "*The mission of a design science is to develop knowledge that the professionals of the discipline in question can use to design solutions for their field problem*" *(Van Aken, 2005, p. 20)*

The purpose of the thesis research questions was to find more holistic answers than those discussed in each individual paper to find solutions to the problems outlined in the introduction (chapter 1.5) of this thesis. The research questions for the thesis were developed based on the theoretical background and the research objective of the thesis. Also, findings from the papers contributed to the rationale and refinement of the thesis research questions through a design science approach.

Table 3-1 shows how each of the four papers contributes to answering the thesis research questions. In the following paragraphs, the rationale behind these research questions is elaborated.

*Table 3-1: Research questions for the thesis*

| Thesis Research questions | Paper 1 | Paper 2 | Paper 3 | Paper 4 |
|---|---|---|---|---|
| **RQ I:** What is the magnitude of transaction costs in construction projects? | (✓) | | | ✓ |
| **RQ II**: What is the relationship between transaction costs and client-contractor collaboration in projects? | ✓ | ✓ | ✓ | |
| **RQ III**: How can connecting the research field of project transaction costs with the research field of client-contractor collaboration contribute to improved performance in future projects? | ✓ | ✓ | ✓ | ✓ |

The first research question for this thesis (RQ I) is related to the magnitude of the transaction costs. As shown in the literature study in Chapter 2, little research has attempted to quantify the size of these project transaction costs and a need for further research that investigate pre- and post-contract transaction costs for client and contractor has been identified.

The rationale for the next research question (RQ II) is that there is a research gap concerning the relationship between transaction costs and client-contractor collaboration. There exists a fair amount of research that identifies benefits that can be achieved through collaboration between a client and its contractor (Eriksson, 2010; Yeung et al., 2007). Much of this research is focused on various collaborative delivery models such as alliancing, partnering or IPD, while other studies focus on collaborative work processes such as Virtual Design Construction (VDC) or similar processes. However, in chapter 2.4, a research gap was identified, indicating the need for research that investigates the specific relationship between client-contractor collaboration and the transaction costs in projects. The rationale for the second thesis research question (RQ II) is therefore to investigate this relationship and contribute to closing the identified research gap.

The third research question (RQ III) addresses the problem of poor productivity in construction projects (Zhang et al., 2018b; Fulford and Standing, 2014; Abdel-Wahab and Vogl, 2011) and exploring how connecting two research fields may help to improve project performance. The theoretical background for the thesis is presented in chapter 2. It shows that transaction costs have received little attention within the theoretical field of project management research, and they also appear to receive little attention in the field of project practitioners. To illustrate this concern, the latest edition of PMBOK (PMI, 2017) consists of a total of 977 pages but transaction costs are not mentioned once.

## 3.2 Research questions for individual papers

In Table 3-2, the specific research question for each paper is presented. The rationale behind each of these is elaborated in the following paragraphs.

***Table 3-2: Specific research question(s) for each paper***

| **Paper** | **Research question(s)** |
|---|---|
| **Paper 1**<br>"Factors affecting transaction costs and collaboration in projects" | **RQ 1**: Which of the 26 transaction cost factors presented by Li et al. (2015) have the largest influence on collaboration in projects?<br>**RQ 2**: What are the differences and similarities in the findings from projects in the construction industry, the ICT industry and oil and gas industry?<br>**RQ3:** What are the differences and similarities of the findings between the contractor perspective and the client perspective? |

| | |
|---|---|
| **Paper 2**<br>"In search of Empirical Evidence for The Relationship between Collaboration and Project Performance" | **RQ:** What is the relationship between collaboration quality in projects and project performance in terms of cost, schedule and quality? |
| **Paper 3**<br>"Follow the collaboration compass" | **RQ:** How do project managers use different mechanisms in their day-to-day practice to achieve successful collaboration in the relationship between client and contractors in projects? |
| **Paper 4**<br>"Dissecting the Project Anatomy: Understanding the Cost of Managing Construction Projects" | **RQ:** What proportion of the total cost in construction projects is spent by the client and its contractor on managing the project? |

### 3.2.1 Rationale for research questions in Paper 1

Pinto et al. (2009) encourage researchers to further investigate the relationship between trust and project transaction costs and Li et al. (2015) call for further empirical research on the framework which contains factors that determine project transaction costs. While there exists a fair amount of research on the various collaborative approaches (Eriksson, 2010; Yeung et al., 2007), a research gap is identified related to the relationship between collaboration and transaction costs in projects. Existing research investigating which transaction cost factors in projects influence collaboration the most has not been found. In addition, von Danwitz (2018), who performed an extensive literature review of existing project management research, identified the need for more cross-industry research in the future, as most studies today are industry-specific. Therefore, it would be particularly useful to perform the study from a cross-industry perspective.

### 3.2.2 Rationale for research question in Paper 2

The majority of empirical research on the relationship between collaboration and performance in construction projects is focused on comparing projects that use different delivery methods and contract arrangements, as was shown in Table 2-7. Eriksson and Westerberg (2011) encourage researchers to collect data from a large number of projects to test their proposition that there is a positive relationship between collaboration and project performance.

> *"The value of having this framework tested is potentially great as the project management literature has many indications that increased cooperation may be a good strategy for achieving project success, but empirical evidence delineating this in a more holistic way is lacking" (Eriksson and Westerberg, 2011, p. 206).*

There is a need for more empirical research to investigate the relationship between collaboration and project performance (Bond-Barnard et al., 2018; Silva and Harper, 2018; Meng and Gallagher, 2012). According to von Danwitz (2018), there is a general need within project management research for more quantitative studies based on large datasets.

### 3.2.3 Rationale for research question in Paper 3

There is some literature that provides summaries of various collaborative mechanisms, such as Dietrich et al. (2010) and Eriksson et al. (2009) but existing research that maps how different mechanisms are used for projects with different characteristics has not been found. There is a need for more practice-oriented studies of collaboration in the client-contractor relationship that are useful for project managers (Baiden et al., 2018; Svejvig and Andersen, 2015). There is also a need for more studies on collaboration in projects from different industries, as the majority of the existing studies are based on construction projects (Braun and Sydow, 2019). In that respect, one can argue that there is a need for studies that investigate collaboration mechanisms used for projects with different characteristics based on a sample of projects from different industries.

### 3.2.4 Rationale for research question in Paper 4

Studies that quantify transaction costs in projects are scarce and more research is needed (da Fonseca et al., 2018, Guo et al., 2016, De Schepper et al., 2015, Li et al., 2015, Rajeh et al., 2015). A common feature of the existing studies presented in Table 2-4 is that they mainly focus on the transaction costs related to conducting the procurement itself in terms of bidding and contract negotiation but exclude costs related to monitoring the work during the construction and operational phase of the project (Li et al., 2015). With reference to chapter 2.2.4 there is a need for a holistic study of project transaction that covers both pre-contract and post-contract phases as well as covering both the client and the contractor perspective. More research in the field of project transaction costs has also been suggested by Pinto et al. (2009). In more general terms, there is also a need for more quantitative project management studies based on large datasets (von Danwitz, 2018). There appears to be a potential to improve project performance through a better understanding of project transaction costs but currently the knowledge is limited about the size of such transaction costs in construction projects.

## 3.3 Literature review

The research methods applied in this thesis are described following the taxonomy of the research onion (Saunders et al., 2019) in section 3.4 through 3.10, but this does not describe how literature searches were conducted. Therefore, the process of conducting the literature review is first presented separately here in order to outline how literature searches were conducted in this PhD project.

*Table 3-3: Summary of literature review process*

| Phase | Literature review topic | | | |
|---|---|---|---|---|
| Exploring phase 2017 | Main thesis literature review<br>• Project transaction costs<br>• Client-contractor collaboration<br>• Project management theory<br>⇨ Identified research gap<br>⇨ Led to research questions | | | |
| Paper phase 2018-2019 | Paper 1<br>Factors affecting transaction costs and collaboration in projects | Paper 2<br>Relationship between collaboration and project performance | Paper 3<br>Collaboration mechanisms | Paper 4<br>Quantified transaction costs in projects |
| Monitoring phase<br>2018-2020 | All of the above | | | |

The process of conducting the literature review for this thesis can be briefly outlined in three phases as shown in Table 3-3. The exploring phase describes the main part of the literature review for this thesis and it was mainly conducted during the first 6-9 months of my work with the thesis. This review provided an overview of the state of the art within the specific research fields and identification of research gaps. The second row of the table shows how narrower literature reviews were conducted for each paper based on each paper's specific research objective. The third row in the table describes the "monitoring phase", which lasted until the end of the PhD project. Keeping in mind that a PhD project stretches over a period of several years it is important to continuously monitor the state of the art within the research field to ensure that the research always considers the latest available studies published by others within the field.

### 3.3.1 Narrative review vs systematic review

In medicine, physicians can use a stringent approach to search existing literature to find specific answers supported by evidence in order to find the best treatment for a patient with specific symptoms. This is an example of a very systematic literature review (Cook et al., 1997). While a structured review provides quantitative, and evidence-based, answers to very specific questions, a narrative literature review is more useful to obtain a broader perspective on a topic. Through the narrative, or semi-systematic review, the researcher gets an overview of the theories and research related to the field of research. It acts as both a theoretical background for the research (Bryman, 2016) as well as a basis for discussing its contributions over time (Snyder, 2019). The main differences between narrative reviews and systematic reviews are outlined in Table 3-4.

***Table 3-4: Differences between narrative reviews and systematic reviews, adopted from (Cook et al., 1997, p. 378)***

| Feature | Narrative Review | Systematic Review |
|---|---|---|
| Question | Often broad in scope | Often a focused clinical question |
| Sources and search | Not usually specified, potentially biased | Comprehensive sources and explicit search strategy |
| Selection | Not usually specified, potentially biased | Criterion-based selection, uniformly applied |
| Synthesis | Often a qualitative summary | Quantitative summary |
| Inferences | Sometimes evidence-based | Usually evidence-based |

While the criteria for a literature to be considered systematic in medicine are stringent, the systematic literature approach has also been adopted in other research domains. In general, the main characteristic features of a systematic literature review is that it is based on a defined search strategy that is documented (Kitchenham, 2004). The search process should also be replicable and transparent for the reader (Tranfield et al., 2003).

The literature review process in this thesis started with a systematic literature review based on a defined search strategy with multiple keywords to search a selection of journals. This was combined with a more narrative approach where I was curious and allowed myself to wander off the main track, following references and citations both backwards and forwards in time and finding contributions in journals that were not part of the initial search. Often this introduced me to journals that I had not originally been aware of, where significant contributions in the field had been published. Such tracing of literature back to its original sources as well as identifying newer works where it is cited is also an important aspect of a literature review (Klein and Müller, 2020) and the literature search process for this thesis can best be described as a combination of both structured and narrative approaches. The following sections describe the detailed process for the literature review that was conducted in this thesis.

### 3.3.2 Sources and search strategy for the main literature review

The main literature search started with a specific search strategy. The starting point from the literature review was to search for articles published within the following three journals: International Journal of Project Management (IJPM), Project Management Journal (PMJ), International Journal of Managing Projects in Business (IJMPB). The reason for limiting the search to these three journals was that they are highly recognised and considered by many as leading within the field of project management research (Aarseth et al., 2017; Padalkar and Gopinath, 2016).

Regarding the distribution of hits between the three journals, this is illustrated in Figure 3-2. The majority of the hits were found in IJPM (72%) followed by IJMPB (19%) and PMJ (9%). This also reflects the number of articles searched in the various journals, as the search in IJPM included articles from a timespan of 34 years while the search in PMJ included only six years of publications.

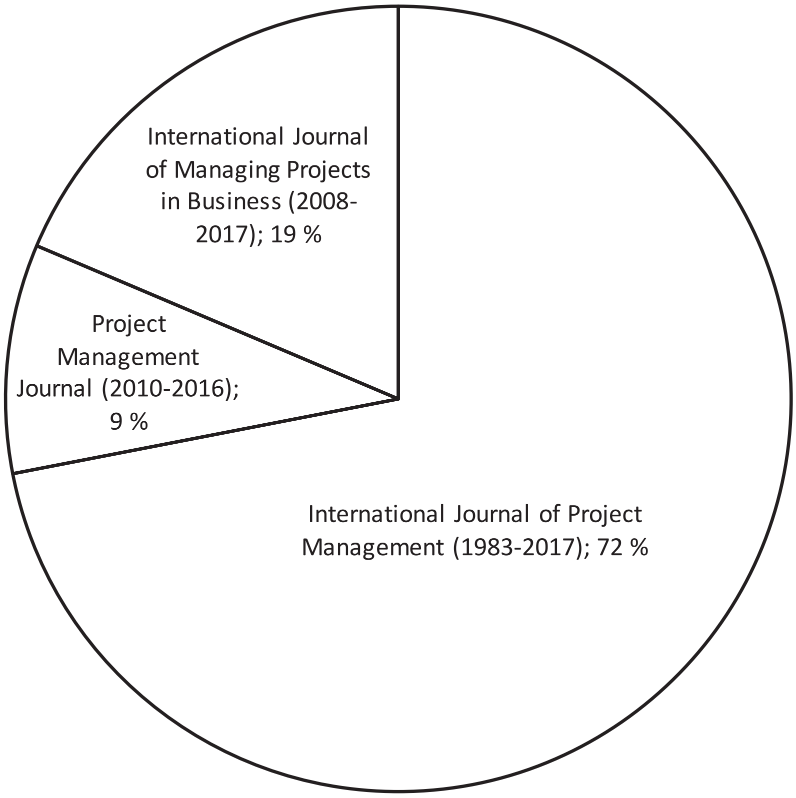



***Figure 3-2: Distribution of hits in the three journals that were the starting point for the literature search***

Many different search words were applied at this point to ensure that the search was broad enough to capture the essence of the research field of this thesis. This first initial stage produced a total of 1697 hits where these search words occurred in the title or in the abstract of a paper in either IJPM, PMJ and IJMPB. Several of these hits were duplicate hits, meaning that several of the different search words occurred in the title or the abstract of the same paper. Such duplicate hits were merged to ensure that each article only occurred once, which reduced the number of articles to less than half the size of the original search. Next, the title and abstract of these articles were reviewed to reject and filter out articles that were outside the domain for the objective of this thesis. The publication year was also part of this screening in order to capture the state of the art and most recent contributions in the field. Articles published in the last 5-10 years were in general more carefully screened then older articles. However, some of the older publications were still relevant and should not be overlooked. The number of times articles have been cited was therefore also used as a criterion when sorting older articles and trying to assess their relevance to the state of the art. Figure 3-3 shows a histogram with the status of the number of hits on different search words in the three journals approximately halfway through the screening process. This figure also shows the breadth of the search terms applied at this stage.

After this screening, the total number of relevant hits was reduced to 260. Again, the abstract of the remaining articles was reviewed, this time more carefully, to further reduce the number of articles based on their relevance. The remaining articles were more carefully read and synthesised using a combination of creative mind-mapping tools, spreadsheets, EndNote and paper copies with notes. The three journals were only the starting point, and significant elements of snowballing were applied along the way using Google Scholar and Scopus to follow interesting traces left in the reference lists in the papers. Several times, following backward and forward citations led me to new and significant contributions in journals that I had been unaware of. This included interesting travels back in time to classic contributions from the most distinguished researchers in the field several decades ago. It was truly inspiring to read some of these cornerstone books and articles that have later been acting as a springboard for so many branches of new research. Following the trail backwards from Williamson (1975) to Coase (1937) and eventually all the way back to Marshall (1890) is one example of such a journey.

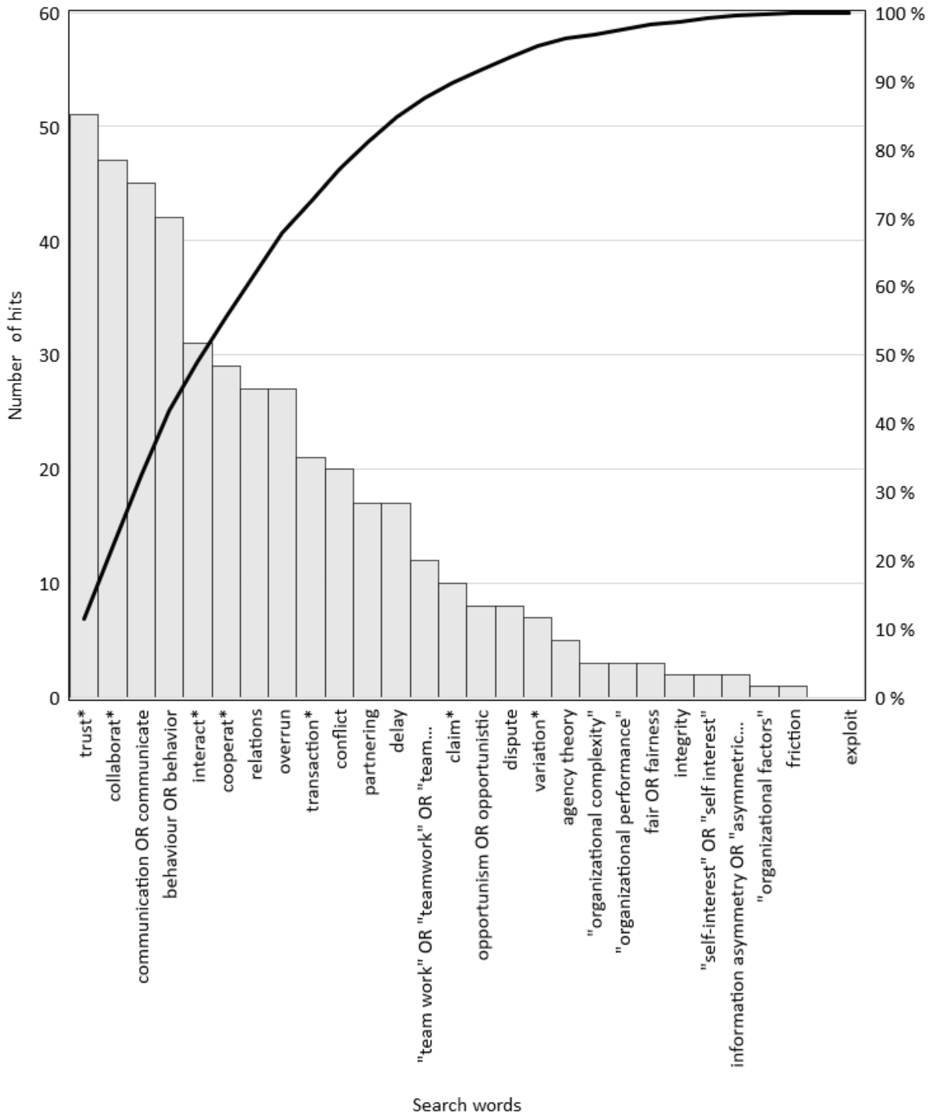



***Figure 3-3: Histogram of hits, halfway through the screening process***

This was a process that was explorative in nature, where being curious and spending time were important success factors. Again, mind-mapping tools, EndNote and spreadsheets were used to organise the process. Gradually, as the process matured and saturated, I was in a position to develop concept matrices and tables to capture the state of the art within my research field. In total this process took a significant part of the time during the first 6-9 months of the period as a PhD student.

### 3.3.3 Synthesising – use of concept matrices

Concept matrices have been used extensively in this thesis to synthesise and sort the literature in a logical way based on the concept that was discovered. An example of a generic concept matrix is shown in Table 3-5. Sometimes, it may be useful to expand the concept matrix in order to differentiate between different units of analysis applied in the studied literature to detect whether the specific article is within or outside the relevant research domain (Webster and Watson, 2002). For example, the results from the literature review presented in Table 2-7 on page 96 illustrate how a concept matrix was used to differentiate between units of analyses that were applied in the studied literature.

***Table 3-5: Concept matrix, adopted from (Webster and Watson, 2002, p. 17)***

| **Articles** | **Concepts** | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | … |
| 1 | | | | | |
| 2 | | | | | |
| … | | | | | |

### 3.3.4 Paper phase – Specific literature search for each paper

The literature search conducted for each paper had a somewhat different approach than the main literature review that was described in section 3.3.2. The starting point for the main literature review was a broad variety of search words within a limited number of journals, followed by snowballing. For the individual papers, the search was focused more on literature related to the paper's specific research objective. However, the search was not limited to only a few journals but used a wide variety of sources, typically, by searching the Scopus database and using Google Scholar followed by snowballing following references and citations both forward and backward. Several articles and books that were found from the main literature review were also relevant to the theoretical background in the individual papers.

### 3.3.5 Monitoring phase - keeping an eye on the latest developments

Even though the majority of the literature review was conducted during the first 6-9 months of the PhD project, this does not mean that it finished at this time. New research is published every month and it is important to monitor the research field during the entire period of work with the PhD thesis to supplement the initial literature review. For example, new literature that was found during the search for each individual paper supplemented the main literature review for the thesis. In addition, I subscribed to automatic notifications from Scopus and was notified by e-mail each time new articles were published based on relevant keywords and author names. I also subscribed to the most relevant journals and reviewed their table of contents for each new issue that was published.

To illustrate this point, and the relevance of the monitoring phase, a quick review of the references listed in chapter 8 of this thesis reveals that 60 out of a total of 328 references are published in 2018 or later. In other words, 18% of the cited literature in this thesis was published after the main literature search was completed in 2017.

## 3.4 The research onion

A vast number of concepts and terms are used in literature to describe research methods. Often similar concepts or phenomena have different names and it is easy to get confused (Klakegg, 2016). To consistently describe the structure of the research methods used in this thesis, the taxonomy of the research onion as presented by Saunders et al. (2019) is strictly followed. The reason for choosing to follow one taxonomy is to try to avoid confusion and be able to be consistent and structured when explaining how the research was conducted for the thesis.

The research onion is shown in Figure 3-4. In the following sub-chapters, each of the six layers of the onion will be addressed for the papers in this thesis, from the outermost layer (philosophical position) to the innermost core (data collection and analysis).

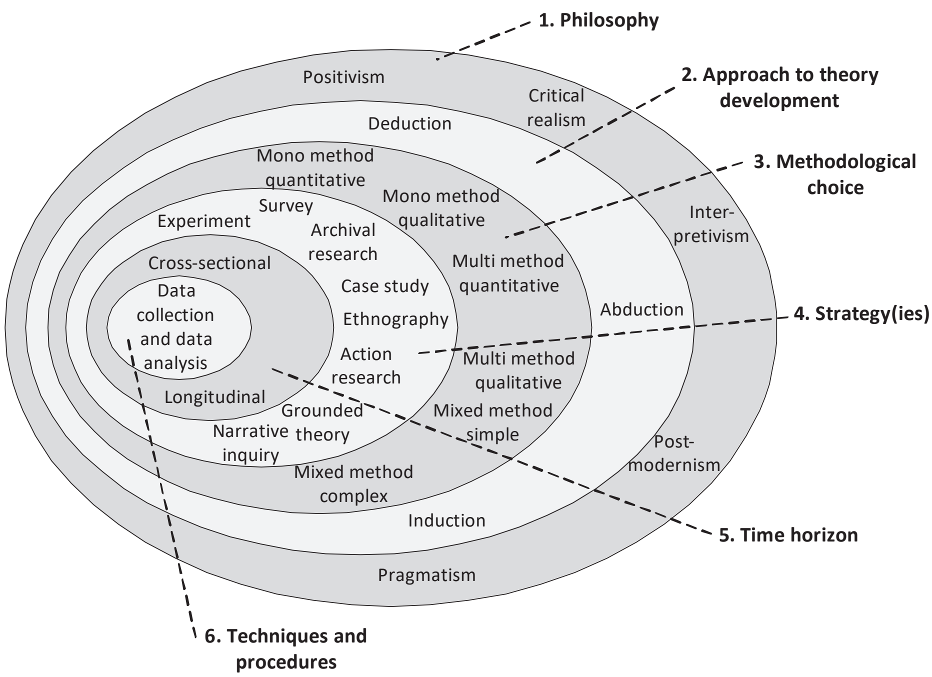



*Figure 3-4: The research onion, redrawn from (Saunders et al., 2019, p. 130)*

In Table 3-6, a summary is presented of the research methods for the papers in this thesis. The first row describes the researcher's philosophy so that the reader of this thesis is made aware of "how I as a researcher" see the world. The following rows in the matrix describe each layer of the research onion for the individual papers. In the next section, the research method for each paper will be explained in further detail using the framework of the research onion.

***Table 3-6: Overview of research methods for the papers in this thesis***

| **Author's dominant philosophical position** | Critical Realism | | | |
|---|---|---|---|---|
| | Paper 1 (causal purpose) | Paper 2 (descriptive purpose) | Paper 3 (normative purpose) | Paper 4 (descriptive purpose) |
| **Approach to theory development** | Deduction | Deduction | Deduction | Deduction |
| **Methodological choice** | Qualitative | Quantitative | Qualitative | Quantitative, |
| **Sampling strategy** | Narrative inquiry | Survey | Narrative inquiry | Survey |
| **Time horizon** | Cross-sectional | Cross-sectional | Cross-sectional | Cross-sectional |
| **Data collection** | 38 semi-structured interviews | Data from 142 project cases in Nordic 10-10 database | 38 semi-structured interviews | Data from 134 project cases in Nordic 10-10 database |

## 3.5 Philosophical position (1st layer of research onion)

When presenting research, it is important that the reader is made aware of the researcher's philosophical position. This makes the reader aware of the beliefs and assumptions taken by the researcher when conducting the research, which will ultimately influence the research process (Bryman, 2016). Likewise, it is crucial that the researcher is self-aware of his or her own philosophical position, as this is vital knowledge in order to design a good research strategy (Klakegg, 2016). There are typically three sets of assumptions that influence the research process (Saunders et al., 2019):

- Ontology assumptions (about what we consider realities)
- Epistemology assumptions: (about what constitutes acceptable knowledge)
- Axiology assumptions: (about how one's own values influence research)

A summary of key elements that describe philosophical positions in business and management research is shown in Table 3-7.

***Table 3-7: Comparison of five research philosophical positions in business and management research, re-produced from (Saunders et al., 2019, p. 144)***

| **Ontology**<br>(researcher's view on reality) | **Epistemology**<br>(researcher's view on what constitutes acceptable knowledge) | **Axiology**<br>(researcher's view on role of values in research) |
|---|---|---|
| | **Positivism** | |
| • Real, external, independent<br>• One true reality<br>• Granular (things)<br>• Ordered | • Scientific methods<br>• Observable and measurable facts<br>• Law-like generalisations<br>• Numbers | • Value-free research<br>• Researcher is detached, neutral and independent of what is researched |

| | | |
|---|---|---|
| | • Causal explanation | • Researcher maintains objective stance |
| | **Critical realism** | |
| • Stratified/layered (the empirical, the actual and the real)<br>• External and independent<br>• Intransient<br>• Objective structures<br>• Causal mechanisms | • Epistemological relativism<br>• Knowledge historically situated and transient<br>• Facts are social constructions<br>• Historical causal explanation as contribution | • Value-laden research<br>• Researcher acknowledges bias by world view, cultural experience and upbringing<br>• Researcher tries to minimise bias and errors<br>• Researcher is as objective as possible |
| | **Interpretivism** | |
| • Complex and rich<br>• Socially constructed through culture and language<br>• Multiple meanings, interpretations and realities<br>• Flux of processes, experiences and practices | • Theories and concepts are too simplistic<br>• Focus on narratives, stores perceptions and interpretations<br>• New understandings and worldviews as contribution | • Value-bound research<br>• Researchers are part of what is researched (subjective)<br>• Researcher's interpretation is key to contribution<br>• Researcher being reflexive |
| | **Postmodernism** | |
| • Nominal<br>• Complex and rich<br>• Social constructionism through power relations<br>• Some meanings, interpretations and | • What counts as "truth" and "knowledge" is decided by dominant ideologies<br>• Focus on absences, silences and oppressed/ repressed | • Value-constituted research<br>• Researcher and research embedded in power relations<br>• Some research narratives are repressed and silenced |

| | | |
|---|---|---|
| realities are dominated by and silenced by others<br>• Flux of processes, experiences and practices | meanings, interpretations and voices<br>• Exposure of power relations and challenge of dominant views as contribution | at the expense of others<br>• Researcher is radically reflexive |
| **Pragmatism** | | |
| • Complex, rich and external<br>• "Reality" is the practical consequence of ideas<br>• Flux of processes, experiences and practices | • Practical meaning of knowledge in specific contexts<br>• "True" theories and knowledge are those that enable successful action<br>• Focus on problems, practices and relevance<br>• Problem solving and informed future practice as contribution | • Value-driven research<br>• Research initiated and sustained by researcher's doubts and beliefs<br>• Researcher is reflexive |

To improve the awareness of my own philosophical position as a researcher, I used a reflexive tool called HARP (**H**eightening your **A**wareness of your **R**esearch **P**hilosophy) which is presented by Saunders et al. (2019). Based on a questionnaire of 30 different statements, a score is calculated that indicates which philosophical position(s) the respondent is leaning towards. The higher the score, the higher is the preference for the position. The results from this test are presented in Table 3-8. Such a test is, of course, only a starting point for further reflections and does not provide a simple and definite categorisation of a researcher's philosophy. However, I do find that the results from this test correspond well with my own beliefs and I am not surprised that critical realism, followed by interpretivism received the highest score and that positivism is found at the bottom of the table.

***Table 3-8: Results from HARP test taken by the author of this thesis***

| Philosophical position | PhD candidate's score |
|---|---|
| Critical Realism | 15 |
| Interpretivism | 13 |
| Pragmatism | 10 |
| Postmodernism | 9 |
| Positivism | -1 |

I believe my philosophical research position is dominated by critical realism and will therefore elaborate a bit more on the *ontology, epistemology* and *axiology* assumptions that are typical for a critical realist.

### 3.5.1 Ontology

Ontological issues concern what a researcher considers to be reality (Saunders et al., 2019). As a critical realist, reality is crucial and the critical realist therefore considers ontological assumptions as particularly important (Reed, 2009; Fleetwood, 2005). Bhaskar (1978) suggested that a critical realist aims to understand and explain what we experience and observe in a reality that consists of three overlapping layers, as illustrated in Figure 3-5. The innermost layer, *the empirical,* is what is observed or experienced. However, our senses may be deceiving us and we may overlook the bigger picture of what is actually occurring. This middle layer, *the actual,* is the event as it actually occurred. The underlying cause for the event is first found in the outermost layer, *the real*. Due to this layered ontology, a critical realist will search for explanations to understand what mechanisms cause the events that we experience (Saunders et al., 2019; Bryman, 2016; Bhaskar, 1978).

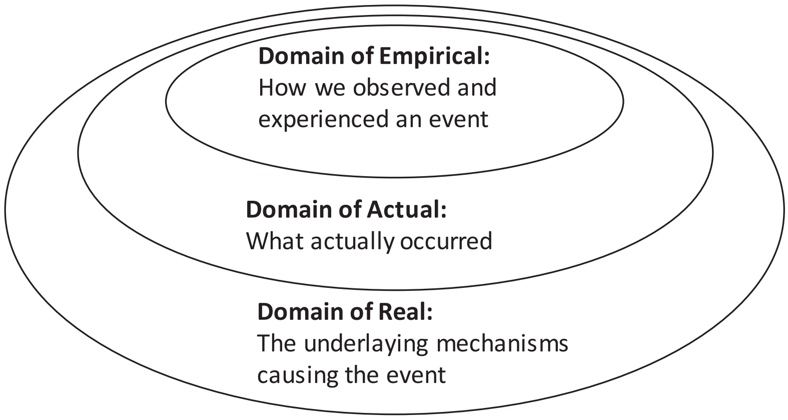



***Figure 3-5: Critical realist ontology, adopted from (Saunders et al., 2019, p. 148; Bhaskar, 1978, p. 56)***

### 3.5.2 Epistemology

Epistemological issues concern what a researcher believes should be considered as acceptable knowledge (Bryman, 2016). A critical realist considers knowledge to be transient and changing over time. An event must therefore be analysed within the context of when it occurred (Saunders et al., 2019; Reed, 2009). Such context-specific knowledge does not allow formulation of general hypotheses or laws to predict the future. To get a deeper understanding of the causal mechanisms, a critical realist researcher often prefers to use a combination of strategies (Ackroyd, 2009; Reed, 2009).

### 3.5.3 Axiology

Axiological issues concern the extent to which the researcher considers, and allows, his or her own role to influence the research (Saunders et al., 2019). While a positivist researcher claims that research should be performed strictly independently and unaffected by the researcher, the critical realist takes a mildly subjectivist approach and acknowledges that the research will, to some extent, be influenced by the researcher (Saunders et al., 2019). A researcher's cultural background and worldview and how this may have influenced the research must therefore be taken into consideration when presenting research. However, it is the aim of a critical realist to minimise such bias and try to be as objective as possible (Saunders et al., 2019).

## 3.6 Approach to theory development (2nd layer of research onion)

The second layer of the research onion (see Figure 3-4) addresses various approaches to theory development as synthesised in Figure 3-6. Generally speaking, the approach may be either *deductive* or *inductive* depending on the point of departure for the research.  Through deduction, the researcher forms a hypothesis based on existing theory and then collects and analyses data to verify or falsify the hypothesis. In contrast, the inductive approach starts with analysing data and then develops theory based on the observations and findings from this research (Bryman, 2016). Often, researchers apply a combination of induction and deduction, alternating between data and theory. This is often described as *abduction*, often starting with observing "a surprising fact" (Saunders et al., 2019).

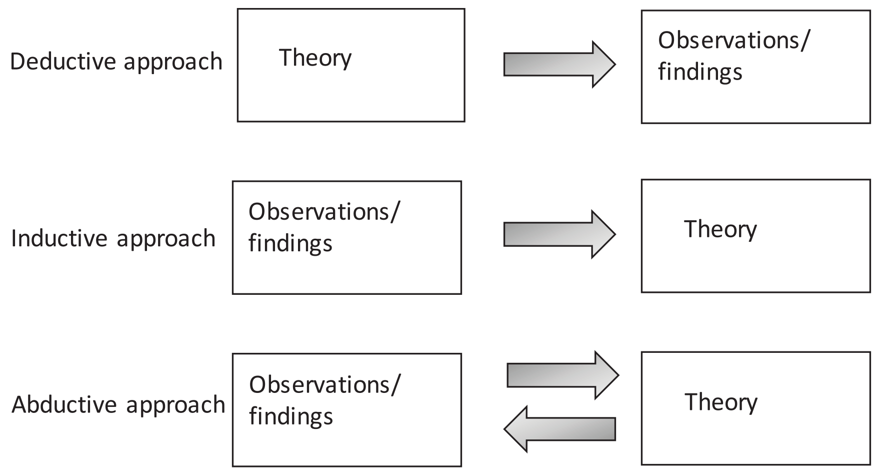



***Figure 3-6: Approaches to theory development, adopted from (Saunders et al., 2019; Bryman, 2016)***

A researcher's dominant philosophy will influence the approach to theory development. Generally speaking, positivists often incline to deduction and interpretivists to induction, while postmodernists, pragmatists and critical realists often tend towards abduction (Saunders et al., 2019).

### 3.6.1 Paper 1 – Deductive approach

The point of departure for the research in this paper is an existing framework of factors affecting transaction costs, which was developed by Li et al. (2015). The research objective of the paper is to test this framework. Hence, the paper mainly uses a deductive approach. However, it does include elements of abduction, as the paper expands the use of the existing framework and since one new factor emerged from the findings.

### 3.6.2 Paper 2 – Deductive approach

The starting point for this paper is existing theory that suggests there is a positive relationship between the level of collaboration in projects and how well projects perform. In this paper, data are collected and analysed to test if there is such a relationship. Hence, this paper uses a deductive approach.

### 3.6.3 Paper 3 – Deductive approach

Int this paper, the starting point is existing research on mechanisms that are used in projects to improve collaboration.  The purpose of the paper is to investigate how project managers use these mechanisms in their projects. Hence, this paper uses a deductive approach.

### 3.6.4 Paper 4 – Deductive approach

The starting point for this paper is the theory of transaction cost economics applied to construction projects. The purpose of the paper is to collect and analysis data from existing projects to describe and quantify these costs in construction projects through deduction.

## 3.7 Methodological choice (3rd layer of research onion)

The third layer of the research onion (see Figure 3-4) is related to the methodological choices available for the researcher. It is common to distinguish between two main different types or methods, which are *quantitative* methods and *qualitative* methods (Bryman, 2016; Alvesson and Sköldberg, 2009). A research design that uses quantitative methods typically focuses on the numbers related to data collection and analysis. If the research design uses qualitative methods, there is more emphasis on the words than on the numbers (Bryman

2016). Both quantitative and qualitative methods have their strengths and weaknesses. It is often favourable to use *mixed methods* that combine both quantitative and qualitative methods. This is commonly described as *triangulation* (Saunders et al., 2019; Bryman, 2016).

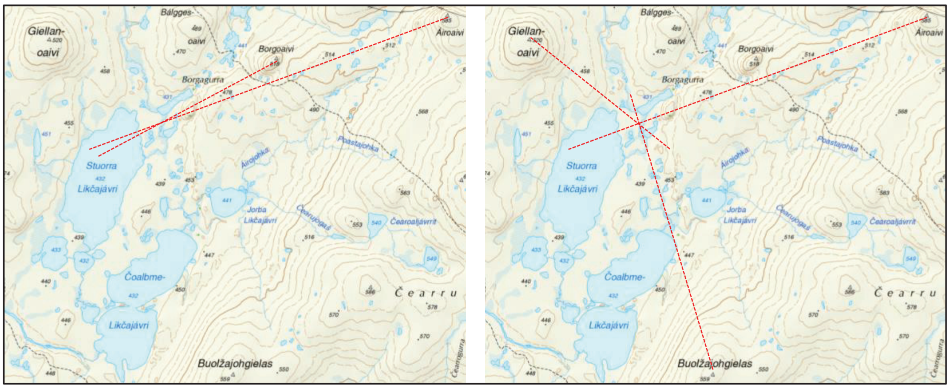



***Figure 3-7: Poor triangulation (left) and good triangulation (right)***

The concept of triangulation is illustrated in Figure 3-7. This image shows a map section from one of my winter expeditions on Finnmarksvidda in Northern Norway. The purpose of this is to illustrate how triangulation is used to find an exact location on the map based on visual observations of the surrounding terrain by using a handheld compass. In order to find the exact location, a minimum of two sources (such as two mountain tops) that can be identified on the map must be visible in the terrain. A straight line can then be drawn on the map based on the bearing to the sightings (the angle), which is read from the handheld compass aimed at the mountain top. The point on the map where these two lines intersect shows the coordinates for my exact position. The accuracy of this method mainly depends on three key factors. The first is related to how accurate it is possible to measure the bearing with the handheld compass aimed at a mountain top. The second factor is related to the angle between the sightings. If the angle between the two lines is small, it is more difficult to identify the exact location on the map.

The third factor is the number of sources (mountain tops). Measuring the bearing to three mountain tops instead of two will greatly improve the accuracy of the task of finding the exact location. On the left map in Figure 3-7, only two sources are used and the angle between them is small. The right map shows how three sources are used instead of two. In addition, the angle between the lines is better. The purpose of this anecdote was to illustrate that increasing the number of different sources in research (mountain tops) and ensuring that the methods used are not too similar (the angle between them) improves the quality of the research.

Several properties may influence the selection of a research method. These may be organisational properties, historical properties, personal properties, political properties, evidential properties or ethical properties (Buchanan and Bryman, 2009).

In a study of recently published articles on project management, von Danwitz (2018) found that both qualitative and quantitative methods are commonly used, and that 49% of the contributions were qualitative, 31% quantitative, 15% conceptual, 4% mixed and 1% other methods.

This thesis uses a combination of qualitative and quantitative methods. Papers 1 and 3 use qualitative methods while papers 2 and 4 use quantitative methods. Such triangulation allows the researcher to investigate the research objective of the thesis from different angles.

## 3.8 Sampling strategies (4th layer of research onion)

The fourth layer of the research onion (see Figure 3-4) concerns different strategies that can be used to collect data. Saunders et al. (2019) use the term *sample strategies* to describe this, while Bryman (2016) refers to this as various *research designs* and Yin et al. (2014) use the term *research methods.* This thesis follows the terminology used by Saunders et al. (2019) and uses the term sample strategies in order to be consistent with the terminology used within the taxonomy of the research onion. Table 3-9 shows a summary of different sampling strategies. The following sub-chapters contain a description of the sampling strategy applied for each of the four thesis papers.

***Table 3-9: Research sample strategies, adopted from (Saunders et al., 2019; Bryman, 2016; Yin, 2014; Glaser and Strauss, 1967)***

| **Sampling strategy** | **Brief description** | **Most relevant use** |
|---|---|---|
| Experiment | Define two opposing hypotheses: The null hypothesis and the hypothesis. Test data statistically against the null hypothesis to either accept or reject the hypothesis. | Quantitative methods.<br><br>Exploratory/explanatory purposes<br><br>"how" and "why" questions |
| Survey | Collect data that can be analysed using statistics.<br><br>Typically uses questionnaires, structured observations or structured interviews. | Quantitative methods<br><br>Exploratory / descriptive purposes<br><br>"what", "who", "where", "how much" and "how many" questions |
| Archival research | Analysis of documents and media.<br><br>Examples are letters, diaries, contracts, organisational documents, government documents, media articles, digital recordings, social media, photographs, online data, etc. | Can be used both in quantitative methods and in qualitative methods, or when combining the methods.<br><br>"who", "what", "where", "how many" and "how much" questions |

| | | |
|---|---|---|
| Case study | In-depth study of a phenomenon in its real context and setting.<br><br>Single or multiple cases. | Can be used both in quantitative methods or in qualitative methods or when combining the methods.<br><br>Exploratory / descriptive / explanatory purposes<br><br>"how" and "why" questions |
| Ethnography | Participant observation and fieldwork. Researcher participates and observes for a given period. | Qualitative methods |
| Action research | Iterative process where researcher diagnoses a problem, proposes an action to be taken and then evaluates the effect of the action. | Qualitative methods |
| Grounded theory | Process to analyse, interpret and explain meanings to build theory<br><br>Analyse data underway as they are collected until saturation is reached. | Qualitative methods<br><br>Inductive / abductive approach |
| Narrative inquiry | Story told by a narrator, typically a participant in an interview. Researcher analyses meaning and compares and triangulates stories from other participants. | Qualitative methods<br><br>"how" and "why" questions |

### 3.8.1 Paper 1 and 3 sample strategy – Narrative inquiry

A narrative inquiry strategy was used for paper 1 and paper 3. The research objective for these papers made it important to get a rich and comprehensive understanding of the topic, as the aim was to study factors and mechanisms, rather than numbers. This was the main reason for choosing the narrative inquiry strategy instead of, for example, a survey strategy. For paper 1, the specific research questions are formulated as "which" and "what", and as "how" for paper 3. A quick look at Table 3-9 might suggest that a survey sampling strategy could have been more relevant to use rather than the narrative inquiry for paper 1. However, the survey strategy, for example by using a questionnaire, provides limited insight into the reason behind the answers from the respondents (Bryman, 2016). The narrative inquiry, which was used in paper 1 and paper 3, gives the researcher access to deeper organisational realities that are collected as complete stories rather than responses to predefined fragmented questions (Saunders et al., 2019). The strategy allows the respondents to elaborate their stories and it is possible to collect additional data. It also makes it possible for the researcher to conduct probing to get more information from the respondent (Bryman, 2016).

### 3.8.2 Paper 2 and 4 sample strategy – Survey

The research objective for paper 2 and 4 calls for a sampling strategy where data are analysed quantitatively. Both paper 2 and paper 4 have a descriptive purpose and the specific research questions are formulated as "what" questions. The purpose of these two papers is to describe the current situation, in terms of numbers and measurements. Therefore, a survey strategy is well suited to the objective of these papers. The survey strategy allows the researcher to collect data that can be analysed by statistics, both descriptive and in terms of investigation of relationships and correlations (Saunders et al., 2019). In terms of the ability to generalise findings to a larger population, the survey strategy is more suited than for example case studies and narrative inquiries, as the sample size of the survey is larger (Bryman, 2016).

## 3.9 Time horizon (5th layer of research onion)

The 5th layer of the research onion is related to time. Should the research provide an image of the status at a given time or should it cover development over time? Saunders et al. (2019) uses the metaphors of the *snapshot* and the *diary* when describing time horizons in research design. The cross-sectional studies are snapshots where the researcher study a particular phenomenon at a particular time. On the other hand, longitudinal studies are like diaries that provide a representation of how a phenomenon or events develop over time. An obvious strength of longitudinal studies is that they manage to capture change and developments. However, longitudinal studies require that the researcher has sufficient time available (Saunders et al., 2019; Bryman, 2016).

All the papers in this thesis are cross-sectional studies. For paper 1 and paper 3, the data were collected over a period of 3-4 months – a short period and a snapshot of time in the context of project management research. The dataset used for paper 2 and paper 4 has been collected over a few years by the Nordic 10-10 organisation and would potentially allow the researcher to conduct some elements of longitudinal design. However, the element of development over time was not crucial for the research objective in these papers. One could also argue that a few more years are still needed until the dataset contains data from a time span long enough to allow meaningful longitudinal analyses to be conducted. However, it should be possible in the future to conduct longitudinal research based on this dataset as data from new projects are received every month.

## 3.10 Techniques and procedures for data collection and analysis

The inner core of the research onion (see Figure 3-4) is related to the specific details of how data were collected and analysed (Saunders et al., 2019). The following section therefore describes the detailed procedure for data collection and analysis for each of the four papers.

In papers 1 and 3, the research questions are explored through semi-structured interviews. Interviews allow the researcher to explore the research question in depth (Cassell, 2009). Through follow-up questions, it is possible to explore the argumentation of the respondents and get a more meaningful understanding of the reason for their responses. Such interviews are well suited to exploring experience of practice when opinions and experience are important for the research question (Bryman, 2016; Shepherd, 2015; Cassell, 2009).

In papers 2 and 4, the research questions are explored through statistical analyses of a set of data from projects in Norway that register their project data in a common benchmarking database organised by *Nordic 10-10*, an organisation which is managed by the Norwegian University of Science and Technology (NTNU). Bryman (2016) refers to this as *secondary analysis,* when a researcher conducts analysis on a dataset where the primary data were collected by someone else. One of the advantages of analysing existing data is that the quality of the dataset itself is often high. The primary data are often collected through rigorous sampling procedures and the sample size is large (Bryman, 2016). The sampling procedure that was used to collect the primary data in the Nordic 10-10 dataset was developed by the Construction Industry Institute (CII) based on their best practice research as they developed the 10-10 benchmarking tool. The sampling procedure was translated to Norwegian language and adjusted to fit the Norwegian context by the Nordic 10-10 organisation at NTNU in close cooperation with Norwegian industry actors.

### 3.10.1 Semi-structured interviews (Paper 1 and 3)

Respondents were mainly recruited using purposive sampling (Bryman, 2016). The reason for using purposive sampling is to identify respondents that are relevant to the research questions rather than to recruit respondents on a random basis (Bryman, 2016). In addition, elements of snowball sampling were used (Bryman, 2016), as some respondents suggested names of other potential respondents that they claimed had experience relevant to the research. A summary of the demographic distribution of the respondents is presented in Figure 3-8. From a total of 38 respondents, 34 held a role as a project manager or a project director. The respondents had on average 20 years of professional experience. All respondents were located in Norway at the time of recruitment, but several had international experience and most of the companies where respondents worked operated in an international market. The respondents came from 13 different companies in Norway and worked in ICT projects, construction projects or oil and gas projects. From the total of 38 respondents, 29 worked for seven different companies categorised as contractors while nine respondents worked for six different companies categorised as clients.

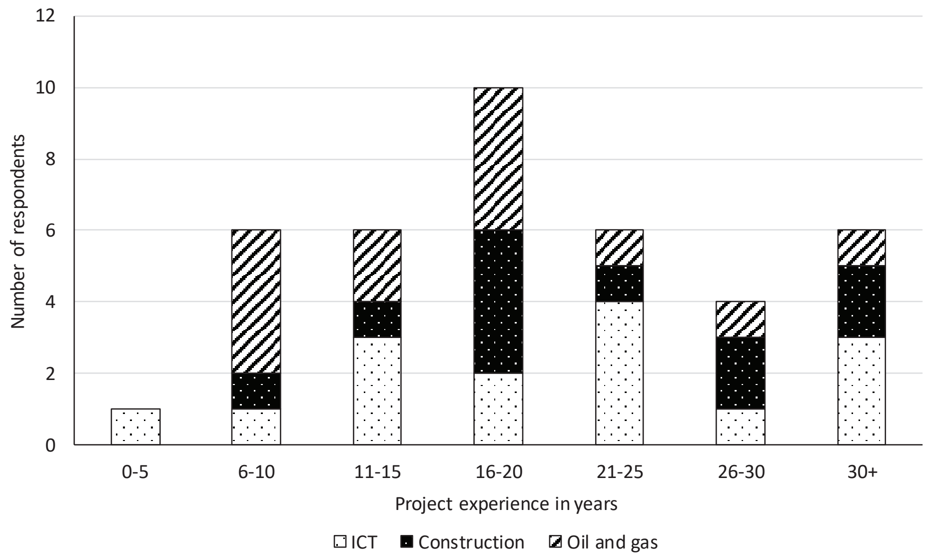



*Figure 3-8: Demographic distribution of interview respondents*

### Interview method

An interview guide was established and two pilot interviews were conducted with colleagues to pre-test the questions in the interview guide (Bryman, 2016) as well as to practise interview skills (Buchanan and Bryman, 2009). Based on lessons learned from the pilot interviews, the interview guide was revised before interviews were conducted. The interviews were conducted in the Norwegian language, which was the native language for the researcher and the respondents. The interview guide has been attached as an appendix to this thesis manuscript.

The interviews were conducted as face-to-face meetings in order to get a more comprehensive impression (Bryman, 2016) and more accurate answers (Shuy, 2002) than what one could achieve through telephone or video calls. Most of the interviews were conducted in meeting rooms at the location where the respondents worked.

Each interview lasted between 60 and 90 minutes. No audio recording device was used, and the interviewer took handwritten notes during the interview. Based on these notes, the interviewer wrote a summary of the interview and sent it back to the respondent for verification the same day. All interviews were conducted by the same person in the period from October 2017 through January 2018. There are good reasons to audio record interviews when performing qualitative research. Audio recorded interviewing allows the researcher to examine the interviews in more detail. It also provides high accuracy and reduces the risk of bias from the interviewer. Furthermore, audio recorded interviews allow other researchers to conduct secondary analysis later (Bryman, 2016). On the other hand, audio recording may cause respondents to be less willing to share information during the interview (Saunders et al., 2019; Warren, 2002).

Ultimately, the importance of interviewing respondents in a context where they were comfortable about sharing information was the main reason for choosing not to audio record the interviews. Since the interviews were not audio recorded, there is increased risk of bias from the interviewer as well as potential lack of accuracy and misunderstandings. To mitigate this weakness, the interviewer wrote a summary of the interview on the same day and returned it to the respondent for approval. Each respondent was asked to review the summary and correct mistakes or clarify misunderstandings. For the purpose of the research of this thesis, it is more important to understand the holistic picture and capture the essence of what the respondents are sharing rather than to capturing specific details word by word.

### Analysis, coding and saturation

A written summary of each interview was stored in a database. These summaries were then imported into a computer-assisted qualitative data analysis software called NVivo. Such software is useful when coding data from a larger number of interviews. However, using such software may increase the risk of fragmentation and one should therefore have high awareness of the context when analysing the data (Bryman, 2016). The process starts with basic coding by topic and then looking for patterns and group codes across the interviews (Alvesson and Sköldberg, 2009; Ely et al., 1997).

Following the idea of theoretical saturation by Glaser and Strauss (1967), one should perform interviews until performing additional interviews does not provide any significant new theoretical understanding, (Bryman, 2016). In an experiment performed by Guest et al. (2006), it was found that saturation occurred after only 12 interviews and Crouch and McKenzie (2006) argue that a small number of cases (fewer than 20) is often sufficient. In a sample of 560 studies that used qualitative interviews, the average number of interviews was 31 (Mason, 2010).

Findings from the interviews were later presented to two different groups of project managers. The first group consisted of 40 project managers working for an IT consulting company. The second group consisted of 18 project managers working for an oil company. Some of the project managers in the two above-mentioned groups had previously worked in the construction industry. The consensus from the feedback from the groups was that the findings corresponded well with their experience as project practitioners.

### 3.10.2 Secondary analysis (paper 2 and 4)

With the aim of improving performance in construction projects, the Norwegian Building Authority (DiBk) initiated a research project to identify measurement tools that industry actors could use to measure and benchmark their performance. Eight different tools for performance measurement were evaluated against various criteria in close cooperation with the industry. The outcome from this study was a recommendation to implement the CII 10-10

Programme for benchmarking in Norway (Andersen and Langlo, 2016). The 10-10 programme was originally developed by the US based Construction Industry Institute (CII) and is designed to evaluate project performance in the construction industry (Yun et al., 2016). Data from each project are recorded and companies receive benchmarking scores on their performance compared with other projects in the database. The categories for rating are based on CII's 30 years of research on best industry practice for 10 input factors and 10 outcomes, hence the name 10-10.

In close cooperation with CII, the 10-10 tool was translated into Norwegian language. This was followed by a period where it was tested in pilot projects. Following successful testing, the tool was branded "Nordic 10-10" (Langlo et al., 2017). The tool is administrated by the Norwegian University of Science and Technology (NTNU) and the author of this thesis have a part-time role in the Nordic 10-10 programme as part of the work duties at NTNU. This task is mainly related to creating and maintaining a common data file, using the software IBM SPSS Statistics, where data registered by each individual project is combined into a common dataset which is made available for academic researchers. Even though the thesis author was involved with administrating the data it is still most fair to consider these data as secondary data since the raw data were not collected by the thesis author, and data collection was based on a questionnaire originally developed by CII.

In Norway, several major construction clients and contractors have implemented the 10-10 Programme in their project organisations and currently data from 142 projects from 26 different companies had been registered. Companies participating in the 10-10 Programme receive feedback on their performance compared to a selection of comparable projects and use this as a tool for continuous improvement. Based on these measures, project organisations can evaluate how they are performing in order to adjust and improve their performance (Choong, 2014). In addition to providing a benchmarking tool for companies, one intention in establishing the 10-10 Programme in Norway was to establish a database with a large volume of reliable project data that could be used for academic project management research (Langlo et al., 2017).

### Description of the dataset

The projects in the database can be grouped into two main categories: infrastructure projects and building projects. The building projects typically include hospitals, schools, apartment buildings and other large buildings. The infrastructure projects are mainly related to road construction projects and power grid development project. With regards to the delivery method used for the 142 projects recorded in the database, the distribution was as follows: 50 of the projects used the design-bid-build method, 76 projects used design-build, 14 used parallel primes, while two used Integrated Project Delivery models.

The dataset for each project consists of two main sections. The first section contains descriptive information, which includes specific scope, cost and schedule data for the project. Both planned and actual values are registered. The second section contains data collected through a questionnaire developed by CII based on their research on industry best practices (Yun et al., 2016). The full set of questionnaires can be downloaded from the 10-10 Programme website https://wikis.utexas.edu/display/CII1010/10-10+Questionnaires. Certified 10-10 benchmarking coordinators facilitate the data collection process in each company through workshop session to ensure reliability of the data. On average, these workshop sessions included 11.5 respondents for each project. The coordinators also provide guidance to respondents who have questions related to interpretation of the questions. Numbers and values such as cost data, schedule data, etc., are entered into the database by the coordinator together with the project manager and/or project control personnel. Furthermore, when a company's 10-10 coordinator submits the data to the database, the data are validated by CII in the United States as a final check of the dataset.

### Statistical analyses of the dataset

All the raw data from the dataset from the Nordic 10-10 Programme were entered into the software IBM SPSS Statistics by the author of this thesis. This software is widely used by researchers to analyse quantitative data (Bryman, 2016).

Bivariate analysis is typically used when searching for evidence that variation in one variable correlates with the variation in another variable. However, one should be aware that a common misuse of such correlations is to interpret them as an explanation for cause and effect (Bryman, 2016). The number between 0 and 1 indicates the strength of the relationship between the variables. A value close to 0 indicates a weak relationship, as opposed to values closer to 1, which indicate a strong relationship (Bryman, 2016). Various labelling systems exist to categorise the value of the correlation, i.e., the strength of the relationship. For example, Taylor (1990) argues that <0.35 indicates weak correlations while values between 0.36 and 0.67 have moderate strength. Higher values indicate stronger correlations. For medical research, Mukaka (2012) suggests the following rule of thumb: negligible (<0.30), low strength (0.30-0.50), moderate strength (0.50-0.70), high strength (0.70-0.90) and very high strength (>0.90).

In addition to the strength of the relationship, it is important to check whether the relationships that are found are statistically significant – i.e., to what extent can one expect that the findings apply to projects outside the sample size. According to Bryman (2016), statistical significance at <0.05 or lower is in general considered acceptable in social research. This means that there is a five percent (or less) chance of identifying a relationship in the specific dataset that is not representative of a larger population.

## 3.11 Reflections and main criticism of research method

Being a PhD student is a journey. Since the start in March 2017 I have learned a lot about research methods. There have been many sources for this learning process, such as PhD courses, conversations with supervisors and colleagues, comments and suggestions for improvement from peer reviewers, reading numerous books and papers, to mention a few.

In general, the research has followed a classical sequential model as was shown in Figure 3-1 (see page 103). However, as I have learned more and more along the way, there was sometimes a need to take a step back and readjust. Hence the process had elements of several iterative loops. There are also things that in hindsight I would have done differently. The following section contains reflections and presents shortcomings and criticism of the research methods used in this thesis. In particular, the following issues will be addressed:

- Reliability (how precise the research method is)
- Validity / generalisability (how valid the findings are outside the studied context)
- Ethical aspects of the conducted research

When measuring something, there are two key issues to address: Are the right things being measured? and how right are these measurements? The first question relate to validity while the second question relate to reliability (Bryman, 2016).

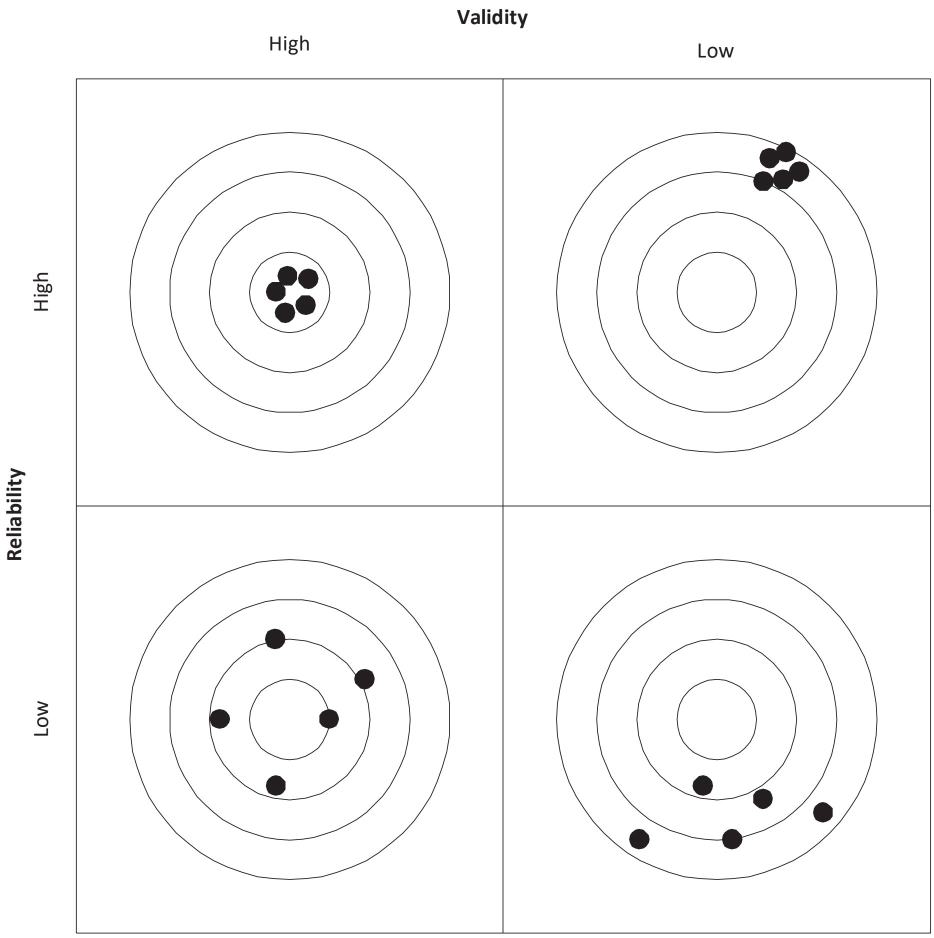



*Figure 3-9: Reliability and validity, redrawn from (Cooper and Schindler, 2008, p. 292)*

Reliability describes the accuracy and precision of a measurement procedure, while validity assesses the extent to which the measurement procedure actually measures what it was intended to measure (Cooper and Schindler, 2008). Figure 3-9 illustrates this using the metaphor of an archer at the shooting range. At the top right corner, the archer hits the same spot every time. This indicates that the reliability of the bow being used is high as the archer hits the same spot each time with high precision. However, the validity is low, as the archer is aiming for the wrong target. The lower left quadrant shows an example where the archer may be aiming at the right target (high validity) but his bow is unreliable as the shots are scattered around the target with low precision. The bottom right quadrant shows an archer aiming at the wrong target (low validity) and uses an unreliable bow unable to shoot the arrow where the archer is aiming. Eventually, in the top left corner, the archer is aiming at the right target and is repeatably able to hit this target with high precision, i.e. achieving high validity and high reliability. When evaluating the quality of research, it is crucial to consider both the reliability and the validity of the research (Bryman, 2016). Both the reliability and the validity of the research in this thesis will be considered further in the following sub-chapters.

### 3.11.1 Reliability of the research

The two main data sources for this thesis are through interviews and the Nordic 10-10 project database. When it comes reliability, this has to do with the accuracy of the research. Four common threats to reliability are listed in Table 3-10. This is followed by a description of what was done in this thesis to mitigate each of these four threats.

***Table 3-10: Threats to reliability (Saunders et al., 2019, p. 214)***

| Threat | Definition and explanation |
|---|---|
| Participant error | "Any factor which adversely alters the way in which a participant performs. For example, asking a participate to complete a questionnaire just before a lunch break may affect the way they respond compared to choosing a less sensitive time" |
| Participant bias | "Any factor which induces a false response. For example, conducting an interview in an open space may lead participants to provide falsely positive answers where they fear they are being overheard, rather than retaining their anonymity" |

| | |
|---|---|
| Researcher error | "Any factor which alters the researcher's interpretation. For example, a researcher may be tired or not sufficiently prepared and misunderstand some of the more subtle meanings of his or her interviewees" |
| Researcher bias | "Any factor which induces bias in the researcher's recording of response. For example, a researcher may allow her or his own subjective view or disposition to get in the way of fairly and accurately recording and interpreting participants' responses" |

### Reliability of interviews in this thesis

To reduce *participant error*, interviews were conducted as face-to-face meetings in order to get a more comprehensive impression (Bryman, 2016) and more accurate answers (Shuy, 2002) than what one could achieve through telephone or video calls. The location of the interview can affect the balance between the interviewer and the respondent (Herzog, 2005). Reluctant respondents may be more willing to share information if they are interviewed in an environment where they feel comfortable (Adler and Adler, 2001). Most of the interviews were therefore conducted in meeting rooms at the location where the respondents work.

A factor that may induce *participant bias* in interviews is, for example, if the person being interviewed worries about how their answers may result in negative consequences for themselves. This may affect how the participant responds to certain questions, for example, if the respondent worries about how her or his boss will react. In order to reduce the risk of participant bias, all interviews were conducted in a room with a closed door to ensure that no others could overhear the interview. The participant was also informed upfront how their anonymity would be ensured.

Audio recording may cause respondents to be less willing to share information during the interview (Saunders et al., 2019; Warren, 2002). However, not audio recording interviews may increase the threat of both *researcher error* and *researcher bias***.** Audio recorded interviewing allows the researcher to examine the interviews in more detail and it provides higher accuracy than if the interviews are not audio recorded. Since no audio recording was used, several measures were taken to reduce researcher error and bias. The first measure was to ensure that there was sufficient time after one interview to finish writing the detailed summary on a computer from my handwritten notes immediately after the interview was conducted. In general, only one interview was conducted in a day, with some exceptions where two interviews were conducted in one day. The second measure was that, within 24 hours after the interview, the summary of the interview was sent to the participant for review. The participant could then provide feedback and correct misunderstandings or highlight misinterpretations of what they had shared during the interview.

The interviews for this thesis were conducted within the first 12 months of the PhD project. Conducting these interviews at this early stage instead of postponing it to later had several benefits. In particular, I learned things from the interviews that opened my mind and inspired me to enhance the literature search to explore related research. However, the 38 interviews were conducted over a period of 3-4 months following the same interview guide. During this period, significant time was spent on conducting these interviews. In hindsight, I still believe that it was good to start the interviewing process this early (the first interview was conducted after 8 months) but there would have been some potential benefits if the period for conducting the interviews had been longer. One option could have been to conduct the interviews over two phases. This would have made it possible to implement more elements from the findings and analyses of the first half of the interviews into a revised interview guide for the second phase with interviews.

### Reliability of data from Nordic 10-10 Programme

The data collection process for the companies that participate in the Nordic 10-10 Programme follows a stringent procedure that is coordinated by a person in each company who has received training and is certified to facilitate this process. The total number of projects that currently have registered data in the database is 142. Only cases that contain the required data have been included in the various statistical analyses conducted in this research. Cases where the value for the measured variable has not been registered in the database are not valid and therefore not included in the statistical analysis.

In paper 2, data from 142 projects are included while paper 4 is based on data from 134 projects. The reason for this difference is that eight of the 142 projects did not include all the data that was needed to investigate the specific research question in paper 4 and the number of projects is therefore reduced to 134 for paper 4.

For paper 2, the rightmost column in Table 4-2, which can be seen on page 169, shows how the number of valid cases varies between 104 and 142 for four different variables that were investigated.

The data are normally collected during defined workshops in the project to reduce the participant error. These workshops are facilitated by the 10-10 coordinator, where relevant people from the project are gathered in a meeting room and register data and respond to survey questions on their personal laptops. During these workshops, the coordinator is available to the participants if they have any questions or need clarification related to interpretation of terms and questions used in the questionnaire.

When it comes to the risk of participant bias, there are two aspects worth mentioning. First, being measured does affect behaviour (Spitzer, 2007) and one can therefore argue that there is a risk that participants in their daily work may focus more on specific elements that they know will be measured through the 10-10 programme than on other elements not specifically measured. There is also a risk of participant bias, as many of the participants to some extent are responsible or accountable for the project outcome. One can therefore argue that this may have influenced how respondents answer certain questions, as they may have an incentive to make their project "look better" than what it really is.

Moving on, the threat from researcher error and researcher bias is reduced simply because a stringent procedure is followed – both in terms of the data collection process during the workshops and in terms of registering the data in the 10-10 database. This process uses a tool developed by the Construction Industry Institute (CII) and after data collection is completed for a project, the entire dataset is validated by CII staff who search for mistakes or inconsistencies before it is uploaded into the data base. However, the process of transferring the dataset from the 10-10 database to the SPSS software was done manually by the author of this thesis. Although great care was taken when conducting this operation, there is a risk that errors may have occurred.

In paper 4, the project management cost for each project was calculated based on the size of the project management teams as registered in the dataset multiplied with annual salary statistics for the Norwegian construction industry. The accuracy of these project management costs is therefore lower than if the projects had recorded these costs directly instead of only registering the average size of the project management team during the project duration.

### Reliability of constructs used in statistical analysis

The more questions that measure the same attribute, the greater the reliability of the data. However, when using multiple indicator construct measures, such as several questions from a questionnaire, it is important to make sure that these questions measure the same thing or phenomenon (Bryman, 2016). Constructs should be built based on existing theory and the internal reliability of the construct must be checked. A commonly used test is to calculate the *Cronbach's coefficient alpha* (Bryman, 2016). This is a coefficient developed by Cronbach (1951) to measure the internal consistency of a scale containing multiple items. The higher the value of the coefficient, the more reliable are the constructs. An often cited source is Murphy and Davidshofer (2005), who suggested that values below 0.6 are unacceptable, 0.7 is low level, 0.8-0.9 is moderate to high level, and above 0.9 is high level. Kaplan and Saccuzzo (2009) state that coefficients in the range between 0.7 and 0.8 are generally considered "good enough" for most research and that the more items included in a construct the more reliable it becomes. Bryman (2016) recommends 0.8 as a rule of thumb for an acceptable level. Although more than two decades old, it is interesting to read the work by Peterson (1994), who investigated alpha coefficients from 832 published studies and found that the mean value was 0.77. Furthermore, Peterson (1994) explored the alpha value for studies using various construct scales. For constructs based on more than three items and with Likert scales containing more than four scale items, the mean value was 0.78 (Peterson, 1994).

Presenting a high Cronbach's alpha is not in itself enough to verify that constructs measure the same attribute (Schmitt, 1996). The constructs must also be based on a solid theoretical foundation to ensure validity (Bryman, 2016), i.e. to verify that they measure the actual phenomena that they are intended to measure. A comprehensive literature search was therefore conducted, and the constructs were based on the theoretical foundation shown in Table 2-5.

Using the IBM SPSS software, the Cronbach's alpha coefficient was calculated for the constructs used in paper 2. Cronbach's alpha for the constructs was found to be in the range between 0.79 and 0.93. It is therefore fair to argue that the questions from the questionnaire that have been associated with each construct have acceptable internal consistency, i.e., the various questions combined into a construct measure the same attribute or concept.

In addition to the Cronbach's alpha being acceptable, the factor loading should be investigated in order to determine the minimum sample size needed to ensure statistical significance. A loading factor of 0.70 or higher means that a sample size of 60 is sufficient. The sample size is between 104 and 142 for the constructs measured in paper 2 and the lowest factor loading was found to be 0.73. According to Hair et al. (2014), a sample size of 100 requires a factor loading of minimum 0.55 to be acceptable – i.e. the sample size used is acceptable.

Furthermore, the composite reliability (CR) value should be minimum 0.70 (Bagozzi and Yi, 1988) and the values for the average variance extracted (AVE) should not be lower than 0.50 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). The lowest CR value found was 0.87 and the lowest AVE value is 0.60, i.e., acceptable.

### 3.11.2 Validity of the research

In terms of research validity, it is common to differentiate between *external validity (generalisability)* and *internal validity*.

#### External validity (generalisability)

External validity refers to which extent it is possible to claim that the findings from the research are valid for a larger sample than what was studied – i.e., to what extent can findings be generalised across persons, settings, and time. In terms of this external validity, one important aspect to consider is to what extent the findings from the papers in this thesis can be generalised outside the context where the data was collected and analysed (Saunders et al., 2019; Yin, 2014). The following section describes key aspects related to the external validity of the research in this thesis.

The two data sources analysed in the papers in this thesis are interviews with project managers from three different industries in Norway and a database with project data from Norwegian construction projects collected through the Nordic 10-10 project. One distinctive aspect of the Scandinavian school of project management is that it is commonly viewed as more focused on the organisational perspective of project management (Andersen, 2016; Walker and Lloyd-Walker, 2016a), where there is particular high focus on building trust (Strand and Freeman, 2015) in the relations between the actors.

Several of the project managers who were interviewed worked in international companies and many had experience from international projects. Many of the projects that were discussed during the interviews included supply chains that crossed many borders. It is therefore fair to claim that even though the interviews were conducted among Norwegian project managers, the findings from these interviews should also be relevant to projects outside Norway.

In terms of the other dataset with project data collected through Nordic 10-10, these are all Norwegian projects. However, the projects are mainly related to construction of various buildings such as schools, offices and apartment buildings and construction of infrastructure such as roads and powerlines. These are all types of projects that are not unique to Norway but relevant to most parts of the world. Also, the questions in the questionnaire that were used by Nordic 10-10 when collecting the data were developed by the CII based on their comprehensive research on best practices from the US (Yun et al., 2016).

Despite the Norwegian context of the interviews and the data collected through the Nordic 10-10 organisation, one can argue that the findings, at least to a certain extent, can be generalised to other settings. In order to generalise findings from research, the size of the dataset matters. The larger the dataset that is investigated, the more likely it is that the findings can be generalised to a larger population (Saunders et al., 2019; Bryman, 2016).

The total number of interviews conducted for this thesis was 38. At this stage, the benefits of conducting more interviews were limited compared to the time this would take as the data started to reach saturation. To improve the external validity (generalisability) of the interviews, respondents from both clients and contractors were recruited to ensure that both perspectives were covered. Also, the dataset from the Nordic 10-10 project contains data collected from both client type companies and contractor type companies.

At the time when the thesis research started, the Nordic 10-10 project database consisted of data from around 90 projects. During the research period, the size of the database grew as more projects registered their data. The SPSS datafile was therefore consciously updated along the way with the latest data as these were made available. Currently, the database consists of 142 projects.

Presenting the results from research to expert groups is a commonly used approach to evaluate the generalisability of research (Bryman, 2016). To address the external validity (generalisability) of the research, findings from the research in this thesis were presented to groups of project practitioners on several occasions summarised below.

- A group of 40 ICT project practitioners (23 May 2018)
- A group of 18 oil and gas project practitioners (21 November 2018)
- A group of approx. 50 construction project practitioners (15 May 2019)
- Master's students participating in the continuous education programme at NTNU (2018-2020)

On three occasions, I was invited to various companies and organisations to present findings from my ongoing research. In addition, as part of my required duties at NTNU, I teach classes in project management for students who are part of the master's programme in project management offered by the university. I also used this opportunity to discuss findings from the research with these master students. These are mature students who work as project practitioners while conducting their master studies as part of a continuous education programme. In general, the feedback from the different groups of project practitioners was that the findings that were presented to them corresponded well with their experience as practitioners.

### Internal validity

Internal validity refers to the measuring tool applied by the researcher, and whether this tool actually measures what the researcher claims that it measures (Cooper and Schindler, 2008). The 26 factors for transaction costs established by Li et al. (2015) were used as a framework for the coding interviews for paper 1 in this thesis. This framework was originally developed for determining transaction costs. In order to justify why these factors can be used for coding interviews about collaboration, an extensive literature search was conducted on factors affecting collaboration. This search revealed that 25 of the 26 factors have been discussed in existing literature. Hence, it is fair to argue that the framework presented by Li et al. (2015) is suited for coding the interviews to study factors that affect collaboration.

Even though the internal reliability of several questions from a questionnaire can be checked using statistics, such as the Cronbach's alpha, this is not sufficient alone. An acceptable internal reliability only means that the questions measure the same concept. However, this does not mean that the questions in a construct measure the concept it was intended for. Therefore, construct concepts must be soundly founded on theory (Bryman, 2016). For paper 2, the questions used in the dataset are not specifically designed to address the research question of the paper, but they are based on certain questions from an existing questionnaire developed by the CII for the 10-10 benchmarking tool. The questions in the questionnaire were reviewed and relevant questions related to the research questions were identified to measure collaboration quality. With this pragmatic approach, it is crucial to verify that the data used from the 10-10 dataset are relevant to the specific research questions and soundly founded on existing theoretical contributions. To ensure this, an extensive literature review was conducted, as presented in Table 2-5.

In this thesis, project transaction costs are quantified in terms of measuring the amount spent by the project on managing the project. This deserves some attention and should be discussed further in terms of the internal validity. The justification of why project management costs are considered transaction costs is based on an extensive literature review of project transaction costs that is presented in Chapter 2.2.3 of this thesis and in particular on research by (da Fonseca et al., 2018; Li et al., 2015; Rajeh et al., 2015; Lee et al., 2009; Walker and Kwong Wing, 1999). Although measuring the project management costs in a project is a relevant indicator to measure project transaction costs, there are also other transaction costs in projects that are not covered by measuring the project management costs alone. Hence, it is fair to claim that the numbers presented in this research in terms of project transaction costs do not include all transaction costs and that the total project transaction costs can be expected to be higher than what is presented in this thesis.

### 3.11.3 Ethical aspects of the research

The ethical aspects related to the research in this thesis is mainly related to privacy rights and handling of confidential information, such as cost data. This relates to both the respondents that were interviewed in this thesis as well as for companies that participate in the Nordic 10-10 Programme.

Respondents who participate in interviews must be treated fairly (Bryman, 2016; Jonasson and Ingason, 2015). To protect the privacy of the participants, their identity and the name of their employer were anonymised. In addition, if respondents named specific clients, partners or shared confidential information, the interviewer ensured that such information was anonymised when writing the summary from the interview. This summary was submitted to the respondent for review and approval. In Norway, the *NSD Data Protection Official for Research* is an agency that ensures that research is conducted according to Norwegian laws related to protection of the individual's right to privacy. The interview guide was therefore sent to this agency for approval. A one-page document with key information was sent to each participant prior to the interview. This document contained information about the purpose of the interview, details about the interview method and how anonymity would be ensured. Each respondent gave their written consent to participate in the interview based on these terms which can be seen in the appendix of this thesis (see Chapter 9).

In the Nordic 10-10 database, companies register data from their projects for the purpose of conducting benchmarking analyses and identify areas for improvement. This information includes specific cost and schedule data. This is information that may potentially harm a company if, for example, their cost data are leaked to a competitor. As a researcher, I have access to the full database with all these data. I therefore ensured that the name of the companies and the name of the specific projects were anonymised when registering the data in the SPSS software to conduct statistical analysis. Data that can be considered confidential have not been revealed in the papers of this thesis in a way in which they can be traced back to a specific company or project.

# 4 Findings from Individual Papers

This thesis contains of four scientific papers, and these are found in part II of this thesis. The purpose of the following chapter is to summarise the findings and discussions from each of these individual papers as listed Table 4-1.

***Table 4-1: Main finding from each paper***

| Paper | Main finding |
|---|---|
| Paper 1 | "Quality of communication" is the most salient factor affecting both transaction costs and collaboration in projects. |
| Paper 2 | Projects with a high level of collaboration perform significantly better in terms of quality of their deliverables. |
| Paper 3 | The most favourable used mechanisms to achieve good collaboration vary between a project's characteristic in terms of novelty, complexity, technology and pace. |
| Paper 4 | At least 18% of the total cost in construction projects are spent on project management in the client's and contractor's organisation. |

In paper 1, the aim was to investigate the extent to which various factors affect both project transaction costs and client-contractor collaboration. In paper 2, the aim was to investigate the relationship between the level of client-contractor collaboration and how well the project performs in terms of cost, time and quality. The aim with paper 3 was to investigate which collaboration mechanisms that was most successfully used for projects with different characteristics. Finally, the aim of paper 4 was to investigate what proportion of the total budget in a project that is spent on project management activities. Through chapter 4.1 to chapter 4.4 the findings from each of these four papers are presented and discussed.

## 4.1 Findings and discussions from Paper 1

The purpose of this paper was to respond to the call for further research on the framework suggested by Li et al. (2015) who presented 26 factors that determine project transaction costs. The objective is to empirically test the framework to identify which factors that have the greatest influence on project collaboration so that practitioners can prioritise their efforts on the most salient factors that will improve collaboration and have a positive effect on project transaction costs.

A total of 38 semi-structured interviews were conducted with respondents from three different industries. Figure 4-1 shows a summary of the findings. The figure shows how frequently the 26 different factors, from the framework proposed by Li et al. (2015), are found in the interviews as factor that influence collaboration.

| The role of the owner | | The role of the contractor | | The transaction environment | | Project management efficiency | |
|---|---|---|---|---|---|---|---|
| Organizational efficiency | 74% | Bidding behaviour | 38% | Project uncertainty | 74% | Quality of communication | 92% |
| Change orders | 56% | Relationship with previous clients | 38% | Integration of design and construction | 46% | Leadership | 46% |
| Relationship with other parties | 41% | Frequency of claims | 31% | Early contractor involvement | 44% | Quality of decision making | 26% |
| Experience in similar type projects | 28% | Qualifications of the contractor | 31% | Completeness of design | 38% | Conflict management | 15% |
| Payment on time | 5% | Relationships with subcontractors | 21% | Incentive/disincentive clauses | 38% | Technical competency | 8% |
| | | Experience in similar type project | 15% | Risk allocation | 33% | | |
| | | Material substitutions | 10% | Project complexity | 18% | | |
| | | | | Competition between bidders | 18% | | |
| | | | | Bonding requirements | 0% | | |

***Figure 4-1: Percentage of interviews in which factor was found to influence collaboration***

### 4.1.1 RQ 1: Most salient factors

The five most frequently found factors that influence both project transaction costs and collaboration level are shown in Figure 4-2. These were: quality of communication, project uncertainty, owner's organisational efficiency, change orders and trust.

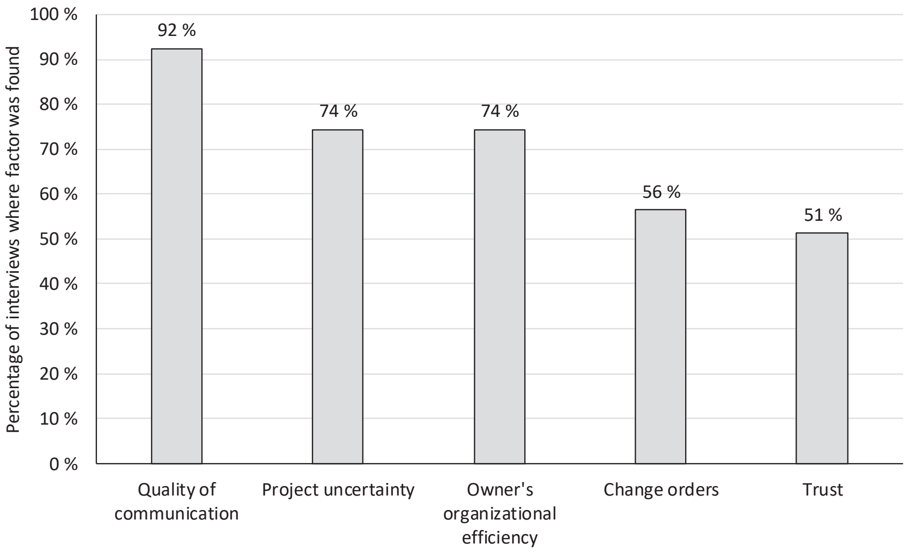



***Figure 4-2: Paper 1, RQ1 - Five most salient factors***

Among the factors that determine transaction costs in projects, *quality of communication* was identified as the factor that has the highest influence on project collaboration. This factor relates to the project participant's ability to communicate in a way where information is shared and misunderstandings are avoided (Costa e Silva et al., 2012). The fact that quality of communication was found to be the most salient factor is in line with existing research on collaboration, as effective communication has been identified as a factor which influences collaboration quality (Aliakbarlou et al., 2018; Nevstad et al., 2018; Yap et al., 2017; Dietrich et al., 2010). Incomplete or poor communication may cause misunderstandings and lead to potential conflicts (Lædre, 2009). Turner and Müller (2004) argue that the best results occur by balancing formal and informal communication. This is in line with the findings from paper 1, as the interviewees described how frequent use of telephone and face-to-face meetings was often the preferred solution for resolving problems. The agreed solution was formalised through use of formal project communication (i.e. e-mail, letter, memo) after the solution was found.

It is not surprising that *project uncertainty* affects project collaboration, as it is critical to have a clear understanding of the scope of work to achieve success in a project, (PMI, 2017). High uncertainty increases the need to collaborate in order to prevent project actors from becoming opportunistic (Um and Kim, 2018; You et al., 2018). In fact, several of the interviewees gave examples of how uncertainty and unclear scope of work caused misunderstandings and extra work. In the early phase of a project, there is a lot of information that is not available. It was therefore particularly interesting to find that those of the interviewees who worked in projects with pain-share / gain-share models reported that such models helped to reduce information asymmetry and uncertainty, as they experienced a high level of openness and willingness to share information between the parties.

Another important finding was related to the *owner*'s *organisational efficiency*. The need for the client to be actively involved in the project was highlighted by several respondents, and in particular by those working in agile projects. One of the requirements for success in agile project management is to have dedicated clients on site that work closely with the contractor (Azanha et al., 2017; Lappi and Aaltonen, 2017). Several of the interviewees confirmed this, as they reported how lack of active involvement from the client had a negative effect on the collaboration in their project. The client's representative must have the right mandate within his/her organisation in order to allow the contractor to perform their task efficiently. Several of the contractor-respondents in the interviews described situations where they were in agreement with the representative from the client, only to find out later that this person did not have the mandate or authority within his or her own organisation to make such decisions. Other examples of low organisational efficiency included examples of internal conflicts in the client's organisation.

Opportunistic contractors may choose to lower their margins and reduce their price in order to increase their chances of winning the contract with a client (Mohamed et al., 2011; Arditi and Chotibhongs, 2009; Tan et al., 2008) and thus speculate that they will recover the loss later through change orders and claims (Lo et al., 2007; Crowley and Hancher, 1995; Zack, 1993). Contractors with more detailed information and knowledge than the client may exploit this situation of asymmetric information (Mandell and Nyström, 2013) and issue many change orders during the project. The findings are in line with existing research as they indicate that opportunistic change orders have a negative effect on the collaboration level in the contractor-client relationship.

Although *trust* is an underlying element of several of the factors in the framework, it is not considered as a separate factor by Li et al. (2015). However, this emerged as an important factor when coding the interviews. The impact of trust in the relationship between clients and contractors has been established by others such as Pinto et al. (2009) and Kadefors (2004). In fact, 21 of 38 interviewees in the conducted study suggested *trust* as a factor that influences project collaboration. This is also in line with findings from previous research, which have revealed a strong relationship between trust and collaboration (Bond-Barnard et al., 2018; Izam et al., 2015).

### 4.1.2 RQ 2: Different industries

Figure 4-3 shows the three most frequently found factors differentiated by the industry where the respondents work. For ICT projects the three most frequent factors were: quality of communication, owner's organisational efficiency and project uncertainty. The three most frequent factors found for construction projects were: quality of communication, project uncertainty and frequency of claims. For oil and gas projects these were: quality of communication, owner's organisational efficiency and trust. There seems to be a consensus between interviewees from all three industries that quality of communication is an important factor that influences collaboration. However, the study also revealed some interesting differences between the industries that deserve further discussion.

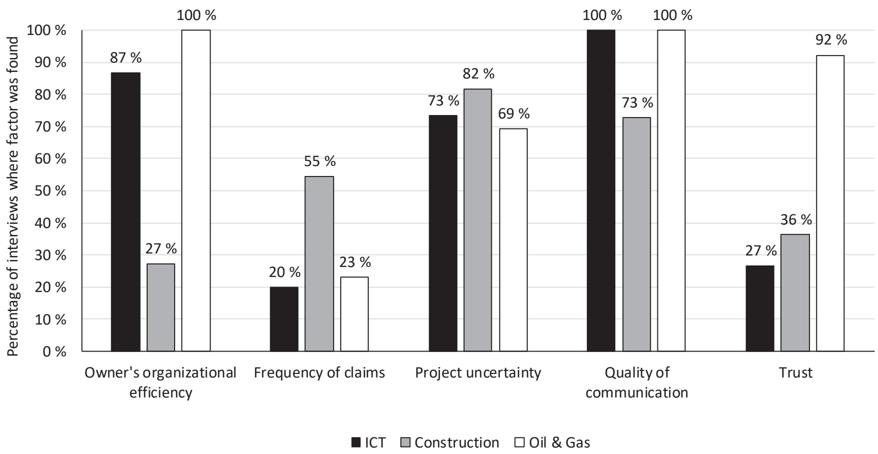



***Figure 4-3: Paper 1, RQ 2 - Top three most frequent factors that influence collaboration in different industries***

First, one can see that interviewees in the construction industry do not consider the owner's organisational efficiency a particularly important factor that influences project collaboration. In contrast, this factor was among the top three most frequently found factors in the other two industries. For example, respondents who worked in ICT projects frequently described how their agile project models required efficient clients. If the owner did not allocate the right resources from its own organisation to participate in these processes on a daily basis, it was difficult to be truly agile. The importance of the owner's behaviour in order to achieve collaboration in construction projects has been presented by (Davies et al., 2009; Eriksson et al., 2009). It therefore came as a surprise that the owner's organisational efficiency was identified in so few of the interviews with respondents working in construction projects.

Secondly, Figure 4-3 shows that trust is considered a very important factor for collaboration in oil and gas projects, while it seems to be in particular less salient in ICT projects. In this discussion, it is worth pointing out that several of the interviewees from the oil and gas industry worked in projects with alliance collaboration models. Such models require trust and openness (Hietajärvi et al., 2017; Walker and Lloyd-Walker, 2015; Hauck et al., 2004), something several respondents underlined. Respondents described how the alliance acts as a unity and is jointly responsible for the execution of the project. If the alliance fails, all members fail; if the alliance succeeds, all members succeed. Moving away from traditional delivery methods to alliancing often foster improved innovation (Che Ibrahim et al., 2017) and better productivity (Sarhan et al., 2017). An interviewed project manager from the client perspective gave an example of how the turnaround time for handling change requests had been reduced from 30 days to 10 days when working in an alliance with the contractors.

*Frequency of claims* was found to be the third most important factor in construction projects, while this factor is significantly less salient in the two other industries. The conflict level in the Norwegian construction industry is high (Kvålshaugen and Sward, 2018) and this may be the reason why frequency of claims was found to be particularly important for projects in this industry. Opportunistic claims often have a negative effect on the client-contractor relationship (Mohamed et al., 2011) and several of the interviewees from the construction industry gave examples of relations with a low level of trust.

### 4.1.3 RQ 3: Different perspectives

It is also worth discussing how the five factors most frequently found for RQ1 vary between the client perspective and the contractor perspective. The result from this analysis is presented in Figure 4-4. The findings do not suggest that there are any large differences between the contractor and the client perspective in how they view which factors influence collaboration in projects. In general, there seems to be a consensus between the contractor and client perspective about the importance of the various factors.

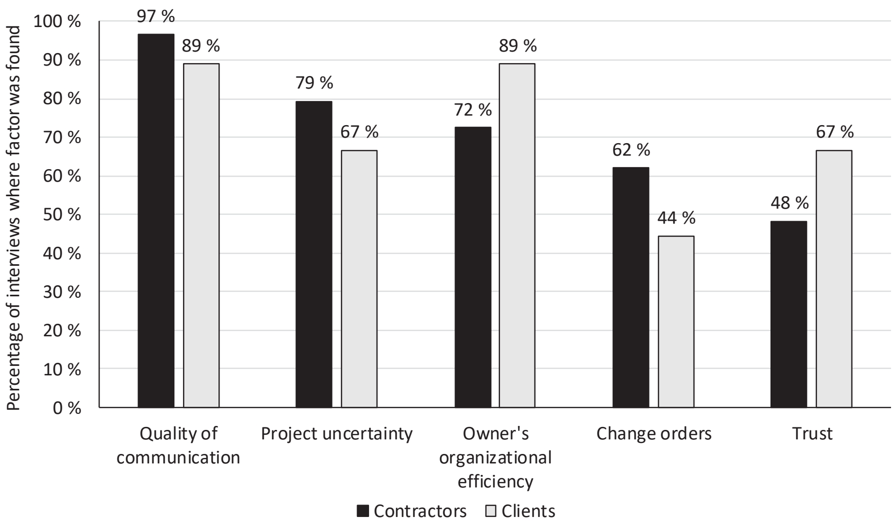



***Figure 4-4: Paper 1, RQ 3 - Five most salient factors that influence collaboration separated by roles***

Keeping in mind that the number of interviewees from the contractor side is approximately three times the number of interviewees from the client side, this does not seem to have any significant impact on the findings related to RQ1 and RQ2. If large differences had been found between the contractor and the client perspective, one could have argued that the findings for RQ1 and RQ2 would be less valid since more contractors than clients were interviewed. As seen from Figure 4-4, both contractors and clients consider quality of communication to be the most salient factor that influences the collaboration level. The largest relative difference between the two perspectives is related to change orders. Contractors seem to consider issues related to change orders to be a somewhat more important factor on the collaboration level in the project than clients do. In particular, contractors stress the importance of reducing uncertainty in order to collaborate better. Clients seem to be aware of the importance of their own role in projects, as they acknowledge that their own organisational efficiency is an important factor that influences collaboration.

## 4.2 Findings and discussions from Paper 2

The purpose of this paper was to measure the collaboration quality in projects and investigate the relationship between collaboration quality in the relationship between client and contractor and project performance in terms of cost, schedule and quality (i.e. within the iron triangle).

An indicator was established to measure the quality of the collaboration in the projects. This indicator was constructed based on collaboration elements that were identified through a literature review that was presented in Table 2-5 and consisted of the following four constructs: trust, communication, teamwork and coordination. This indicator was applied to a dataset from 142 construction projects and used bivariate analyses to investigate the correlation with cost growth, schedule growth and quality level of the project deliverables.

### 4.2.1 Descriptive findings

The main descriptive data from the analysis are shown in Table 4-2 and the frequency distribution of the data is presented in Figure 4-5. The projects experienced a mean cost growth of 14% compared with the planned cost. Out of a total of 104 valid cases, 63 of these reported a cost performance within ± 5% or better compared with the planned cost. The remaining 41 projects exceeded the planned cost by more than 5%, and 16 of these exceeded the planned cost by more than 25%. The mean schedule growth factor was 13%. From 125 valid cases, 85 projects reported a schedule performance within ±5% of the planned duration or better. The other 40 projects exceed the planned duration by more than 5%, where 23 of these exceeded the planned duration by more than 25%. These values for cost growth and schedule growth are similar to results published in a recent study of 418 projects where Chen et al. (2016) found that that 77% of the projects were completed on cost or below, and that 68% finished on time, or ahead of time.

***Table 4-2: Descriptive statistics***

| Variable | Scale | Mean value | Std. deviation | Valid cases |
|---|---|---|---|---|
| Cost growth | (Actual cost / planned cost) - 1 | 0.14 | 0.53 | 104 |
| Schedule growth | (Actual duration / planned duration) - 1 | 0.13 | 0.51 | 125 |
| Quality of deliverables | Indicator ranging from 0-100 | 70.4 | 9.9 | 142 |
| Collaboration quality | Likert (1-5) | 3.76 | 0.52 | 142 |

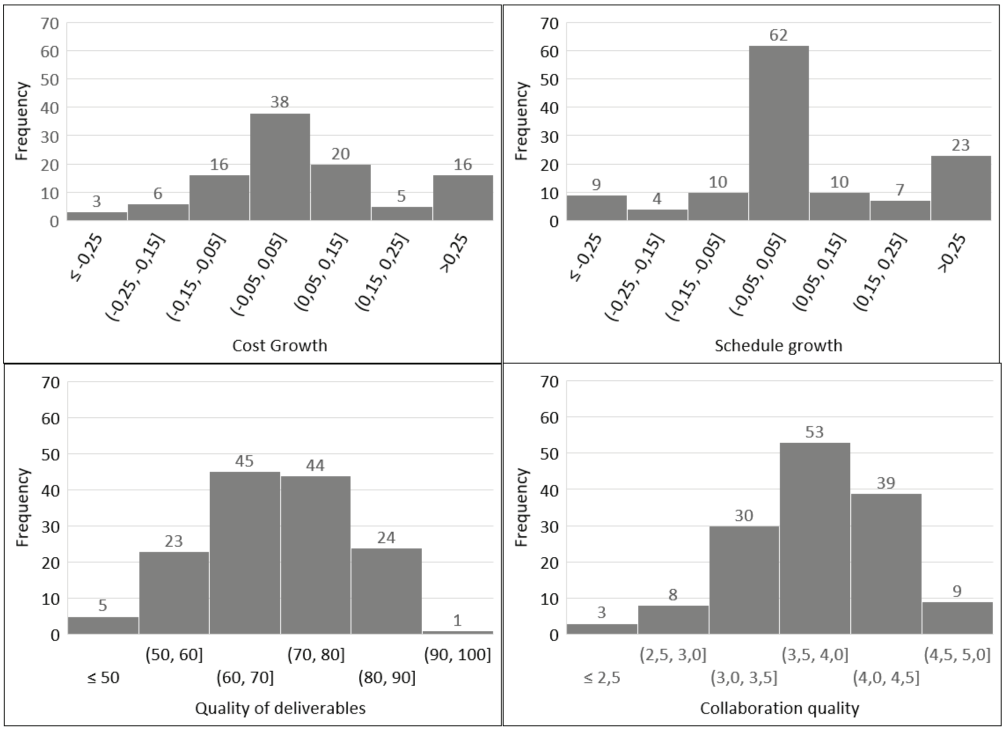



***Figure 4-5: Frequency distribution of results. Cost growth (top left), schedule growth (top right), quality of deliverables (bottom left) and collaboration quality (bottom right).***

The top left and top right diagrams in Figure 4-5 show distribution for cost growth and schedule growth. From those projects that finish above cost or behind schedule, many of them exceed the planned value by 25% or more. The fact that so many of the projects are found to the right in these two diagrams, away from the mean value, explains why the standard deviation is high compared with the mean value for cost growth and schedule growth in Table 4-2.

Moving on, quality of deliverables was measured on a scale from 0-100 and the projects received a mean score of 70.4 for the measured indicator. The bottom left diagram in Figure 4-5 shows that the distribution for this indicator follows a bell curve where few of the projects are to the far left or far right in the diagram. A similar distribution, although slightly skewed, is also found for the quality of collaboration indicator (bottom right diagram in Figure 4-5). On a Likert scale from 1 to 5, the mean score was 3.76 for this variable.

### 4.2.2 Bivariate analysis – Pearson's r correlation

A summary of the Pearson's r correlations is shown in Table 4-3 and in Figure 4-6. This shows that a statistically significant correlation was found between collaboration quality and project performance in terms of the quality dimension. No statistically significant correlations were found between collaboration quality and cost growth or between collaboration quality and schedule growth. These findings are presented in more detail in the following section.

***Table 4-3: Pearson's r correlations between performance and collaboration quality***

| Variable / Variable | | Cost growth | Schedule growth | Quality of deliverables | Collaboration quality |
|---|---|---|---|---|---|
| Cost growth | Pearson Correlation | 1 | | | |
| | Sig. (2-tailed) | | | | |
| | N | 104 | | | |
| Schedule growth | Pearson Correlation | -.002 | 1 | | |
| | Sig. (2-tailed) | .984 | | | |
| | N | 102 | 125 | | |
| Quality of deliverables | Pearson Correlation | -.147 | -.086 | 1 | |
| | Sig. (2-tailed) | .138 | .341 | | |
| | N | 104 | 125 | 142 | |
| Collaboration quality | Pearson Correlation | -.088 | -.081 | .744** | 1 |
| | Sig. (2-tailed) | .372 | .367 | .000 | |
| | N | 104 | 125 | 142 | 142 |

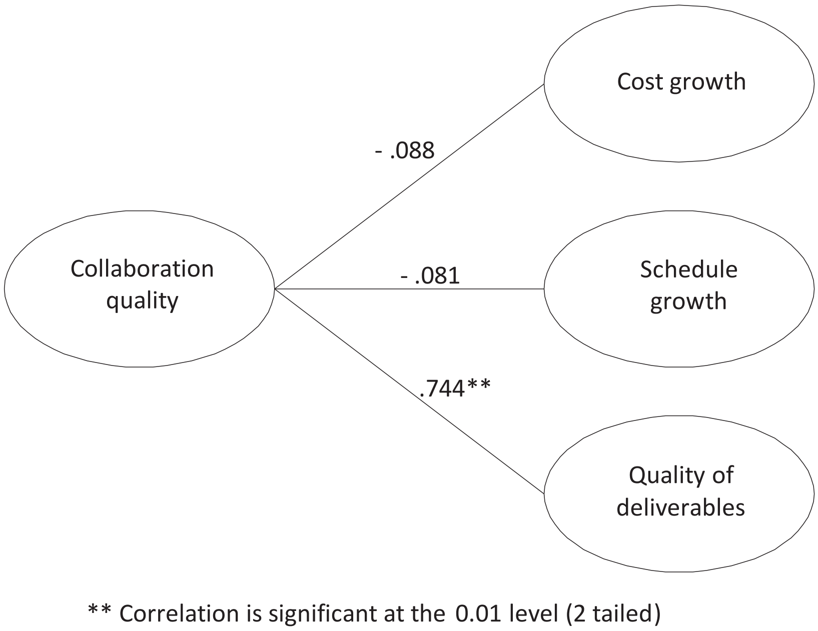



***Figure 4-6: Relationship between collaboration quality and project performance within the Iron triangle***

## Collaboration and cost growth

The correlation between collaboration quality and cost growth was weak (-0.088) and not statistically significant. There is thus no empirical evidence suggesting that there is a clear relationship between the level of collaboration in a project and how well a project perform in terms of meeting its budget. A scatter plot of the results is provided in Figure 4-7 where the collaboration quality indicator is plotted along the horizontal axis and cost growth factor (actual cost vs planned cost) is plotted along the vertical axis. As one can see from the plot, there is no clear relationship between these two indicators.

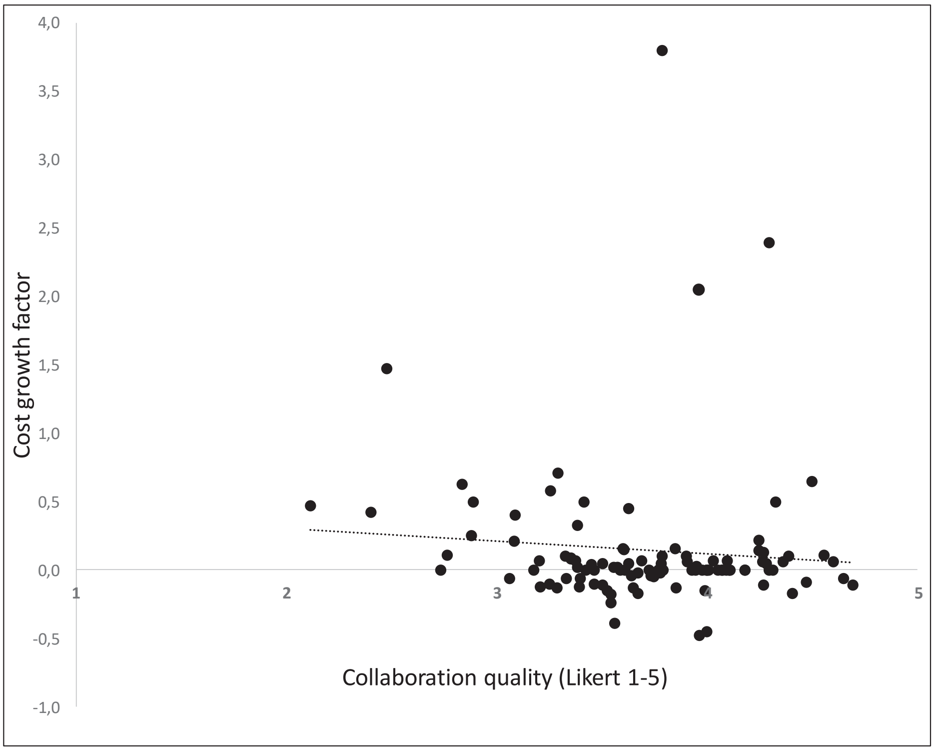



*Figure 4-7: Relationship between collaboration quality and cost growth*

### Collaboration and schedule growth

There were similar results for the relationship between collaboration quality and schedule growth. The Pearson's r correlation was -0.081 and not statistically significant. There was thus no empirical evidence suggesting a clear relationship between the collaboration quality in projects and their success in terms of on-time delivery. This can also be seen from the scatter plot in Figure 4-8. In this plot, the collaboration quality indicator is plotted along the horizontal axis while the vertical axis shows the schedule growth factor (actual duration vs planned duration).

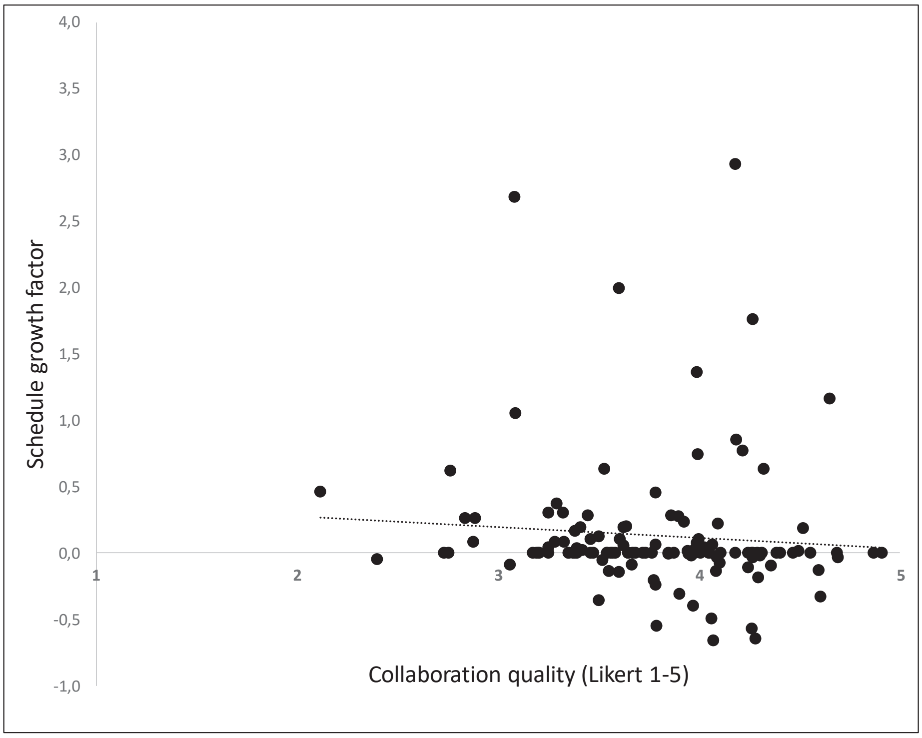



*Figure 4-8: Relationship between collaboration quality and schedule growth*

## Collaboration and quality performance

However, when it comes to performance in terms of the quality of the deliverables there was a moderate to strong correlation (0.744) with the level of collaboration. This correlation was also statistically significant to the 0.01 level. Projects that scored high on collaboration quality in general scored higher on the indicator that describes the quality of the deliverables from the projects. The scatter plot in Figure 4-9 illustrates this relationship. The horizontal axis shows the collaboration quality indicator and the vertical axis shows the rating of the quality of the project's deliverables, rated from between 0-100. Projects with high collaboration experienced fewer changes, errors and repairs than the others. They also more often met functional and regulatory requirements as well as having fewer non-conformances and deviations.

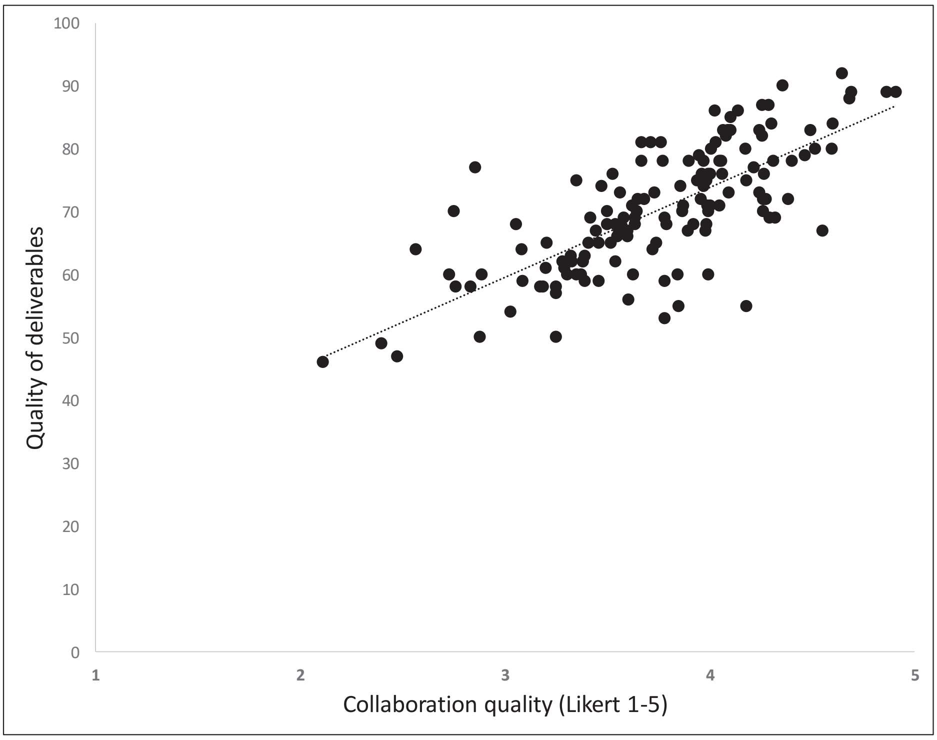



***Figure 4-9: Relationship between collaboration quality and quality of the project's deliverables***

## 4.3 Findings and discussions from Paper 3

The purpose of this paper was to investigate how project managers apply different collaboration mechanisms in projects depending on various project characteristics. Through 38 interviews with project managers the framework, developed by Shenhar and Dvir (2004) to distinguish between different types of projects, was applied to map the use of mechanisms to improve client-contractor collaboration in 69 projects.

Table 4-4 shows the ranking of the various collaboration mechanisms based on the number of projects in which these were used successfully. The most frequently found mechanism that was used to achieve successful collaboration was a*rrange kick-off meeting*. At the bottom of the table is u*se external collaboration facilitators – chaperoning*, a mechanism that was only used in a few of the 69 projects.

***Table 4-4: Ranking of collaboration mechanisms used successfully in projects***

| Rank | Mechanism used to achieve collaboration |
|---|---|
| 1 | Hold kick-off meeting to clarify expectations and establish ground rules for collaboration |
| 2 | Hold regular multidisciplinary work sessions |
| 3 | Spend time with key decision makers and stakeholders |
| 4 | Involve contractors and users early in planning |
| 5 | Open up books and share both bad and good news |
| 6 | Share IT solutions |
| 7 | Encourage frequent travelling to work sites and meetings. Increase travel budget |
| 8 | Co-locate teams, adjust physical workspace |
| 9 | Frequent use of social activities and teambuilding |
| 10 | Use collaborative procurement methods |
| 11 | Use advanced communication tools and video conferencing system |
| 12 | Use external collaboration facilitators – Chaperoning |

Figure 4-10 introduces *The Collaboration Compass*. Each direction of the compass shows the mechanism most frequently used to achieve successful collaboration depending on whether a project is characterised by its novelty, complexity, technology or pace.

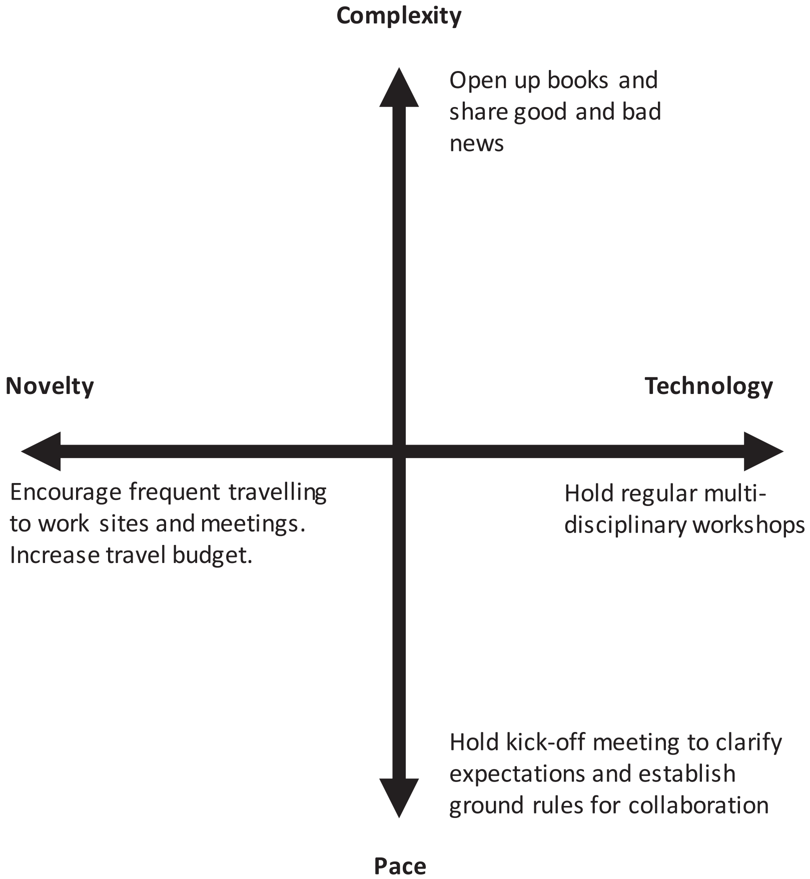



***Figure 4-10: The Collaboration Compass – most used collaboration mechanisms for projects with different characteristics***

The Collaboration Compass indicates that *encourage frequent travelling to work sites and meetings, increase travel budget* was the most frequently used mechanism for projects with particularly high novelty. For those projects governed by the complexity dimension the most frequently used mechanism was *open up books and share good and bad news*. For projects governed by the technology dimension, *holding regular multidisciplinary workshops* was the most frequently used mechanism. Finally, for projects characterised by the pace dimension, the most used mechanism was *hold kick-off meeting to clarify expectations and establish ground* *rules for collaboration*. Each of these four compass directions will be discussed further in the following sub-chapters.

### 4.3.1 Novelty direction – Encourage frequent travelling

Respondents who worked with projects with particularly high novelty reported that they frequently travelled to sites to conduct face-to-face meetings or to be present on the site where work was conducted. Project managers encouraged their team members to travel frequently and not only depend on video conferences, e-mails, etc. Managers of projects with high novelty allocated a significant travel budget and encouraged team members to travel between sites frequently to achieve good collaboration. Although encouraging frequent travelling was the most used mechanism for projects in the novelty direction, it was not much used in the other directions. In fact, Table 4-4 shows that this mechanism only ranks 7$^{th}$ between all projects. One reason for this may be that projects with high novelty have a higher degree of trial and error and later design freeze than other projects (Shenhar and Dvir, 2004) and may require particularly rich communication between the actors. It is therefore not surprising that project managers of this type of projects highlight the importance of meeting face to face to cope with the low maturity such projects may have. Specifications and plans may be unclear and industrial standards are often not available in these types of projects.

### 4.3.2 Complexity direction – Open up books and share information

Respondents who worked with projects with high complexity in particular highlighted the importance of opening up the books and sharing all good and bad news. Projects with high complexity have many interfaces and communication channels (Shenhar and Dvir, 2004) and often an intricate risk picture (Velayudhan and Thomas, 2018; Williams, 2017). Several respondents described the importance of being honest and sharing information with all parties to achieve efficient interface management and to reduce project uncertainty and risk. Opening up books and sharing information requires trust and a willingness to share (Hietajärvi et al., 2017). If there is mistrust – let us say for example that the client is afraid that a contractor may use information to speculate and claim extra payment through opportunistic change order requests, and vice versa – the willingness to share information may be disrupted.

Collaborative procurement methods, such as Integrated Project Delivery (IPD) or alliancing, often have incentives that encourage information sharing (Walker and Lloyd-Walker, 2015) to ensure win-win situations for all parties (Bititci et al., 2007). One could therefore expect that managers in complex projects, where information sharing and open books is particularly important, would also highlight the importance of collaborative procurement methods. However, only a few of the managers of projects with high complexity described the use of such methods and the majority used traditional contracting mechanisms. It is worth mentioning that high-order collaborative procurement arrangements are less common in the Nordic context compared to other regions such as the UK and South-East Asia (Bygballe et al., 2010) and this may therefore influence this particular finding.

The impact of social relations in projects is significant and incentive systems alone are not sufficient to ensure collaborative behaviour; there is a need to invest time in people and building relationships (Bresnen and Marshall, 2000). It is therefore not surprising that the mechanism *spend time with key decision makers and stakeholders* was frequently used across all project types, and in particular for projects with high complexity. For example, one of the respondents in a complex project described how he adjusted his work hours to spend more time with a key decision maker.

*"An important decision maker in the project owner organisation was always very busy during the day, however I noticed that he always worked late in the evenings. I therefore adjusted my working hours so that I spent more time in the building in the evenings as well, when he was less busy. We then had many long talks in his office or at the coffee machine in the evenings. We established common references and a relationship that was very valuable for the project." – project manager –*

### 4.3.3 Technology direction – Multidisciplinary workshops

Managers of high-tech projects described how they often used multidisciplinary workshops in their projects to achieve collaboration. Several of the respondents arranged regular workshops where participants from different disciplines and companies worked together. A wide variety of concepts and methods for such sessions is available, including Integrated Concurrent Engineering (ICE) (Chachere et al., 2004) and Last Planner (Cho and Ballard, 2011). For ICT projects, several respondents described the use of scrum techniques (Takeuchi and Nonaka, 1986). Although the difference between these concepts is distinct, a common denominator for such mechanisms is that they enhance multidisciplinary collaboration through organised work sessions at frequent intervals. The use of regular multidisciplinary workshops was common in the projects studied and many of the respondents described how such workshops were conducted. Several respondents described how they had prepared meeting rooms as a dedicated space where different disciplines could work together, so-called big rooms (Majava et al., 2019).

*"Every Tuesday we conduct ICE meetings. We have a big room where all can sit together. Next to the big room are several smaller rooms where groups can work together. There is a specific agenda for the ICE meeting where dedicated*

*persons are chairing various points on the agenda. During the meeting we always plan ahead for the next three weeks" – project manager –*

Co-location in terms of moving the project team to one location or building was not frequently found in the projects. However, there are clearly some elements of this mechanism being used in the example above as the project manager describes how they use a big room to conduct ICE meetings. The main difference is that co-location as a mechanism means locating the project staff at the same physical location to enhance informal communication on a day-to-day basis (Kokkonen and Vaagaasar, 2018), while multidisciplinary workshops, such as ICE meetings, may only require that the staff from the various actors sit together in one room during these workshops. The rest of the time, they may be working at different locations.

### 4.3.4 Pace direction - Kick-off meetings to establish ground rules for collaboration

The use of kick-off meetings was frequently used across all types of projects but was particularly popular with projects governed by the pace dimension. For such projects, having a short time-to-market is a competitive advantage. Short project duration in these projects has a significant impact on project success (Shenhar and Dvir, 2004). Many of the construction projects were governed by this dimension, because the owner wanted to make the building available for rent or sale as early as possible to start earning money. In order to reduce project duration, roles and responsibilities should be clear (PMI, 2017). To ensure an efficient start-up where all participants as early as possible have a common understanding of the project, many conducted kick-off meetings. During these meetings, roles and routines were established and ground rules were established between clients and contractors. There were several examples of how these kick-off meetings included development of team contracts. Clarifying expectations is an important aspect in this phase (Lloyd-walker et al., 2014). Collaboration meetings were often conducted in the beginning of the projects as a kick-off, but there were many respondents who described how such meetings were conducted at regular intervals throughout the project.

In terms of the stages of group development identified by Tuckman (1965), it may be particularly important for projects in the pace direction to reach the performing stage as quickly as possible. Kick-off meetings with a focus on ground rules for collaboration may reduce the risk of the project suffering a long period of storming. This could also explain why projects in the pace direction often invited users and contractors to participate in the project as early as possible. Also, several respondents in projects categorised by the pace dimension used various versions of the Last Planner system (Ballard, 2000) to ensure that the skilled workers were involved early in the detailed planning of project tasks.

### 4.3.5 Less frequently used collaboration mechanisms

In the above sections, the most frequently used collaboration mechanisms found for each of the four dimensions in the NCTP framework (Shenhar and Dvir, 2004) were discussed. It is also relevant to discuss some of those less frequently used mechanisms that have not already been discussed. All the different collaboration mechanisms listed in Table 4-4 were identified through a literature review of existing research on collaboration mechanisms listed in Table 2-6. Even though some of these mechanisms were found less frequently in this study, it does not mean that they should be considered to be non-relevant.

One third of the interviewed project managers described how they shared IT solutions to achieve collaboration. This was surprisingly low, as the use of common IT solutions through for example BIM models (Matthews et al., 2018), project portals and various online collaboration tools (Harley, 2011) is commonly described in collaborative project management research. Some respondents used project hotels to exchange interface information but only a few of the projects shared their IT solutions on a larger scale. Sharing of IT solutions was much more frequently used in ICT projects than in construction projects. Some of the ICT project managers described how they needed extensive access to the client's internal IT system in order to collaborate with the client's IT team, for example when implementing new solutions.

Only a few of the respondents described how they hired external consultants to help them to facilitate collaboration. A chaperone can be hired to facilitate collaborative behaviour (Smits and van Marrewijk, 2012). Some of the respondents described situations where they had hired consultants to take care of the interfaces between various contractors. The aim was to ensure that the information flow between the contractors was efficient and that interface-related questions were addressed to the appropriate people and solved at the right level. However, there were few examples of extensive chaperoning. There is often a cost-benefit aspect related to hiring such external consultants to facilitate collaboration. The cost of hiring the consultants is a tangible transaction cost that is easily identifiable on the balance sheet. However, the benefits achieved by using chaperoning may be less tangible and more difficult to identify in the balance sheet. Benefits achieved from collaboration are not always easy to measure in terms of money and it may be difficult to prove that the benefit is caused by the use of chaperoning.

Co-location can be an efficient way to improve collaboration and reduce friction (Bygballe and Swärd, 2019; Bosch-Sijtsema and Tjell, 2017). Co-location of project teams was not frequently used in the studied projects and was ranked 8$^{th}$ in Table 4-4. Co-locating teams as a collaboration mechanism was more often used in complex projects than other types of projects. In such projects with many interfaces, the benefits of co-locating teams to improve information flow (Kokkonen and Vaagaasar, 2018) may be particularly useful.

## 4.4 Findings and discussions from Paper 4

The purpose of this paper was to study what proportion of the total cost in construction projects is spent on managing the projects. Through the metaphor of human anatomy, the *project head* refers to the portion spent on managing the project while the *project body* refers to the portion spent on producing the project deliverables.

### 4.4.1 Project management costs in Norwegian construction projects

The project head size was calculated according to Equation 2, where the Project Management (PM) costs for the client and the contractor are summed before this number is divided by the total project cost. Hence, the project head size can be presented as a dimensionless number indicating the proportion of the total project cost that is spent on project management.

***Equation 2:***

$$Project\ head\ size = \frac{\sum_{i=1}^{n} PM\ client\ cost_i + \sum_{i=1}^{n} PM\ contractor\ cost_i}{total\ project\ cost}$$

Analyses of a dataset of 134 Norwegian construction projects showed that the project head consists of at least 18% of the total project cost on average, as illustrated in Figure 4-11. Project management is a transaction cost that is ultimately paid by the client, but the client is willing to pay this price to ensure that the project achieves its goal in what is an uncertain environment (Li et al., 2015; Walker and Kwong Wing, 1999; Williamson, 1996).

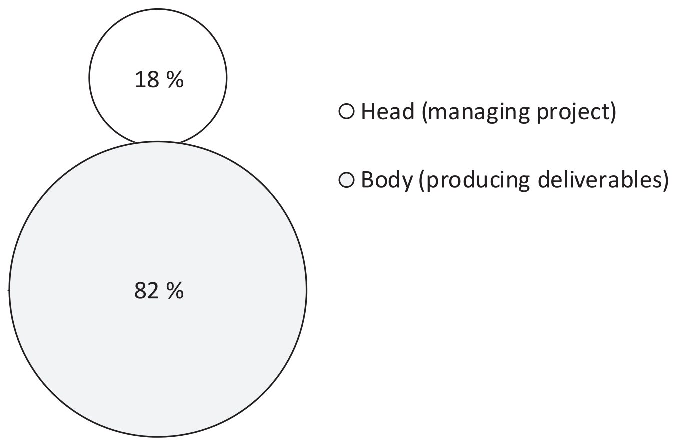



***Figure 4-11: Project head-to-body ratio***

Figure 4-12 reveals details about the size of the head for the client and the contractor's organisation. The lower part of the column shows the proportion (of the total project cost) spent on project management within the client's organisation. The upper part of the column shows the proportion (of the total project cost) spent on project management within the contractor's organisation. The size of the project head is not dominated by the client or contractor perspective but is fairly equally split between the two perspectives. Both the client and the contractor spent approximately the same amount on project management.

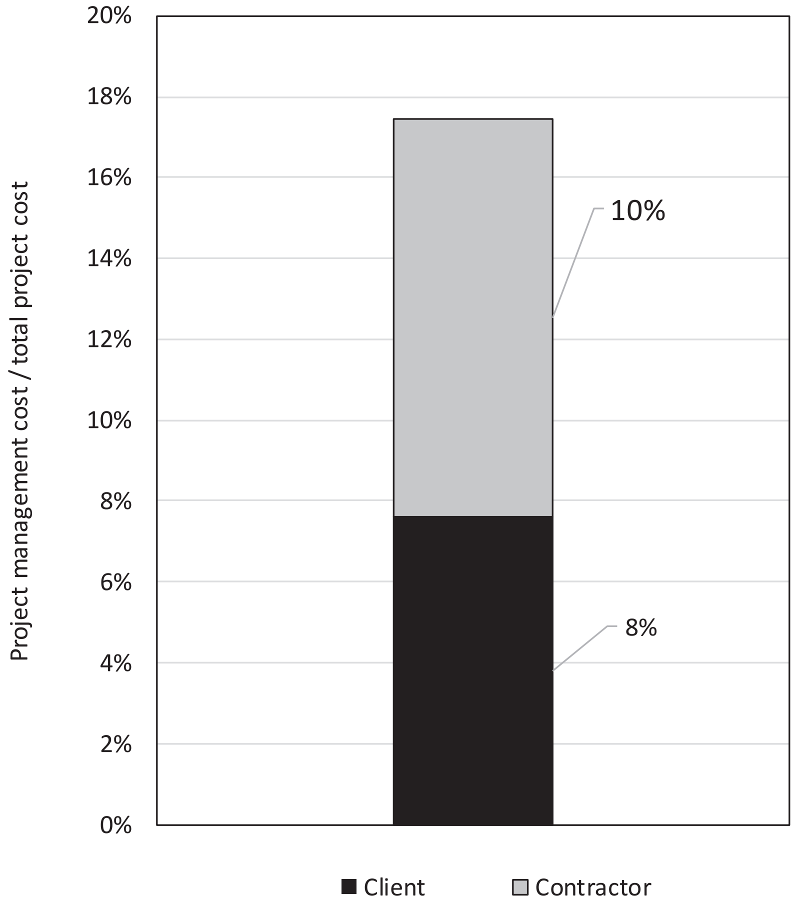



*Figure 4-12: Project head size – client vs contractor*

### 4.4.2 Bivariate correlation between head size and different project characteristics

Table 4-5 shows how the size of the project head correlates with the following four project characteristics: complexity, cost, duration and burn rate. Project complexity is calculated as a common factor based on how project members rated the complexity of their project in terms of each of the following aspects: Size, schedule, contract strategy, diversity of project team, technology risks, process scope, supply chain reliability, external stakeholders, traffic control, location, work zone congestion.

The second characteristic is total project cost measured in million USD. This number includes the total cost of conducting the project through all its phases and includes the contribution from all contractors, subcontractors, consultants etc.

The third applied characteristic is the total project duration. This is reported in number of weeks it took from the start of the concept phase until the execution phase was finished.

A fourth parameter is the project's burn rate. This parameter combines the total cost and the total duration and tells us something about the intensity of the project. The burn rate is simply calculated as total cost divided by total duration (Yun et al., 2016) and is reported in terms of USD million per week.

***Table 4-5: Correlation between amount spent on management and project characteristics***

| Variable / Variable | | PM cost / total cost | Comp-lexity | Total cost | Total durati on | Burn rate |
|---|---|---|---|---|---|---|
| PM cost / total cost | Pearson Correlation | 1 | | | | |
| | Sig. (2-tailed) | | | | | |
| | N | 134 | | | | |
| Complexity | Pearson Correlation | -0.031 | 1 | | | |
| | Sig. (2-tailed) | 0.721 | | | | |
| | N | 134 | 134 | | | |
| Total cost | Pearson Correlation | -0.106 | 0.677** | 1 | | |
| | Sig. (2-tailed) | 0.223 | 0.000 | | | |
| | N | 134 | 134 | 134 | | |
| Total duration | Pearson Correlation | -0.143 | .248** | 0.295** | 1 | |
| | Sig. (2-tailed) | 0.106 | 0.005 | 0.001 | | |
| | N | 129 | 129 | 129 | 129 | |
| Burn rate | Pearson Correlation | -0.126 | 0.521** | 0.848** | -0.016 | 1 |
| | Sig. (2-tailed) | 0.156 | 0.000 | 0.000 | 0.857 | |
| | N | 129 | 129 | 129 | 129 | 129 |
| ** Correlation is significant at the 0.01 level (2-tailed) | | | | | | |

First, there is only a weak, and not statistically significant, correlation of -0.031 between the portion spent on project management and project complexity. There is no clear relationship between how complex a project is and how much money is spent on managing the project.

Secondly, correlation between the percentage of the project budget spent on management and the total project cost was investigated. From Table 4-5 one can see a weak correlation of -0.106, which is not statistically significant.

Third, the correlation with project duration was analysed. This revealed that there is a weak correlation at -0.143, which is also not statistically significant. One can therefore not establish a relationship between the proportion of the project budget that is spent on management and the duration of the project.

Fourth, the correlation between relative amount spent on management and the burn rate in the project is investigated. This analysis identified a weak (-0.126) and not statistically significant correlation between the amount spent on management and the project burn rate. Projects with high burn rates do not appear to spend a smaller ratio of their total budget on project management compared to projects with lower burn rates.

### 4.4.3 Detailed findings from multidimensional analyses

To gain a more comprehensive understanding of how the relative project head size varies between projects with different characteristics, several dimensions should be studied in relation to each other. Simply looking at the two-dimensional correlations in Table 4-5 only offers limited insight. To gain more insight several project characteristics are studied at the same time as shown in Figure 4-13. On each of its six faces, the relative size of the project head is plotted as a function of two project characteristics. Using all six faces of the cube, the project head-to-body ratio for each of the six different possible combinations of project characteristics in terms of complexity, cost, duration and burn rate is plotted. It is then possible to use the cube to study the project head-to-body ratio of projects with different combination of characteristics.

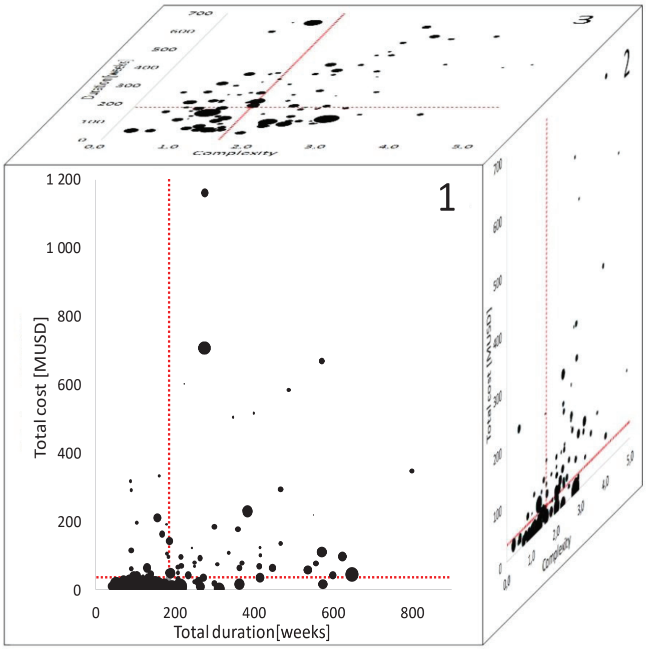



***Figure 4-13: Combining multiple project characteristics***

On each plot, the project head-to-body ratio is plotted as a circle, where the size of the circle indicates the size of the project head as calculated by Equation 2, i.e. the portion of total project cost spent on project management. Each circle represents a project from the dataset. Large circles indicate that the specific project had a large head compared to its body, while smaller circles and dots indicate that the head of the specific project was small compared to its body. The location of the circle in the plot describes the value for the specific project in terms of two project characteristics shown along the horizontal and vertical axis.

The vertical- and horizontal dotted red lines in the plot indicates the median value for the dataset. For Figure 4-13, this means that projects on the left side of the vertical dotted line have a duration below the median, as opposed to those projects to the right of the vertical dotted line, which have a duration longer than the median. Similarly, the horizontal dotted red line shows the median of the project cost. Projects below the line have a total cost lower than the median value in the dataset and projects above the horizontal dotted line have a total cost higher than the median value.

### 1st Face: cost and duration

The first face of the cube is shown in Figure 4-14. The vertical axis indicates the total project cost while the horizontal axis shows the total project duration. The majority of the large project heads are found in the lower left quadrant of the figure. This means that projects with low total cost and short duration spend a larger portion of the total budget on project management compared with projects that have a higher total cost and longer duration.

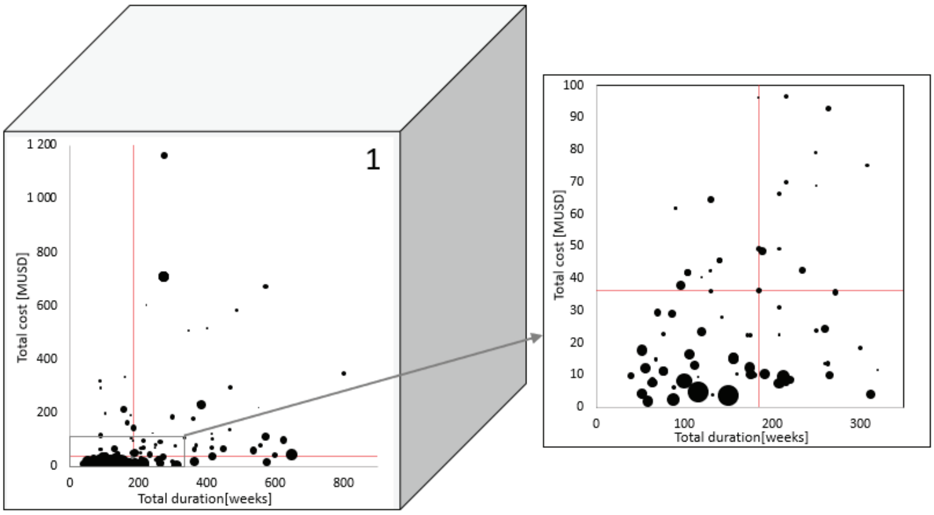



*Figure 4-14: Face 1 - Cost and duration*

### 2nd Face: cost and complexity

Moving on, Figure 4-15 shows the second face of the cube where each project is plotted based on its total cost and complexity. Projects with high cost and high complexity are found in the top right quadrant of the plot as opposed to projects with low cost and low complexity, which are found in the lower left quadrant. On this plot, the large project heads are scattered in multiple quadrants and the plot does not show a clear pattern.

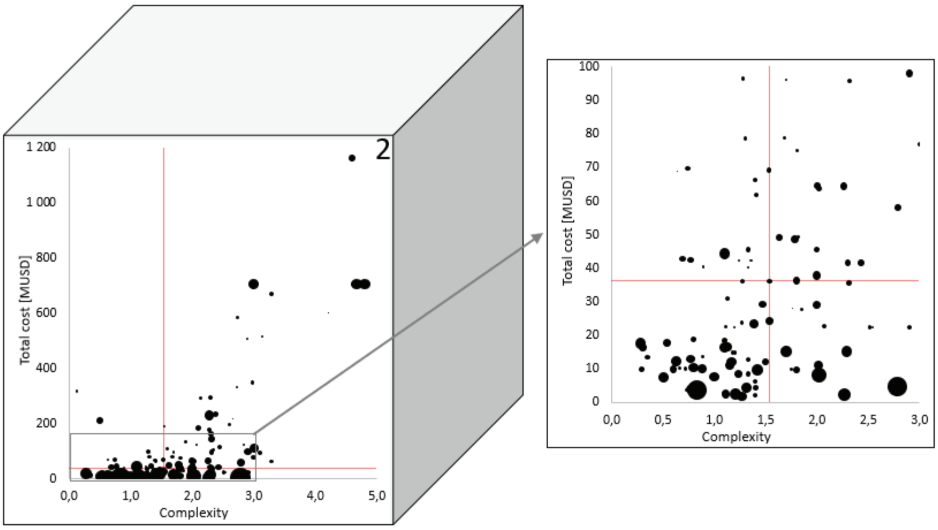



*Figure 4-15: Face 2 - Cost and complexity*

**3rd face: duration and complexity**

The third face of the cube is shown in Figure 4-16. In this figure, projects with high complexity and long duration are found in the top right quadrant, while projects with low complexity and short duration can be seen in the lower left quadrant. Multiple large project heads are found in each of the four quadrants and this indicates that there is no particular pattern to be found.

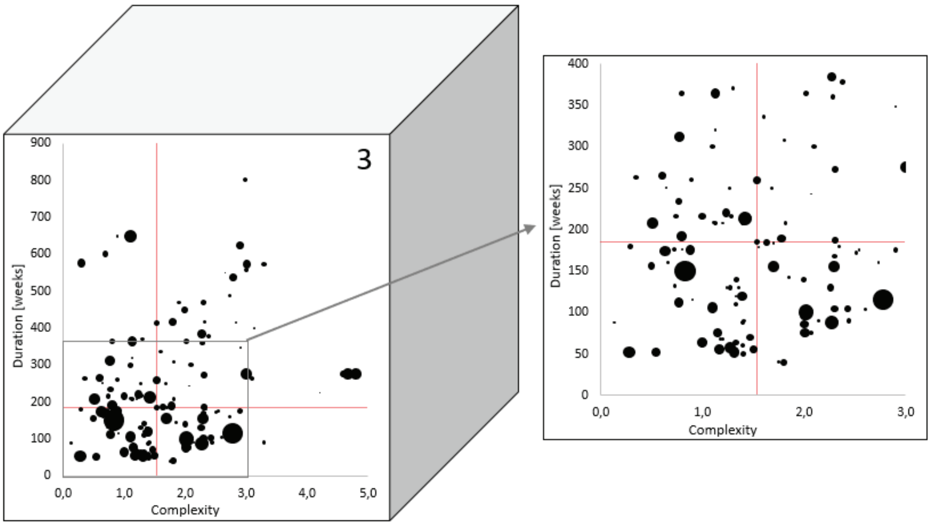



*Figure 4-16: Face 3- Duration and complexity*

### 4th face: burn rate and complexity

Figure 4-17 shows the fourth face of the cube and combines burn rate with complexity. Complex projects with a high burn rate are seen in the top right quadrant while less complex projects with low burn rate are found in the lower left quadrant. Many large project heads are found in projects with low burn rate, i.e. projects found in the lower left and lower right quadrant. However, some of the projects with very high burn rate and complexity also had a large head.

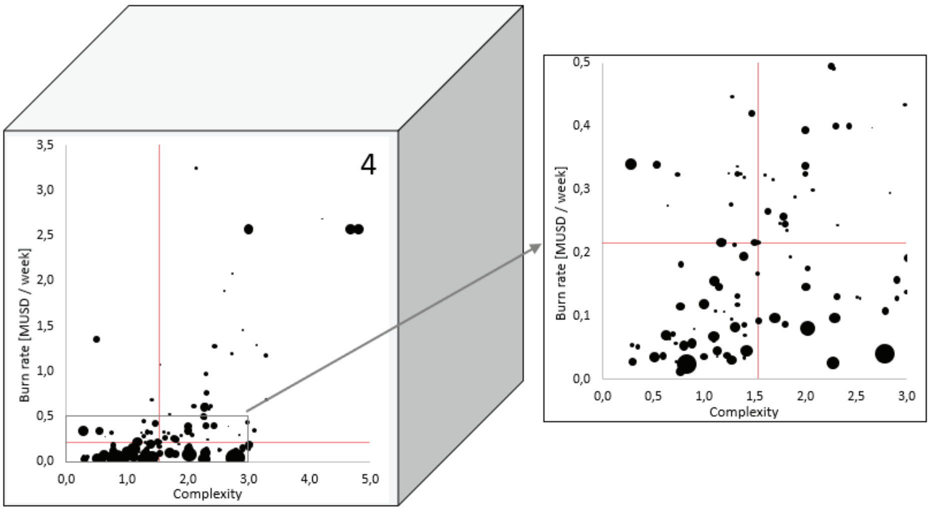



*Figure 4-17: Face 4- Burn rate and complexity*

### 5th face: burn rate and cost

The combination between burn rate and cost is shown in Figure 4-18. It may seem like most of the large project heads are found in the lower left quadrant, but there are also several projects in the other quadrants with large project heads.

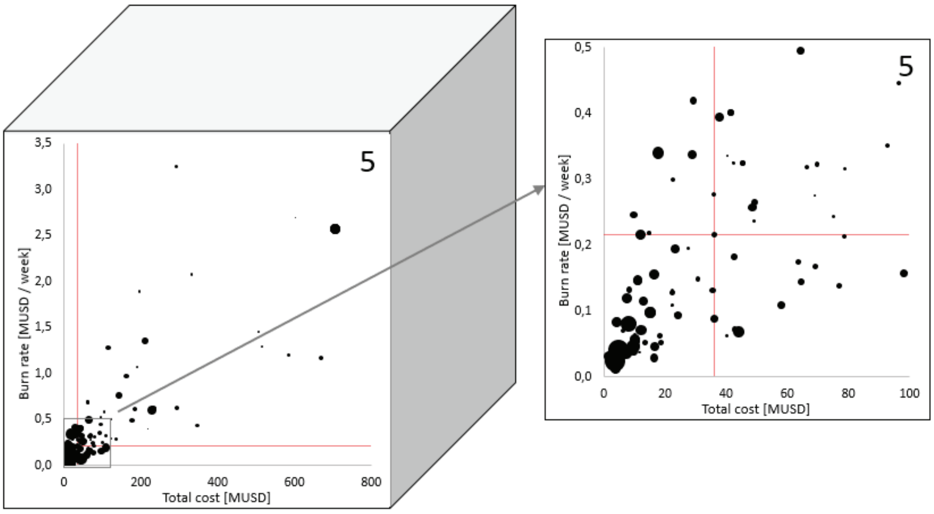



*Figure 4-18: Face 5- Burn rate and cost*

### 6th face: burn rate and duration

Figure 4-19 shows the sixth and final face of the cube which combines burn rate and duration. From this plot we can see that most of the projects in the lower left quadrant have large project heads. However, there are also several large projects present in the other three quadrants.

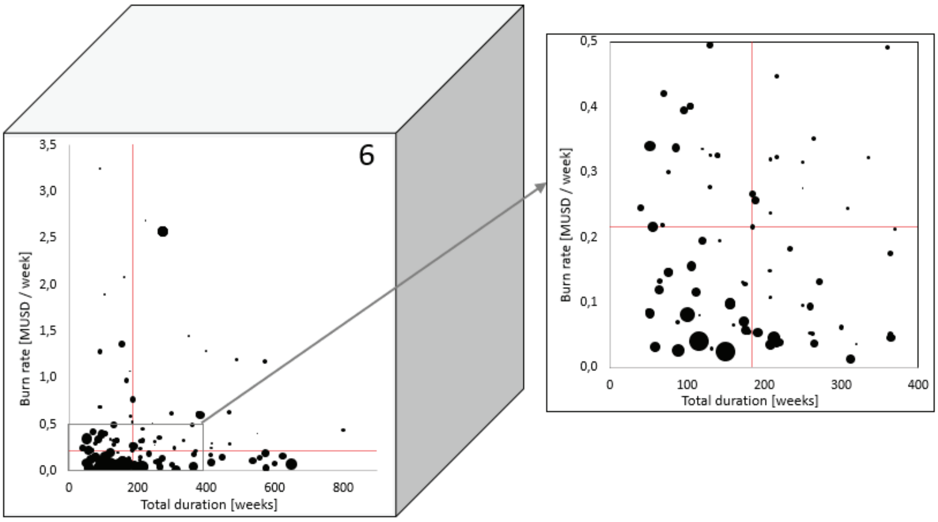



*Figure 4-19: Face 6- Burn rate and duration*

### 4.4.4 Key findings from analyses of project head size and project characteristics

Based on the detailed findings from correlation- and multidimensional analyses, four key findings are identified. These are elaborated and discussed further in the following section.

**No linear relationship between project head size and project total cost**

The correlations presented in Table 4-5 indicate that there is not a simple linear relationship between the size of a project in terms of cost, and how large its project head is.

Often, when establishing budgets for new projects it is common to use reference numbers from previous projects and scale these numbers according to various factors, including project size in terms of cost. However, one should be aware that this is not necessarily a linear relationship and the scaling factor itself must be adjusted according to the total project cost. In other words, a project with a total cost of USD 10 million may have spent a significantly higher portion of its budget on project management than what one should expect from a project costing USD 100 million. One reason for this difference may typically be mobilisation and support activities. A smaller project may require many of the same functions in its project management team as a large project. For example, the controller function is needed for small projects as well as for larger projects. However, the number of controllers needed does not increase linearly for larger projects.

**Projects with short duration and low cost often have large heads**

The fact that no simple two-dimensional correlation with project head size and total costs was found indicates that there are also other dimensions that influence the amount of project management activities in a project.

It is also interesting to see that projects with longer duration do not necessarily spend more on project management than projects with shorter duration. Both the first- and the third face of the cube (Figure 4-14 and Figure 4-16), indicates that there are large heads for projects on both sides of the median duration value. One might expect that as a project takes longer, the project management portion of the total cost would increase, simply because the people in the project management team will be employed for a longer period and therefore paid more than if the project was executed faster. However, combining cost and duration, reveals a pattern where projects with small costs and short duration appears to have a high head-to-body ratio.

## The significance of burn rate

However, for this to be a meaningful discussion it is also necessary to assess the burn rate of the project. Using the analogy of driving a car, the burn rate tells us "how fast the project is driving". The duration only indicates how many hours the car has been driving while the total cost reveals the distance of the journey. Projects with low burn may therefore experience that a higher portion of their total budget is spent on project management than other projects simply because they are driving very slowly and have to pay the driver for a longer time even though the distance they cover is short. This can be seen on Figure 4-19. Projects with long duration and high burn rate are found in the top right quadrant and none of these projects have large project heads as opposed to those in the lower left quadrant with low burn rate and short duration. A particularly interesting learning point from this is that projects with long duration do not necessarily spend a large portion of their total budget on project management if they have a high burn rate.

## The complexity of complexity

Another aspect that affects the size of the project management team is the project complexity. Follow the analogy of driving a car, the complexity reflects the road condition and how difficult it is to drive on it. A general assumption would be that complex projects need more management than less complex projects. Table 4-5 shows that there is no clear correlation simply between complexity and project head size. This can also be seen by looking at face 2, 3 and 4 of the cube (Figure 4-15-Figure 4-17) as there are clearly projects with large project heads with both high and low complexity. At first glance, this may come as a surprise. Common wisdom suggests that more complex projects require a larger project management team than less complex projects. However, this discussion becomes even more interesting when one looks at the other characteristics at the same time. Total cost, duration and burn rate are also aspects that influence the proportion of the project budget that is spent on management. Generally speaking, projects with high complexity require more management than less complex projects, but that does not necessarily mean that a larger portion of the total budget is spent on project management. Projects with high complexity will in general also have more resources available and a higher budget and therefore, even though the project is complex and requires a large project management team, the cost of this team is divided by a larger total budget. Looking at Equation 2 (page 184), this means that the numbers both over and under the division line will increase. Hence, the project head size may still be relatively small compared to the project's body even for complex projects. When complexity increases in a project, it may not only be the head of the project that becomes bigger; the project body may also grow. Complex projects may require the use of more advanced technology and assets and the cost of conducting the work itself will also increase.

Combining complexity with burn rate (Figure 4-17) reveals that the largest project heads are found for complex projects with low burn rate, i.e. complex projects that progress at a relatively slow speed. High complexity is also among the most common causes of project delays (Zarei et al., 2018). One reason for this may be periods where work has to stop and wait for a period – for example, due to a complex interface picture. In such situations it may not be feasible to demobilise the project management team during the waiting period, hence these project management costs may keep running in periods where little work is conducted by the project body itself.

# 5 Thesis Main Findings

In the previous chapter, the findings from each of the four scientific papers were presented. In the following chapter, the findings related to each of the three thesis research questions that were developed in chapter 3.1 are presented. These are the main findings of the thesis based on a holistic approach across the four individual papers. Table 5-1 shows a schematic of how each of the four scientific papers contributes to the answer to each of the three thesis research questions. These findings are presented in more detailed in the following sub-chapters.

*Table 5-1: Main findings of the thesis*

| Thesis Research questions | Paper 1 | Paper 2 | Paper 3 | Paper 4 | Main finding |
|---|---|---|---|---|---|
| **RQ I**: What is the magnitude of transaction costs in construction projects? | (✓) | | | ✓ | On average, project transaction cost was found to be at least 18% of the total cost in a project. Here, the transaction costs were measured as the cost associated with managing the project in the client's and contractor's organisation. |
| **RQ II**: What is the relationship between transaction costs and client-contractor collaboration in projects? | ✓ | ✓ | ✓ | | A theoretical model of the relationship, containing both investment costs and benefits, has been established.<br>Following the collaboration compass, practitioners can navigate towards a sweet spot where the maximum benefits from collaboration can be achieved through the most effective mechanisms for a specific project. |

| | | | | | |
|---|---|---|---|---|---|
| **RQ III**: How can connecting the research field of project transaction costs with the research field of client-contractor collaboration contribute to improved performance in construction projects? | ✓ | ✓ | ✓ | ✓ | Combining the two research fields allows for the creation of a holistic model expressing the relationship between quality of project deliverables, project transaction costs and client-contractor collaboration. |

## 5.1 Magnitude of project transaction costs (RQ I)

The aim of the first research question in the thesis was to get a better understanding about the pure size of project transaction costs through the following research question:

**RQ I:** What is the magnitude of transaction costs in construction projects?

This research question was mainly addressed in paper 4 of this thesis, where the size of the project's head-to-body ratio was investigated – i.e. what proportion of the total budget in a project is spent on management versus how much is spent on production. Here, it was found that on average 18% of the total budget for a construction project is spent by the client and its contractor on managing the project. Costs associated with such management activities are project transaction costs (Lee et al., 2009; Walker and Kwong Wing, 1999). In the following section, the findings from to RQI are presented in further detail, as the 18% is split into different project phases as well as differentiated by the client and contractor perspectives. Furthermore, based on the combined findings from paper 1 and paper 4, a theoretical model is presented to illustrate how the shape of the supply chain may affect the total transaction costs in a project.

### 5.1.1 Variation of transaction cost for projects with different characteristics

Based on the findings from paper 4 of this thesis, it is also possible to say something about how the magnitude of the transaction costs varies between projects with different size, duration, complexity and burn rate. The detailed findings from this research were presented in section 4.4.2 through section 4.4.4. The main point made here was that simply looking exclusively at a two-dimensional relationship, for example between transaction costs and project duration, or between transaction costs and project complexity, only offers limited insight. However, when several dimensions are assessed at the same time, a more comprehensive understanding can be achieved, as the dimensions are related to each other.

The following example illustrates this point: Common wisdom suggests that a project with high complexity should experience higher transaction costs than a less complex project. However, when comparing transaction costs as a function of total project cost, no particular correlation was found with complexity. That is, projects with large complexity did not spend a bigger portion of their total budget on transaction costs compared with less complex projects. This may appear surprising at first, but it makes more sense once the relationship between total cost and complexity is assessed at the same time. This reveals that yes, the absolute size of the transaction cost is higher for more complex projects, but more complex projects also have a higher total cost compared with less complex projects. Hence, the relative size of transaction costs as a function of total cost varies little between projects with different complexity.

Figure 4-13 through Figure 4-19 in the previous chapter illustrate how a six-faced cube can be used to assess transaction costs for the six possible combinations of total cost, duration, burn rate and complexity.

### 5.1.2 Transaction costs during the project life cycle

There are some differences in the results related to how the loading varies during the project life cycle through the phases of conceptualisation, planning and execution as presented in Figure 5-1.

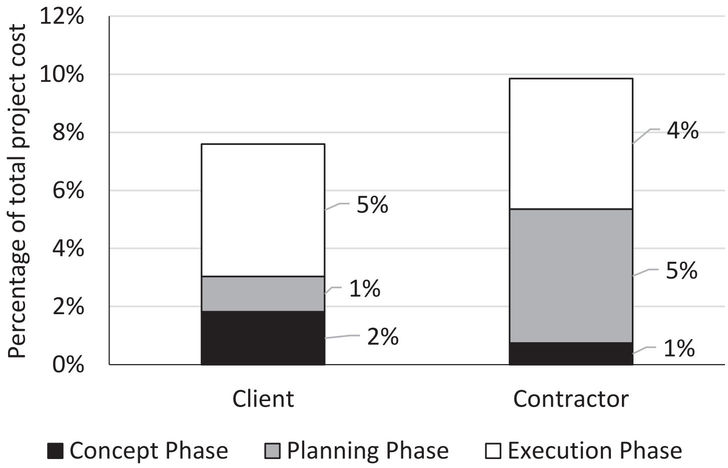



***Figure 5-1: Transaction costs for client and contractor during project life cycle phases***

The results show that the size of the client's project management team is somewhat similar during the two first phases but increases during the execution phase. The contractor's project management team is small during the conceptualisation stage but increases significantly during the planning and execution stages. This deserves some further reflections. During the conceptualisation stage, the client often has a fairly large project management team to define the project and prepare specifications and tender documents. The contractor is often not selected at this stage or only participates partly in the project, unless the project has a high degree of early contractor involvement (Williams et al., 2019; Hosseini et al., 2017). As projects proceed to the planning stage and later to the execution stage, the contractor comes onboard with its project management team. During the execution stage, both the client and contractor have significant project management teams and approximately half of the resources spent on project management are spent during this stage.

### 5.1.3 Pre-contract and post-contract transaction costs

In terms of transaction cost economics, it is common to distinguish between pre-contract and post-contract transaction costs (Li et al., 2015). With reference to Figure 5-1, transaction costs from the concept phases should be considered pre-contract transaction costs, while transaction costs from the execution phase would be considered post-contract transaction costs. However, for the planning phase this is not so clear as it depends on the project delivery method applied and the level of early contractor involvement. In design-build projects the contractor is involved during the planning phase as opposed to design-bid-build project where the contract with the contractor is signed after the planning phase. Transaction costs from the planning phase has therefore been split between pre-contract and post-contract transaction based on the ratio of projects in the dataset that use design-build vs design-bid-build. Hence the pre-contract transaction costs would be 3% for the clients and 3% for the contractors, while the post-contract transaction costs would be 5% for the clients and 7% for the contractors. This is summarised in Figure 5-2, where the transaction costs are sorted into pre-contract and post-contract transaction costs for client and contractor.

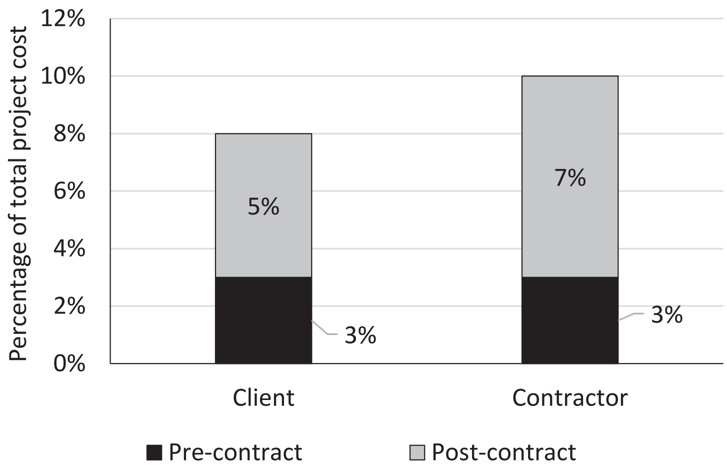



***Figure 5-2: Pre-contract and post-contract transaction costs for client and contractor***

In this section, project transaction costs found in this thesis have been presented by phase as well as from the client and contractor perspective. In the next section, a conceptual model is developed to illustrate how the transaction costs in a project may increase if the supply chain is fragmented.

### 5.1.4 Shape of the supply chain: make-or-buy decision

Paper 4 was limited to studying the two top tiers in a project's supply chain, as illustrated in Figure 5-3, which shows a simplistic model of a supply chain in a construction project where the client has hired one contractor that is responsible for both the design and construction (design-build). On each tier, an actor performs work for the actor on the tier above and subcontracts work to the tier below.

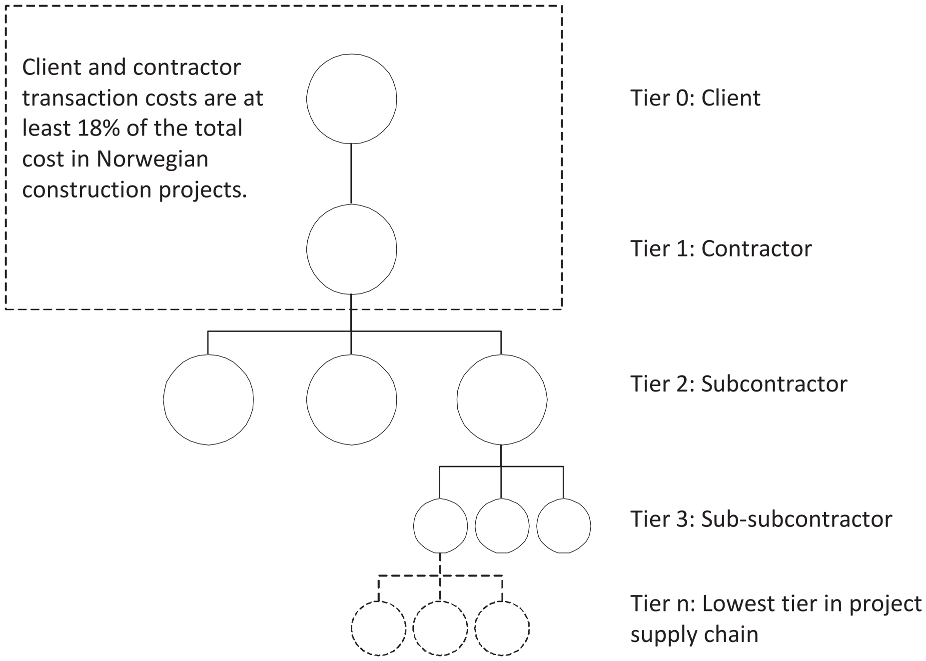



***Figure 5-3: Transaction costs in Norwegian construction projects***

During the interviews conducted in paper 1, project managers described situations where they had to spend significant resources on safeguarding their interests from an opportunistic counterpart by applying increased monitoring and control throughout the supply chain. With reference to agency theory (Arrow, 1991), the contractor is both a principal and an agent, as illustrated by the schematic in Figure 5-4, being an agent in the relationship with its client while being a principal in its relationship with its subcontractors.

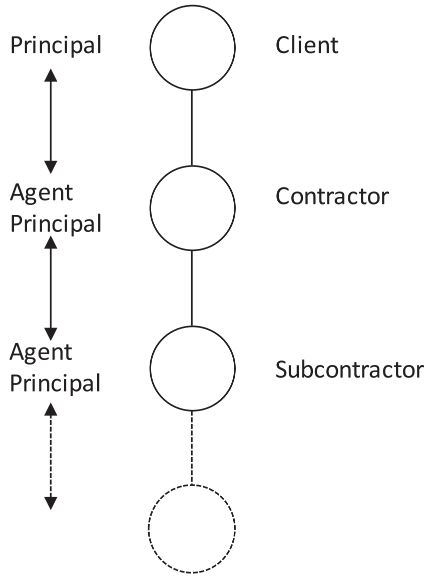



***Figure 5-4: Principal-agent relations in a project supply chain***

Agency problems were highlighted by several respondents who were interviewed for this thesis. For example, contractors explained how they had to safeguard their interests in both the relationship with their client and in their relationship(s) with their subcontractor(s).

Hence, the "shape" of the project supply chain appears to influence the total size of transaction costs in a project. In transaction cost economics, the make-or-buy decision relates to whether a company is producing the goods itself or paying another company to produce it on their behalf (Williamson, 1975). The ratio between how much work a company conducts itself and how much they pay others to conduct the work can be expressed as the make/buy ratio. A low make/buy ratio indicates that the supply chain is fragmented with many actors on multiple tiers while a high make/buy ratio indicates the opposite, i.e. a flat supply chain that consists of relatively few actors.

Figure 5-5 shows a theoretical illustration of where production occurs in a project supply chain depending on different make/buy ratios. If the companies in the supply chain conduct 90% of their work themselves and only subcontract the remaining 10% to lower tiers, more than 97% of the total work is conducted by the contractor itself and its tier 2 subcontractors. However, if each company only conducts 25% of the work itself, and subcontracts the remaining 75% to other companies, the work scope is distributed further down the supply chain, where a substantial amount of production occurs at lower levels.

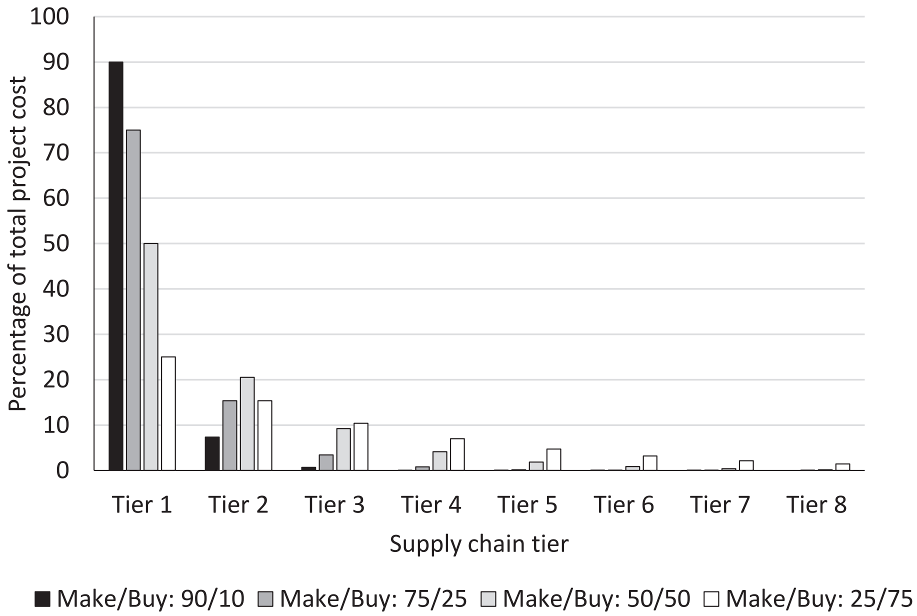



***Figure 5-5: Distribution of scope production through supply chain***

From a transaction cost point of view, the make/buy ratio in a project's supply chain is relevant. A flatter supply chain (where most production occurs at the higher tiers) should have lower transaction costs than a supply chain with many levels, as there are transaction costs associated with managing each of these tiers (Williamson, 1975).

This thesis found that a contractor on average spent an amount equivalent to at least 10% of the total project cost on transaction cost activities (see Figure 5-2). Based on this it is possible to make some reflections on project transaction costs depending on the make/buy ratio in the project supply chain.

Figure 5-6 shows a theoretical illustration of the accumulated transaction cost in projects depending on the make/buy ratio through the supply chain. The figure is based on the finding that contractors on average spend an amount equivalent to 10% of the project value on transaction costs. It is further assumed that this is a proportional relationship that can be found throughout the supply chain. For example, if each tier in the supply chain on average conducts 90% of the work itself, and only buys the remaining 10%, the accumulated project transaction costs saturate at the third tier at approximately 20% of the total cost of the project. The reason for this is that most of the value is produced at these upper tiers and there is little value further down in the supply chain. However, if each company in the supply chain only produces 25% of the value itself, and subcontracts the remaining 75% of their work, the project transaction costs throughout the supply chain are substantial and in sum may exceed 35% of the total project value when transaction costs from all parts of the supply chain are summarised.

The purpose of this illustration is to show how the make/buy ratio potentially has a significant effect on a project's total transaction costs. Projects with a flat supply chain where the majority of production occurs at the upper tiers spend significantly less money in total on transaction costs compared to projects where the make/buy ratio is low and much production occurs at the lower levels in the supply chain.

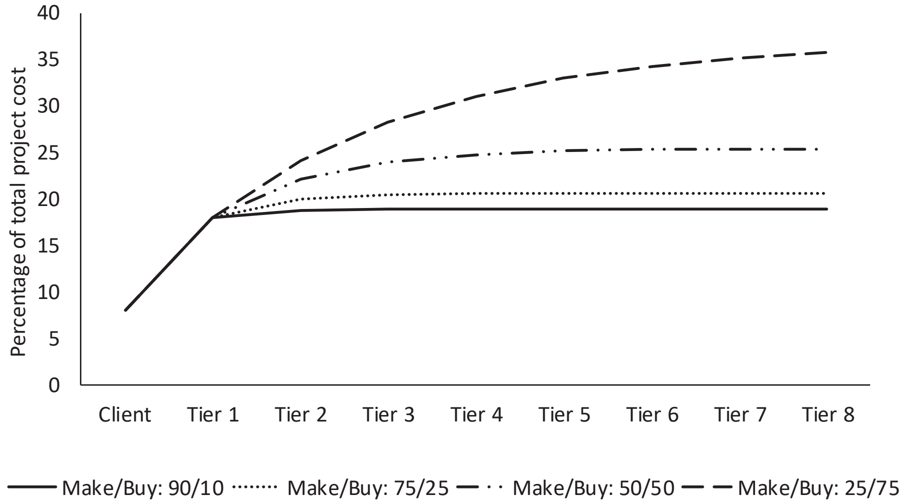



***Figure 5-6: Conceptual model of accumulated project transaction cost in supply chains with different make/buy ratio***

However, one should mention that this model has some serious limitations. First, it assumes a 10% project transaction cost throughout the entire supply chain, based on the findings from paper 4 in this thesis. This thesis has only investigated the client-contractor relation in the project supply chain, and future research on transaction costs further down in the supply chain would be very useful in order to verify or reject this assumption of 10% throughout the supply chain. In Figure 5-5 and Figure 5-6, the make/buy ratio has been set at a fixed rate for the entire supply chain to illustrate the mean make/buy ratio in the chain. This was done for the sole purpose of illustrating how the make/buy ratio may influence the magnitude of transaction costs in the project. However, in most supply chains the make/buy ratio will vary significantly between companies on the same tiers and between tiers.

## 5.2 Optimising project transaction costs through collaboration (RQ II)

The second research question for this thesis addressed the following:

**RQ II**: What is the relationship between transaction costs and client-contractor collaboration in projects?

This research question was addressed through the findings from paper 1, 2 and 3 in this thesis. In the following sub-chapters, a conceptual model is developed expressing the relationship between project transaction costs and client contractor collaboration. First, the model shows how improved collaboration has a positive effect on transaction costs through lowering safeguarding and administration costs. Following this, another element is added to the model, as the investment cost of applying collaborative mechanisms is also included. Finally, the section shows how the compass developed in paper 3 can be applied to the model to maximise benefits from collaboration at the lowest possible investment cost.

### 5.2.1 Reduced safeguarding and administration costs through client-contractor collaboration

The relationship between project transaction cost and the level of collaboration between a client and its contractor was investigated in paper 1 of the thesis. There are certain factors that have a positive effect on both project transaction costs and client-contractor collaboration, and paper 1 identified the most salient of these factors. Projects that do well on these factors spend less money on protecting their interests (safeguarding costs).

If there is poor communication and a lack of trust in the relationship, both parties will invest in measures to safeguard their interests. An example of this is increased pre-contract transaction costs because the client prepares very detailed specifications. Post-contract transaction costs also increase if the parties' trust in each other is low (Kadefors, 2004). The client may spend significant resources to monitor closely the work conducted by its contractor while the contractor spends much time documenting its work to ensure that it gets paid for extra work and change orders. In a project where there is good collaboration between a client and its contractor, many such transaction costs are avoided.

Existing research has shown that collaborative behaviour between a client and its contractor builds trust (Bond-Barnard et al., 2018), which in turn has a positive effect on project transaction costs (Pinto et al., 2009; Kadefors, 2004). This logic is similar to what was found in paper 1, where trust emerged as a salient factor that respondents claimed contributed to collaboration. Studying the factors that influence transaction costs, this thesis found that many of these factors also influenced the level of collaboration in the relationship between a client and its contractor. Good communication has a positive effect on a project's transaction costs and is also a key factor to achieve good collaboration. Other elements are reduced uncertainty, fewer change orders and more trust.

Benefits harvested in the relationship between collaboration and transaction costs are expressed in Figure 5-7. The horizontal axis indicates the client-contractor collaboration level from low to high. The vertical axis describes the project transaction costs from low to high. The red line drawn in the diagram indicates the project's safeguarding and administration costs. This also includes costs associated with handling conflicts and disputes, monitoring and control.

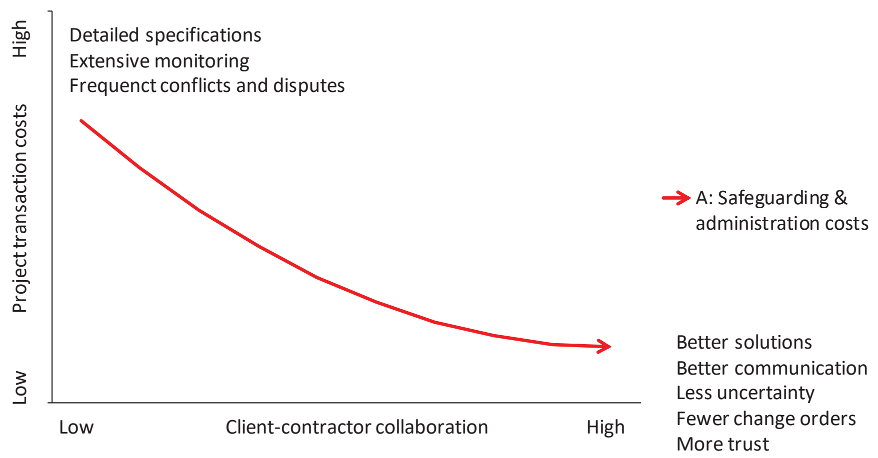



***Figure 5-7: Reduction of safeguarding and administration costs through collaboration***

As the level of client-contractor collaboration increases, transaction costs related to safeguarding and administration decrease. Improved collaboration contributes to multiple benefits such as better solutions, better communication, less uncertainty, fewer change orders and more trust. This leads to less need for detailed specifications, less extensive monitoring, and fewer conflicts and disputes. In the interviews conducted for papers 1 and 3, respondents claimed that if collaboration is poor, significant benefits could be achieved even with a slight increase in collaboration. This indicates that the red curve is not linear, but rather follows a function where the cost of conflicts, monitoring and control drops significantly if a project's collaboration level improves from low to medium. A further increase in collaboration continues to provide more positive effects but at a less significant rate.

### 5.2.2 The cost of investing in collaborative mechanisms

However, the relationship that is presented in Figure 5-7 has an important limitation: it only shows the benefits harvested through increased collaboration. What the figure does not show is the costs associated with investing in the collaboration mechanisms that are needed to create better collaboration in the project. That is, the red line in Figure 5-7 only shows one part of the picture. Through the interviews conducted in paper 1 and paper 3, it also emerged that yes, collaboration has a positive effect on transaction costs, but in order to achieve such collaboration, certain investments have to be made in collaborative mechanisms. Such mechanisms were covered in paper 3 of this thesis and arranging kick-off meetings is an example of a popular mechanism applied by many projects. This is illustrated by the following example given by one of the interviewed project managers.

> *"Prior to starting phase one, we conducted a kick-off for the entire team which counted 25 people. The meeting lasted for two days and included representatives from the client, contractors and subcontractors…. Through group sessions, team contracts were developed" – project manager –*

As this example illustrates, there are clearly quite significant costs associated with applying a collaborative mechanism. For example, arranging the above kick-off meeting may require hiring a venue as well as the cost of taking people away from their workplace for two full days. Such investments are also project transaction costs. In Figure 5-8, collaboration investment costs have been added to the picture, and these are indicated with a blue line. This line also follows an exponential function rather than a linear form. As the collaboration level increases, it requires more and more effort to improve it further. In other words, the investment costs to move from low to medium appear to be lower than the investment cost that would be required to move from medium to high collaboration.

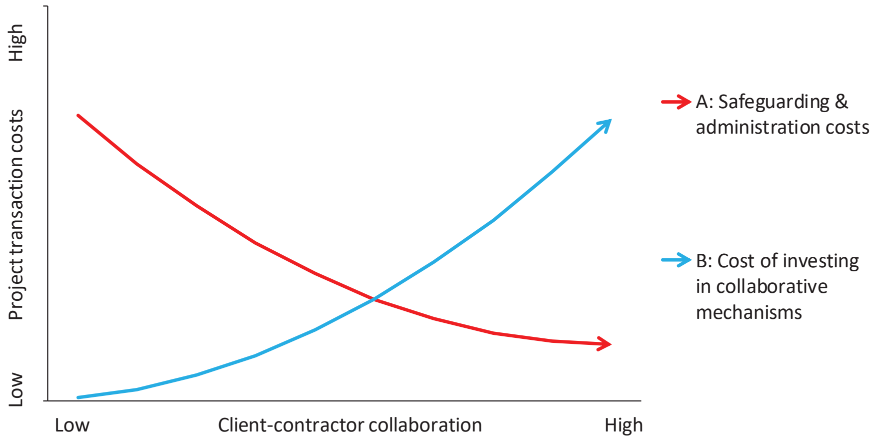



*Figure 5-8: Adding the cost of implementing collaboration mechanisms*

### 5.2.3 The theoretical sweet spot – The perfect balance

So far, the diagram shows a blue and a red line: one showing safeguarding and administration costs (red) and one that shows the cost of investing in collaborative mechanisms (blue). The diagram is now further expanded in Figure 5-9. Here a new purple line is drawn to show the accumulated project transaction costs as a function of client-contractor collaboration. This line is calculated as the sum of safeguarding and administration costs and the cost of investing in collaborative mechanisms, i.e. it is the accumulated sum of the red and the blue line. This new (purple) line follows the shape of the classic bathtub curve that indicates that there is a theoretical optimal point, the so-called sweet spot, where the function has its minimum value.

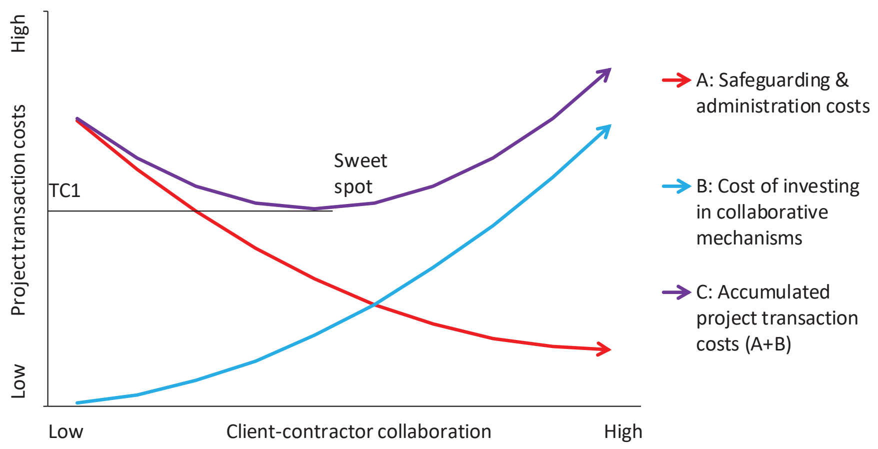



***Figure 5-9: Accumulated project transaction costs and identified sweet spot***

The sweet spot indicated in Figure 5-9 shows the theoretical point for a project where the accumulated project transaction costs are lowest, indicated as TC1 on the vertical axis. At this theoretical optimal point, benefits achieved from collaboration mechanisms have been perfectly balanced with the investment cost of applying mechanisms to build collaboration. Beyond this theoretical sweet spot, it may be contra productive to spend more resources on collaboration mechanisms as most benefits have already been harvested and investing more could simply cost more than it would save.

Consider for example a project found in the upper right corner of Figure 5-9. Such a project achieves good collaboration. Still, the transaction costs are also high. Knowing from paper 1 and 2 that collaboration has a positive effect on transaction costs and quality, this may seem a bit strange. However, it is possible to invest more in collaboration mechanisms than warranted by the benefits achieved. Such a paradox would occur for example if a project manager spends more money on mechanisms than the value of the benefits harvested. For example, let us say that a project has held an expensive teambuilding event that led to significantly better collaboration among the project actors. Simply holding another identical teambuilding event shortly afterwards does probably only offer small additional benefits, while costing the same as the first event.

### 5.2.4 Applying the most suited mechanisms to adjust the sweet spot

As shown above (Figure 5-9) a theoretical sweet spot is found where costs and benefits from collaboration are perfectly balanced. Simply following this analogy may lead to the premature conclusion that there is nothing further to do once this sweet spot is reached and that the transaction costs cannot be optimised further through collaboration. However, the purple bathtub curve simply expresses the sum of the blue and the red line, meaning that if the shape of the red or the blue line is adjusted the purple line will also change. This opens for further optimisation, and the rationale behind this is elaborated below.

The shape of the red and the blue line depends on the cost-benefit aspects with the various collaborative mechanisms. Paper 3 of this thesis identified how various collaborative mechanisms may be more suited to certain projects based on the project's characteristics. For example, projects with a high level of novelty may harvest significant benefits from increasing their travel activity, while other types of projects may not harvest the same benefits from increased travel activity compared to what it costs.

The point argued here is that the shape of the curves in Figure 5-9 depends on the suitability of the collaborative mechanisms for a specific project. A project manager who applies mechanisms that are particularly well suited for the project may therefore experience a situation as indicated in Figure 5-10 instead. Here the dotted lines indicate the new situation as better suited mechanisms are applied. As a consequence, more benefits are harvested at a lower investment cost and the sweet spot has moved down and to the right in the diagram. Hence higher collaboration is achieved, and the total transaction cost is reduced to a new value, TC2.

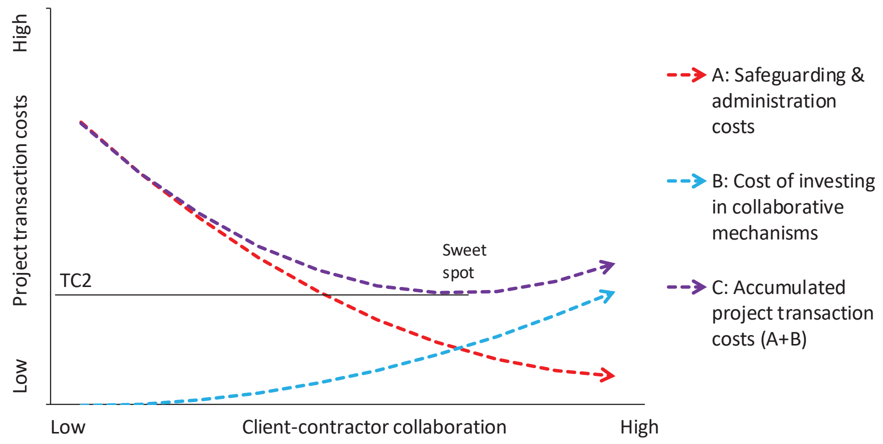



*Figure 5-10: Moving the sweet spot*

The aim is to ensure that the mechanisms that provide the best benefits at the lowest cost are prioritised, thus finding the lowest possible value for the function describing the accumulated project transaction costs. This is summarised in Figure 5-11, where a combined diagram is shown where a plot of the new situation (Figure 5-10) is superimposed on the first situation (Figure 5-9). In this combined figure (Figure 5-11) the solid blue line describes the investments made in collaborative mechanisms in a project. However, if the project manages to apply collaborative mechanisms that provide more benefits at lower investment cost, new blue and red lines can be drawn, indicated with the dotted line.

Hence, the new situation has a different shape that moves the sweet point where the red and the blue line cross to a position where more project transaction costs are lower. This difference between the sweet spot for the two situations can be expressed as a delta, Δ. The aim is thus to maximise the delta by applying the best suited collaboration mechanism for the project.

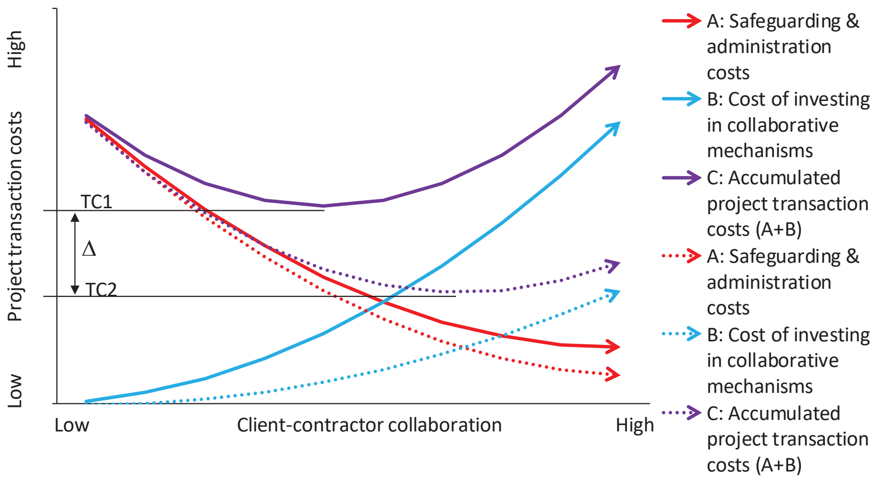



*Figure 5-11: Lowering the total transaction costs by applying collaborative mechanisms most suited for a specific project*

In order to identify which mechanisms are most suited for a specific project a tool was developed that can be applied in projects. Paper 3 identified how some of the numerous different mechanisms that can be used by a project manager to improve collaboration may be more cost-efficient than others depending on the project and its context. To help project managers identify the most favourable mechanisms, i.e. to maximise the delta in Figure 5-11, a compass has been proposed as navigation tool as was shown in Figure 4-10 (see page 177) . Project managers can use this compass to navigate towards a sweet spot as far down to the right as possible in Figure 5-11, hence maximising the delta and optimising the transaction costs further in terms of balancing investment cost versus benefits. A more detailed description of the collaboration compass itself can be found in chapter 4.3 and the implications of the compass are further discussed in chapter 6.2.

## 5.3 Improving project performance through a holistic approach (RQ III)

In the previous section the relationship between collaboration and transaction costs was presented, showing how applying the "right" collaborative mechanism for a given project can be used to optimise the project transaction costs. The third research question in this thesis addressed the problem of poor productivity in the global construction industry (Zhang et al., 2018b; Fulford and Standing, 2014).

**RQ III**: How can connecting the research field of project transaction costs with the research field of client contractor collaboration contribute to improved performance in construction projects?

This research question is assessed in two stages. First, a three-dimensional model is established based on the findings from the four papers in this thesis. Following this, data from construction projects that use the Nordic 10-10 benchmarking tool are applied to the model to illustrate its relevance for improving project performance.

Looking back at Equation 1 on page 79, the total cost of a project is the sum of its production costs and its transaction costs – i.e. to improve project performance, both these elements are relevant. This allows for a more meaningful understanding of how the research fields of project transaction costs and client-contractor collaboration can contribute with solutions to improve performance in projects.

### 5.3.1 Optimising transaction costs - A three-dimensional puzzle

Adding the aspect of quality performance to the relationship that was presented in chapter 5.2 allows for the creation of a three-dimensional model called *The Puzzle of Project Transaction Costs*. This model, shown in Figure 5-12, expresses how collaboration, transaction costs and quality are all related to each other. The aim is to solve the puzzle and position the project in the optimal place where project transaction costs are low, while quality performance and collaboration remain high at the same time.

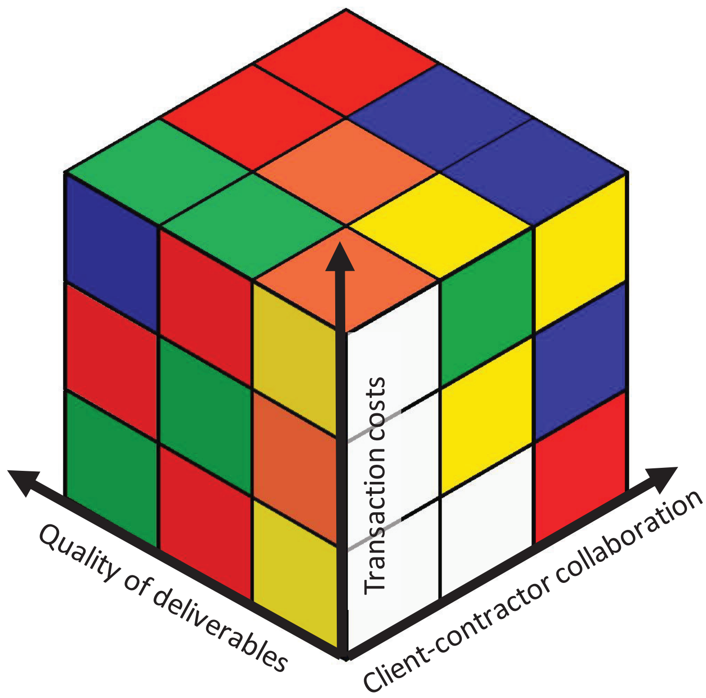



***Figure 5-12: The Puzzle of Project Transaction Costs***

### The first axis: project transaction costs

The first axis of the model describes the relative size of the transaction cost in a project from low to high. In paper 4 this was expressed as the project *head size*. This is a dimensionless number where the project transaction costs were divided on the total project cost. Hence, projects where the transaction costs are small compared to the total project cost are found at the lower end of this scale which goes from low to high.

### The second axis: client-contractor collaboration

The second axis of the model describes the client-contractor collaboration dimension. In other words, it illustrates how good the collaboration is between the client and its contractor(s) in a project. Client-contractor collaboration can be measured by applying the collaboration quality indicator that was proposed in paper 2 in this thesis. This indicator was constructed from 18 different measures that cover key aspects such as: trust (Pinto et al., 2009; Kadefors, 2004), communication (Nevstad et al., 2018; Turner and Müller, 2004), teamwork (Caniëls et al., 2019; Hoegl and Gemuenden, 2001) and coordination (Dietrich et al., 2010; Chan et al., 2004).

### The third axis: quality of project deliverables

The third axis of the model describes the quality of the project deliverables. In paper 2 quality was measured by an indicator developed by CII. This indicator measures several aspect of quality such as: the extent to which the deliverables meet the intended requirements and specifications (Arditi and Gunaydin, 1997), the number of errors, non-conformances and deviations (PMI, 2017; Yeung et al., 2013) as well as client satisfaction (Oakland, 2012; Juran and Godfrey, 1999).

From paper 2 in this thesis the relationship between project performance and client-contractor collaboration was investigated. As shown in Figure 5-13, a particularly strong relationship was found between collaboration and the quality performance in the projects. In other words, projects with high collaboration produced deliverables with fewer errors and mistakes compared to projects where there was less collaboration between client and contractor.

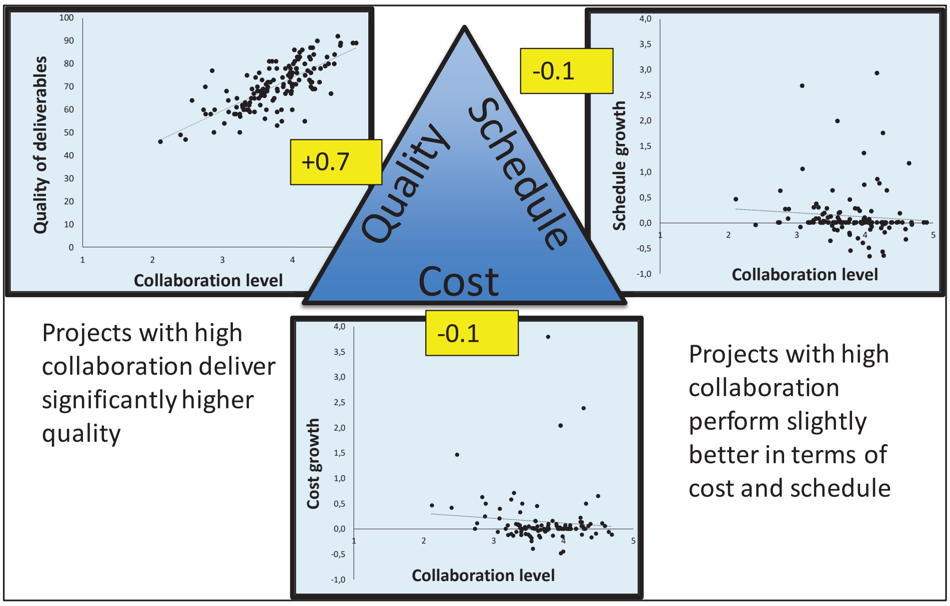



***Figure 5-13: Correlation between collaboration and project performance within the iron triangle***

This relationship between collaboration and quality performance is also relevant since this affects both the project transaction costs and the project production costs. By doing things right the first time, repairs and rework are avoided. The cost of poor quality (PMI, 2017) can be significant and large benefits can be achieved if the quality of the project deliverables is improved (Barbosa et al., 2017; Fulford and Standing, 2014). This importance of "doing things right the first time" was something that several of the respondents in the interviews of this thesis highlighted as they described how poor quality was a recurring problem in their projects. As well as additional production costs, poor quality can also cause additional transaction costs in terms of legal and dispute resolution costs as well as the need for increased monitoring and control.

### A holistic model where all three dimensions are related

Similarly, to trying to solve a Rubik's cube, solving the puzzle of project transaction costs is also challenging as adjusting one of the parameters will also affect the other dimensions. In this model, all three dimensions relate to each other, meaning that if one dimension is altered, others will also be affected. In a conversation, related to this thesis, with a director working in the Norwegian construction industry this paradox was illustrated:

> *"As we try to fix the transaction costs in one place, they keep popping up somewhere else instead!" – director working in the Norwegian construction industry –*

From paper 1 the relationship between transaction costs and collaboration was investigated. Changes in collaboration also influence the project transaction costs, as paper 1 showed how many of the same factors that affect transaction costs also affect collaboration. Similar, paper 2 showed how quality and collaboration are strongly correlated. There is also a relationship between quality and transaction costs in terms of the cost of monitoring and control.

For example: consider a project located in the top position at the rear of Figure 5-12. At this position, quality, collaboration and transaction costs are high. In order to improve the performance of this project further, the project manager may want to reduce the transaction costs, for example by reducing the travel budget in the project or cutting down on the size of the project management team. However, this may also affect both quality and collaboration performance, shifting the project into a position inside the cube that was not the project manager's intention.

This model can be applied by project practitioners as a tool for continuous improvement. By measuring their performance in each of the three dimensions and plotting the location in the framework during the project the project manager can monitor how the project moves between different positions in the cube as various measures are implemented in the project to improve performance.

### 5.3.2 Applying the model on the Nordic 10-10 dataset

To further illustrate the application of the model, data from projects in the Nordic 10-10 dataset have been plotted in the model. In total, the available dataset contained 142 projects, but for eight of these projects data were missing and the number of valid cases was therefore reduced from 142 to 134. Using the previously described indicators for each axis, the score from each project was categorised as low/medium/high depending on how it compared with the scores from the other projects in the dataset. For example, a project that received a collaboration quality score that was among the lowest 1/3 of the dataset was categorised as *low*. Those projects whose score was among the top 1/3 in the dataset were categorised as *high*, while the remaining 1/3 of the projects were categorised as *medium* in this dimension. This exercise was done for each of the three dimensions: client-contractor collaboration / quality of deliverables / project transaction costs.

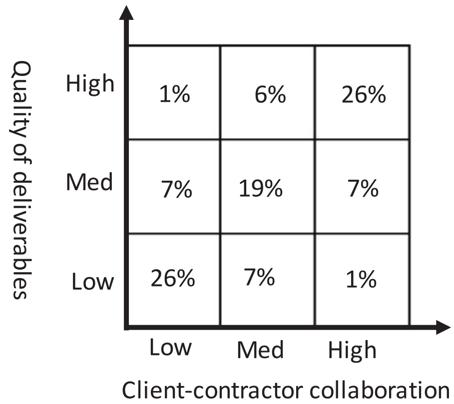



***Figure 5-14: Relative distribution of Norwegian construction projects, two dimensions***

Figure 5-14 shows a two-dimensional representation of the score for 134 different projects when taking a two-dimensional top view of the model that was shown in Figure 5-12. In this two-dimensional top view, results are distributed from low/medium/high along two axes, being the quality of deliverables and client-contractor collaboration. Figure 5-14 reveals that most projects are found along the diagonal in the model, as 26% have scored low-low, 19% scored medium-medium and 26% scored high-high. In total this means that 71% of the projects are found along this diagonal. This illustrates the strong correlation that was found between quality of deliverables and collaboration in Paper 2. Projects with high client-contractor collaboration do well on quality of deliverables, while those who score low on client-contractor collaboration also score low on quality of deliverables. There are few projects that have low quality of deliverables and high client-contractor collaboration and vice versa. From this two-dimensional plot it appears that 26% of the projects are found in the most favourable position where there is high collaboration between the client and its contractor, and the quality of the project deliverables is high.

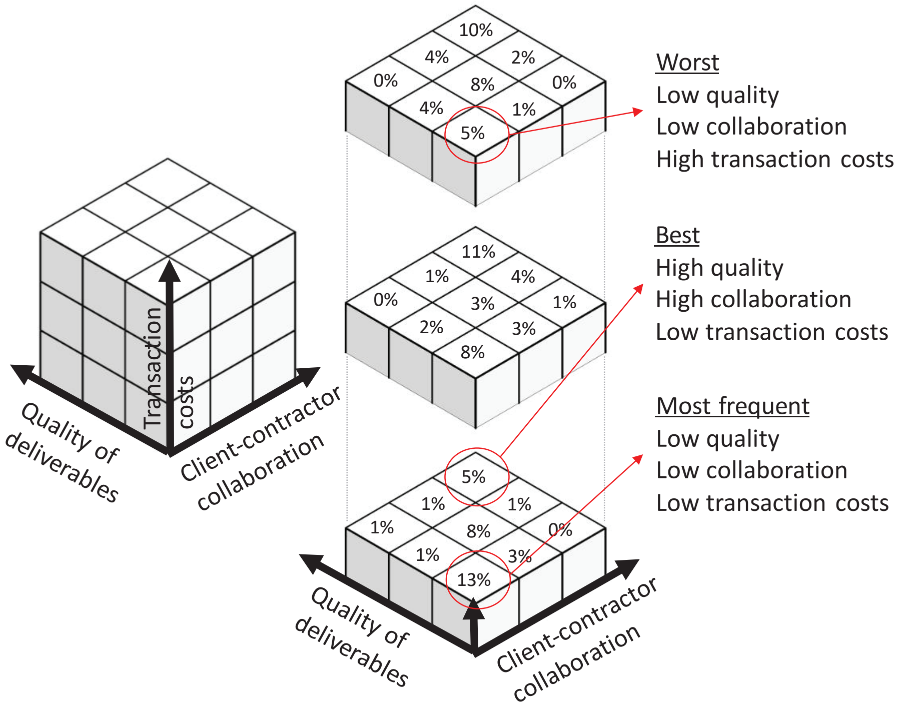



***Figure 5-15: Relative distribution of Norwegian construction projects, three dimensions***

However, what this two-dimensional model fails to show is the transaction cost dimension. Once a more holistic approach is taken and all three dimensions from the model shown in Figure 5-12 are included, the picture becomes much more interesting. Now, the distribution of the 134 projects are plotted in all three dimensions as shown in Figure 5-15. Suddenly one can see that in fact only 5% of the projects are found in the ideal location of the model. From the 26% of the projects that scored high on client-contractor collaboration and quality of deliverables, only a few of these projects managed to keep the transaction costs low at the same time. In terms of improving project performance, this example shows why it is important to assess all three dimensions holistically and not only to focus on two dimensions of the model in isolation.

The relative distribution of the 134 projects in the model is summarised in Figure 5-15 and the following pages describe some further findings related to this. One can see that projects that score high on client-contractor collaboration and quality of deliverables have both low and high transaction costs. This is interesting, as it illustrates the point made in chapter 5.2 that the relationship between transaction costs and collaborations is two sided as both benefits and investment costs contribute to the project transaction costs. For example, 10% of the projects score high on all three dimensions. Such projects experience excellent collaboration and high quality of the deliverables but pay high transaction costs. With reference to Figure 5-9, these projects may have passed the sweet spot in the figure and invested more money in collaboration mechanisms than the benefits that are harvested. In such a scenario, applying the collaboration compass from paper 3 may be useful in order to optimise the transaction costs.

Moving on, there are three positions in the model that are particularly interesting, and these deserve further elaboration. These are indicated in Figure 5-15 and will be presented further in the following paragraphs and are as follows: The worst, the ideal and the most frequently found position.

### Worst: low quality, low collaboration and high transaction costs

What is common for projects in the worst position in the model (see Figure 5-15) is that they struggle with poor client-contractor collaboration, quality of the deliverables is low, and the transaction costs are high. Lack of trust and poor communication may lead both parties to spend more and more resources on securing their interests against opportunism from the counterpart leading to a further decline in trust and increasing transaction costs. Furthermore, the poor quality of the deliverables increases both production costs and transaction costs as rework and repairs are needed and costly monitoring and control measures are implemented to prevent future mistakes and errors while legal advisors argue about who is to pay for the repairs.

Five percent of the projects were found in this "worst" position in the model and most likely faced serious challenges in terms of poor performance. During the interviews conducted for this thesis some of the respondents had experienced working in such projects and one of the more extreme examples is quoted below:

> "*The work conducted was poor and significant errors were discovered early in the construction period. Still, the contractor ignored this and kept working in the same manner causing more and more errors. Major repairs and rework had to be conducted at the end and the project was completed after two years instead of after six months as planned. This was followed by a lengthy legal conflict with the contractor who went bankrupt. It is so much cheaper to get things right the first time!*" *– client, construction project –*

Looking back at Figure 5-9, projects found in this position in the model would be found all the way to the left in the diagram with high safeguarding costs and little collaboration. Projects located in this position in the model may harvest significant benefits if collaborative mechanisms are applied, leading to reduced safeguarding costs and improved quality of the deliverables.

### Best: high quality, high collaboration, low transaction costs

In the diagonally opposite corner of the model, the ideal position is found (see Figure 5-15). Here, collaboration is high, transaction costs are low, and the quality of the project deliverables is good. Out of 134 projects in the dataset, seven projects (5%) were among the top 1/3 performers in all three dimensions. This indicates how difficult it is to do well in all three dimensions at the same time. In order to achieve this, the project manager must focus on all three dimensions holistically and not only focus on one or two dimensions at a time. Focusing on only one dimension may result in shifting the performance in the other dimensions as well.

In terms of project performance, the aim for project managers should be to navigate their projects towards this ideal spot as it should offer the lowest sum of production and transaction costs. For example, in terms of production costs, early involvement of contractors with their detailed knowledge may lead to the identification of more effective and better construction methods and the close collaboration between the client and its contractor reduces the number of mistakes and errors that need correction. In terms of transaction cost, a high-performing collaborative relationship with open communication minimises the need for the parties to spend resources to protect their interests as they trust their counterpart not to exploit the situation and for example present opportunistic change orders or claims.

As with navigating in the mountains, it is important to check the project position frequently and adjust the course if needed. In the project context, this means that the project manager should regularly measure the performance of the project in all three dimensions to monitor that the project is staying on the right course towards the ideal position in the model.

### The most frequent: low transaction costs but poor quality and collaboration

Another aspect that deserves to be discussed is that 13% of the projects scored low both on quality and collaboration (see Figure 5-15), but they did not suffer from high transaction costs. That is, although the low transaction costs may appear positive, the projects had low collaboration and struggled with their ability to deliver the expected quality. Several contractors who were interviewed as part of the research in this thesis illustrate this paradox, as they mentioned how their clients did not spend enough resources to participate actively in the project together with the contractor. The lack of active involvement from the client had a negative effect on collaboration and the contractor's ability to identify solutions that would be best for the client. Hence, the transaction costs may be low as the client spends few resources on following up its contractor, but opportunities for better performance may be overlooked. The fact that almost 13% of the projects are found in this position is particularly interesting when the findings from paper 1, 2 and 4 in this thesis are compared.

Interviews in paper 1 revealed that it is important that the client allocates sufficient resources from its own organisation. This view was shared by ICT project managers as well as project managers in oil and gas projects. However, only 30% of construction project managers shared this view compared with 87% of ICT project managers and 100% of project managers working with oil and gas projects. At the same time, construction project managers were much more focused on frequency of claims than project managers in the two other industries and construction contractors in general preferred that the client did not get too involved in "their work". This may indicate that construction project managers may be less eager to involve their clients actively compared with other industries.

## 5.4 Painting the landscape of project transaction costs

As pointed out on several occasions in this thesis, project transaction costs are not simply waste that should be eliminated. The aim is rather to minimise the sum of project production costs and project transaction costs (Lee et al., 2009; Walker and Kwong Wing, 1999; Williamson, 1979) and avoid transaction costs that do not contribute to lowering the production costs (Lu et al., 2015; Rajeh et al., 2015; Lumineau and Quélin, 2012). This thesis shows that such transaction costs can be optimised through client-contractor collaboration. As trust increases from collaboration, the parties need to spend fewer resources on disputes or on safeguarding their interests against opportunistic behaviour. At the same time, this thesis also found that there are significant transaction costs in projects, and at least 18% of the total cost in construction projects consists of transaction costs. Most likely, the number is considerably higher, as there are other transaction costs not measured by the research in this thesis. The magnitude of these costs suggests that the field of project transaction costs deserves more attention from scholars and practitioners within the field of project management.

The following section contains a metaphoric illustration of project transaction costs with the aim of capturing the essence of the findings from the research conducted in this thesis and to plant some initial seeds for discussing these findings. Hence the following metaphor acts as a prologue to the next chapter where the findings from the thesis are discussed.

### The project landscape and associated transaction costs

With the aim of operationalising and illustrating the relevance of project transaction costs, a picture is painted (Figure 5-16) that scholars and project practitioners can hang on their mental wall as a reminder of project transaction costs and their relevance to both theory and practice.

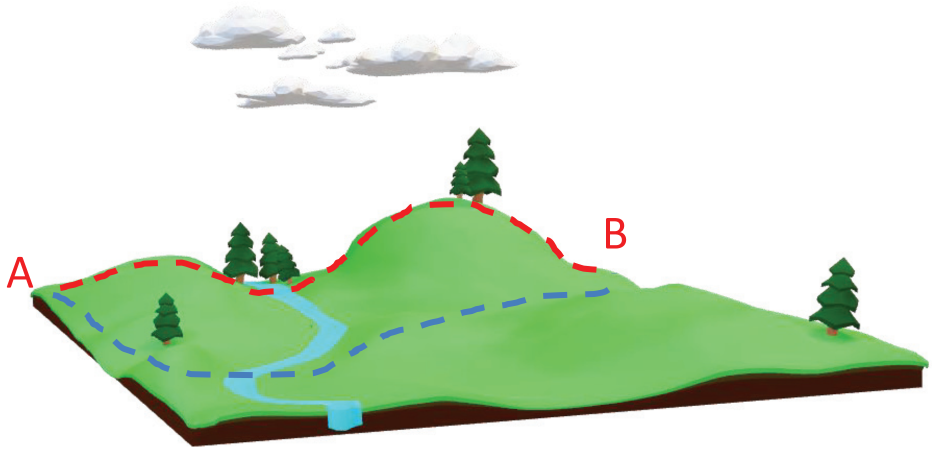



*Figure 5-16: The project landscape and associated transaction costs*

Every project is unique with its own features (PMI, 2017). Using the analogy of a landscape, hiking from one point to another, the project characteristics describe the project terrain, and the project makes the journey across this landscape from A to B, as shown in Figure 5-16. In terms of transaction costs, Williamson (1981) reminds us that these can be expressed through friction. In a journey through the project landscape, the transaction costs for the project can be illustrated as the effort needed to climb up steep hills, cross difficult rivers or protect ourselves from wild animals. All the energy spent on such activities to overcome friction represents transaction costs.

However, it may be possible to find another route across the terrain that may be a little longer in terms of distance, but that requires less effort as there is less resistance and friction, i.e. a route with lower transaction costs. Examples would be going around the mountain instead of over it or finding a path that leads us to a bridge where the river can be easily crossed. This is illustrated by the explorer Lars Monsen, who spent three years crossing the wilderness of Canada alone from coast to coast.

> " *The one that hikes a lot in the wilderness will always search for the easiest route through the terrain. The consumption of energy should be as low as possible. In summertime, it may be wise to avoid wet marches and difficult water-crossing while such marches and lakes may be the best option wintertime when they become frozen. One follows the lead lines in the terrain and looks for signs of changing weather. One adjusts and travels with the weather instead of fighting it. When the storm arrives, you find the best shelter and use the opportunity to rest so that you can give full speed once the sky clears" (translated from Monsen, 2019, p. 170)*

Projects vary in size and duration, just as some hikes involve taking a large group on a long journey while other hikes may be shorter and only involve a few persons. Some terrain is more complex to cross as it may require difficult river crossings and climbing steep mountains, while some terrain may be easy to cross by following marked pathways through open plains. This metaphor of describing the landscape terrain illustrates different elements of project characteristics. One may differentiate between projects based on industry types, size and duration or apply more generic frameworks for taxonomy such as the NCTP framework model developed by (Shenhar and Dvir, 2004). Pervading the whole model is uncertainty. Weather conditions may change along the way and influence the journey in many ways. Heavy fog may make navigation more difficult and blizzards may force the group to halt and wait in their tent until the sky clears. A journey of great urgency may have to be done during winter while a less urgent journey can be postponed to the summer when weather is more predictable. Sometimes it may be most safe to follow paths where others have hiked before. However, the conditions may have changed and simply following paths from the past may lead to new opportunities being overlooked.

### The tale of a group, their guide and their misery

Stakeholders may have different goals for what they want to achieve from a project. As a metaphor, consider a group of friends on holiday in the mountains who choose to hire a local guide to help them with a journey from A to B. This guide may have an incentive to complete the journey as fast as possible, as the guide is paid a fixed amount for the task of guiding the group safely from A to B. However, the group may be interested in fishing and expect the guide to make sure that their paths cross the best fishing streams in the area. If the group and the guide have not communicated properly and aligned their goals for the journey upfront, conflicts may occur. Halfway through the journey, the guide may propose to adjust the course according to the group's wish to find the best fishing streams, but the guide demands extra payment for this. The guide has superior knowledge of the area and the rest of the group are not comfortable with travelling alone in a terrain with which they are less familiar, so they have to choose whether to pay the guide extra for the detour or resign themselves to following his trail directly to B and forget about their fishing plans. Their trust in the guide has vanished.

Once arrived at their destination, the group demand a refund as they are disappointed and claim that the guide did not provide the service that they had expected. Group members spend valuable time of their remaining holiday to study the guide's website to identify what they were promised and build the claim. However, the guide reminds the group about the document that they had signed upfront where terms and conditions had been presented in complex language prepared by the guide's solicitor. Later, the guide realises that one of the group members works as a travel agent and now the guide fears that a loss of reputation may hurt his future business as a guide. He therefore proposes to give the group a 50% refund in order to resolve the conflict, something that the group accepts after lengthy negotiations. The outcome of this journey is two disappointed parties. The group is disappointed that their holiday did not meet their expectations and they are frustrated about the time they spent on discussions and disputes. At the same time, the guide failed to earn money from this job and now has to consider how he can make up for this loss when guiding other groups in the future. Both parties experienced significant transaction costs.

From the framework by Li et al. (2015) it is clear that there are many factors that affect transaction costs and conflict resolution is just one example. The holiday group in this metaphor may for example spend some time upfront to identify different guides in the area and check their references to ensure that they hire the best suited guide instead of simply choosing the guide who offers the lowest cost. Another option for the group could be that one of its members attends a training course to refresh his Boy-Scout navigation skills while another member studies the fishing opportunities in the area on various websites and forums. Hence the group could be able to conduct their journey without needing to hire a guide. However, the decision to travel alone or not will depend on the complexity of the landscape (the characteristics of the project) and the uncertainty related to weather conditions. A group planning a weekend fishing trip in the middle of the summer in an easy terrain does not need to spend as much time for planning the trip as a group that plans to cross an arctic mountain plateau in the middle of winter. The transaction costs for these two projects in terms of planning and preparations would surely differ a lot.

### The group and their guide – the alternative (happy) ending

If there was excellent collaboration between the group and their guide, the story might have been different. Let us assume that the group identified during the early stage of the planning that they should invite the potential guide for a kick-off meeting. Here, the guide presented them with different options depending on what the group hoped to achieve from the project. When there was mutual understanding of the goals, they found a suitable compensation format and agreed how to handle changes that might occur along the way. The guide now understood that the most important criterion for his clients to consider this journey a success was related to the fishing. If the group managed to catch some big trout, they would potentially come back later for another trip and spread the word to other potential future clients.  The guide therefore planned the trip with this in mind and ensured that the route would pass several of the best fishing spots he knew about in the area. He also planned for various alternative options that he could present to the group if the weather changed or the fishing failed.

# 6 Discussion of Findings

In this chapter the main findings presented in Chapter 5 in this thesis are discussed. The structure of this discussion follows the axis of the three-dimensional model shown in Figure 5-12 (page 222). Hence, the findings in each of the following three dimensions are discussed:

- Transaction cost dimension
- Collaboration dimension
- Quality dimension

This thesis has identified how combining the research field of project transaction costs with the research field of client-contractor collaboration can contribute to optimising transaction costs in construction projects through a holistic three-dimensional model called The Puzzle of Project Transaction Costs.

In her frequently cited paper, Kadefors (2004) used the metaphor of "opening a black box" of relations in projects as she studied trust in inter-organisational project relations. The Puzzle of Project Transaction Costs also appears to have been hiding inside another "black box" that most researchers so far only have been able to peep inside.

On the following page, Figure 6-1 illustrate how the findings from the research in this thesis together have been used to open this box from different angles in four different scientific papers. The first paper established the relationship between client-contractor collaboration and transaction costs in projects. In the second paper, the relationship between client-contractor collaboration and project performance was explored, while the third paper identified the most favourable collaboration mechanisms for a specific project based on its characteristics. The fourth and final paper investigated and quantified the size of project transaction costs in Norwegian construction projects.

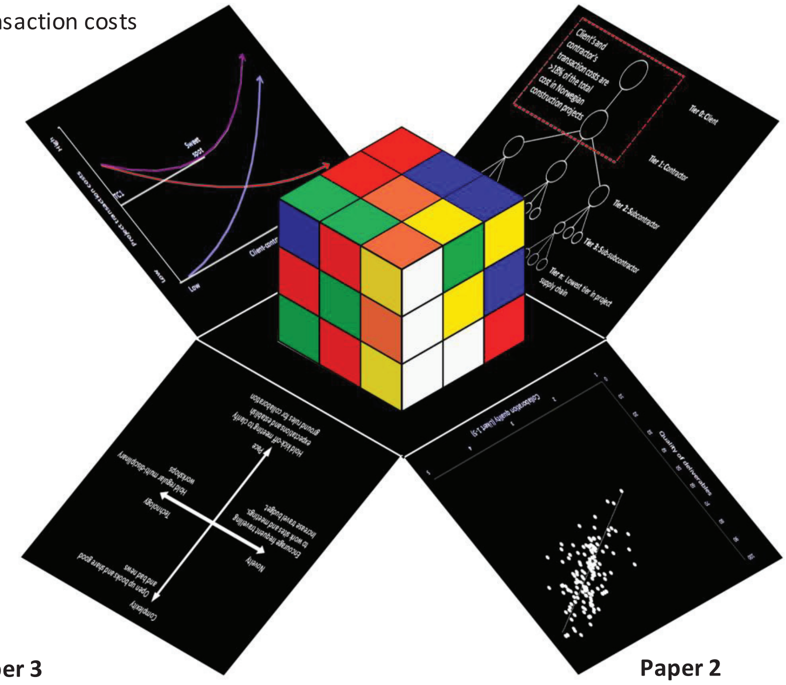



***Figure 6-1: "Inside another black box" -The Puzzle of Project Transaction Costs***

## 6.1 The transaction cost dimension of the puzzle

In the following sub-chapter, the findings related to the transaction cost dimension of the three dimensional model will be discussed (see Figure 5-12 on page 222).

First the size of the project transaction costs found by the research in this thesis will be compared with findings from previous research in the field. Secondly, transaction costs for projects with different delivery methods are discussed.

Figure 6-2 compares the findings from this thesis with previous studies. In this figure, transaction costs are reported as a percentage of the total project cost and separated by phases (pre-contract and post-contract). At first glance, the numbers found in this thesis are in the higher range of what others have found previously.

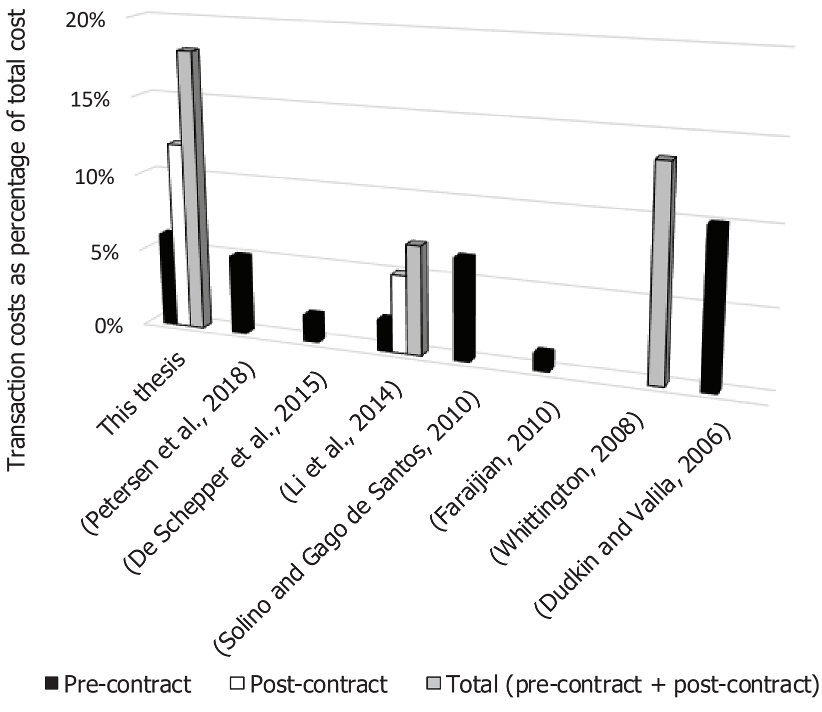



*Figure 6-2: Comparison of studies quantifying project transaction costs*

However, there are two particular aspects related to this that are worth further mention when comparing studies that quantify project transaction costs. The first is related to whether the studies cover both pre-contract and post-contract transaction costs or if they are limited to only one of these phases.

The second aspect is related to the project supply chain, and whether the research only covers transaction costs for one actor (for example the client) or includes transaction costs for multiple actors in the supply chain, such as contractors or subcontractors. In the following section the findings from this thesis will be dissected and compared with the elements that have been covered by previous research on project transaction costs.

Since none of the existing studies are directly comparable by looking at Figure 6-2, it is of little value to compare the total 18% value found in this thesis directly with existing studies alone. However, it is possible to dissect the findings of this thesis and compare them element by element to what others have found. Existing studies mainly focus on pre-contract transaction costs isolated to either the client or the contractor perspective. This can be seen in Table 6-1, where the main findings from existing research have been summarised together with the findings from this thesis.

In Table 6-1, findings from the studies have been sorted both according to which phase and which perspective they cover. None of the existing studies quantifies pre-contract and post-contract transaction costs for both the client and the contractor. This thesis therefore contributes with new knowledge related to quantification of project transaction costs, as the research in this thesis covers both the client's and the contractor's organisation in both the pre-contract and post-contract phase.

***Table 6-1: Element of project transaction costs quantified by studies***

| | Client | | Contractor | |
|---|---|---|---|---|
| | Pre-contract | Post-contract | Pre-contract | Post-contract |
| (Petersen et al., 2018) | | | 5% | |
| (De Schepper et al., 2015) | | | <2% | |
| (Li et al., 2014) | 2% | 5% | | |
| (Soliño and Gago de Santos, 2010) | | | 6.5% | |
| (Farajian, 2010) | | | <2% | |
| (Whittington, 2008) | 13.5% | | | |
| (Dudkin and Välilä, 2006) | | | 10% | |
| | | | | |
| This thesis | 3% | 5% | 3% | 7% |

Following the dissection presented in Table 6-1 it is possible to discuss separate elements from the findings in this thesis and compare the numbers to findings in existing research.

## Contractor's transaction costs

In the recently published study by Petersen et al. (2018) pre-contract transaction costs were found to be 5% of the total cost in a project. However, this is limited to contractor's pre-contract transaction costs, i.e. the contractor's costs associated with preparing and negotiating bids, and it does not include post-contract transaction costs. This study was based on a survey among 261 private contractors in various industries in Denmark where respondents reported the size of their pre-contract transaction costs compared with the total cost.

This thesis found that the contractor in total spends 10% of the total project budget on transaction costs. In terms of the difference between the pre-contract and post-contract phase, the split was 3% and 7%.

Hence, this thesis found lower pre-contract transaction costs for the contractor than what Petersen et al. (2018) found. This is also lower than the findings from the research presented by Soliño and Gago de Santos (2010) who collected data from infrastructure projects in EU countries conducted in the period between 1992 and 2007 and found that contractor's pre-contract transaction costs were on average 6.5% of the total cost of a project. Dudkin and Välilä (2006) found that contractor's pre-contract transaction costs averaged 10% of the project value when they analysed data from 55 projects from six different sectors in the UK. One reason for this difference may be that this thesis measures pre-contract transaction costs for the contractor that won the job, while the above-mentioned studies also includes transaction costs for unsuccessful bidders.

The research by De Schepper et al. (2015) and  Farajian (2010) is also limited to cover pre-contract transaction costs borne by the contractor. However, both these studies found these costs to be less than 2% of the total project cost, similar to what is found in this thesis. It is worth mentioning that both De Schepper et al. (2015) and Farajian (2010) cover infrastructure projects while the research in this thesis covers a combination of infrastructure projects and building projects. However, when sorting the findings in this thesis between infrastructure and building projects there is little difference in terms of the size of the transaction costs between these two types of projects.

As can be seen from Table 6-1, none of the existing studies found include data from contractor's post-contract transaction costs. In that respect, this thesis makes a modest contribution with new empirical data to the field. Although the dataset in this thesis has its limitations it shows that the contractor appears to have more than twice as high transaction costs in the post-contract phase compared with the pre-contract phase.

### Client's transaction costs

Moving on, it is also interesting to compare the findings in this thesis with the work conducted by Li et al. (2014) as their research covered both pre-contract and post-contract transaction costs for clients which they found to be, on average, 7% of the total project cost. These findings were based on an e-mail survey among 239 US construction clients. When comparing the findings from this thesis with the findings from Li et al. (2014), one can see that the findings are similar. Both studies found that the client's transaction costs were 7-8% of the total project cost and that the client experienced higher transaction costs during the post-contract phase than during the pre-contract phase. In other words, the client's costs related to monitoring and administration of the work conducted by its contractor(s) were higher than the costs experienced prior to contract signing. Whittington (2008) did not separate client's transaction costs into phases but found that from a case study of six US highway projects, the client's transaction costs were on average 13.5% of the total project costs.  This is somewhat higher than what Li et al. (2014) found and what was found in this thesis.

### The Norwegian project context

Measuring the size of project transaction costs in Norway leads to some interesting reflections in terms of external validity, i.e. the extent to which these findings can be generalized outside Norway. The context of the Scandinavian school of project management is commonly viewed as more focused on the organisational perspective of project management (Andersen, 2016; Walker and Lloyd-Walker, 2016a), where there is more focus on building trust (Strand and Freeman, 2015) in the relations between the actors. Projects with higher trust should need less management (Williamson, 1996) and one could therefore be tempted to assume that the project transaction costs in Norwegian projects may be smaller than in other parts of the world.  However, the trust level in

Scandinavian projects can certainly be debated and Kadefors et al. (2007) found a generally low level of trust between clients and contracts in their study of Swedish construction projects. The conflict level in Norwegian construction projects has also be found to be high (Kvålshaugen and Sward, 2018). The transaction costs in projects studied in this thesis may therefore very well be similar to projects from other parts of the world but this is difficult to verify, as no directly comparable studies have been found. High awareness of cultural differences between countries is therefore important when comparing the findings from this research with findings from other parts of the world as cultural aspects will influence project transaction costs depending on the level of openness and trust (Aarseth, 2014).

During these discussions, the findings presented in this thesis have been compared to existing research. The existing research only covers separate sections of the puzzle, i.e. either limited to pre-contract transaction costs or to covering only the client or the contractor’s transaction costs. However, when the findings from this thesis are dissected and compared with this existing research bit by bit, it corresponds well in general, by covering both pre-contract and post-contract transaction costs as well as both the client and the contractor's transaction costs. This thesis provides a more holistic understanding of the size of project transaction costs that what exists from before, as existing research only covers isolated pieces of the puzzle.

### Variation of transaction costs between different delivery methods

The findings from the research in this thesis also allow for some discussions related to how project transaction costs may vary between projects using different delivery methods. In the dataset for paper 4, which contained in total 134 projects, Design-Bid-Build was used by 50 projects and Design-Build was used for 68 projects. Whittington (2008) suggests that transaction costs in Design-

Bid-Build projects may be 25% higher than for projects that use Design-Build. However, this thesis found no particular difference in the transaction costs between projects that used these two different delivery methods. Other delivery methods such as parallel primes, integrated project delivery and construction management at risk were also used by a couple of projects in the dataset analysed in this thesis, but too few to allow a meaningful discussion. However, several of the respondents in the interviews conducted in paper 1 of this thesis worked in projects that applied alliancing. These respondents described how the trust level was significantly higher now than in previous projects that they had worked in that used more traditional delivery methods, something that is illustrated by the following respondent.

> *"In the alliance we share all our commercial details with the client and our partners. We really have to trust each other" – contractor working in an alliance project –*

Increased trust is an example of one of several potential positive outcomes when applying collaborative delivery methods (Børve, 2019) in projects and may lead to reduced transaction costs in terms of, for example, fewer change orders or opportunistic claims (Kadefors, 2004). Since the quantitative project transaction costs found in this thesis are mainly limited to projects that apply more traditional delivery methods, one can assume that the number would be lower than the 18% if more projects that used for example IPD, partnering or alliancing were included in the dataset.

When it comes to different compensation formats, there were some differences found in the dataset for this thesis. The project transaction costs were in general larger for the 56 projects that used lump sum compensation formats than for the 25 projects that used a cost-reimbursable compensation format. The project transaction costs for cost-reimbursable projects was approximately 60% of the size of the transaction costs found for lump sum projects. A Student's t-test indicated that this was a systematic difference. This finding supports previous research by Li et al. (2014) who found that transaction costs were significantly higher in projects that used lump sum compensation compared with other types of compensation format.

Looking back at Figure 2-8 and Figure 2-9 on page 88 and page 89, the research in this thesis suggests that one can expect lower transaction costs in projects that utilise delivery methods that facilitate integration and collaboration between client and contractor rather than separation and few pain-share/gain-share incentives.

## 6.2 The collaboration dimension of the puzzle

In the following sub-chapter, the findings related to the client-contractor collaboration dimension of the three dimensional model will be discussed (see Figure 5-12 on page 222).

Similar to what was found by Mohamed et al. (2011), Arditi and Chotibhongs (2009) and Tan et al. (2008), this thesis also found many examples of situations where opportunistic contractors may choose to lower their margins and reduce their price in order to increase their chances of winning the contract with a client and thus speculate that they will recover the loss later through change order requests and claims. Contractors with more detailed information and knowledge than the client may exploit this situation of asymmetric information (Mandell and Nyström, 2013) and issue many change order requests during the project. The findings in the thesis are in line with existing research, as it was confirmed that opportunistic change order requests have a negative effect on the collaboration level in the contractor-client relationship. According to Kvålshaugen and Sward

(2018) the conflict level in Norwegian construction industry is in general high. The findings from this thesis support this as *frequency of claims* was found to be a much more salient factor affecting collaboration and transaction costs in construction projects than in ICT or oil and gas projects.

Existing research within the field of client-contractor collaboration has established that there are significant benefits that can be harvested in projects through better collaboration between a client and its contractor (Aarseth, 2014). For example, the positive effects from collaboration have been established by the synergy model by Bititci et al. (2007). The positive effects that can be harvested through collaborative project delivery methods such as alliancing, partnering and Integrated Project Delivery models are also well established through major contributions to the field such as Walker and Lloyd-Walker (2015). It is well established that collaboration, in general, has a positive effect on project performance (Bond-Barnard et al., 2018; Um and Kim, 2018; Cicmil and Marshall, 2005; Turner and Müller, 2003). Generally speaking, collaboration is good and should lead to win-win situations for all parties (Bititci et al., 2007; Yeung et al., 2007) in a supply chain. The value of the relationship between customers and suppliers in supply chains is also enhanced if there is a high degree of collaboration (Vaaland and Håkansson, 2003).

Among the factors that determine transaction costs in projects, this thesis found *that quality of communication is* the one that has the highest influence on project collaboration. This is in line with existing research, where effective communication has been identified as a factor which influences collaboration quality (Aliakbarlou et al., 2018; Nevstad et al., 2018; Yap et al., 2017; Dietrich et al., 2010). Incomplete or poor communication may cause misunderstandings and lead to potential conflicts (Lædre, 2009).

It is well established that many of the positive effects from collaboration also have a positive effect on project transaction costs. For example, increased trust and openness reduces the need for monitoring and control (Pinto et al., 2009; Kadefors, 2004) and the parties can therefore reduce their transaction costs related to safeguarding their interests against a potentially opportunistic counterpart (Williamson, 1996). This corresponds well with what was found in the research conducted in this thesis. Many respondents described how they spent a significant amount of time to ensure that they were not taken advantage of by an opportunistic counterpart. One finding that emerged from the interviews in paper 1 was that respondents working in the construction industry considered *frequency of claims* and *project uncertainty* as particularly important factors affecting project transaction costs and collaboration. One of the respondents gave the following example:

> "*Some contractors take advantage of our lack of detailed knowledge about their field of expertise in order to earn extra money through change orders*"
> *– client, construction project –*

The findings in this thesis suggest that, as expected, there is a clear positive relationship between increased collaboration and avoiding unnecessary transaction costs caused by conflicts and disputes. This thus avoids situations similar to the Wembley stadium project example that was mentioned in the introduction (chapter 1.1) of this thesis where £22 million was spent on legal costs.

However, while most existing research in the field has focused on the benefits achieved through collaboration, this thesis contributes with an additional aspect that is less covered by previous research in the field: This thesis also considers both the benefits that are harvested through collaboration and the investment costs of applying mechanisms to achieve the desired collaboration. Through the lenses of transaction costs economics these investment costs also have to be considered. This finding was deducted and presented in chapter 5.2 of this thesis.

Both the cost and the benefits from applying collaborative mechanisms have to be evaluated. Considering both aspects allows for a more holistic understanding and this is further discussed in the following paragraphs.

### Optimising transaction costs – cost vs benefits

As emphasised several times in this thesis, the aim is not "simply" to reduce the project transaction costs, but rather to optimise the project transaction cost so that the total sum of transaction costs and production costs is minimised (Ikuabe et al., 2020; Lee et al., 2009; Walker and Kwong Wing, 1999; Williamson, 1979). Those transaction costs that do not give a positive contribution to the project should be reduced and avoided. For example, significant savings could be achieved if costs related to managing disputes and conflicts are avoided or if time-consuming administrative process are improved (Guo et al., 2016; Lu et al., 2015).

However, a too narrow focus on reducing transaction costs may lead to several paradoxes. For example, associated costs where a client travels to a construction site to verify work conducted by its contractor are example of transaction costs (da Fonseca et al., 2018). Such travelling costs can easily be reduced if the client decides to reduce the number of its site visits. However, as a consequence, there is a risk that poor quality in the construction work will remain undetected and not discovered until later. This may be particularly relevant if the contractor acts opportunistically and is tempted to select solutions with lower quality if the number of client inspections is reduced. Hence, simply reducing the number of site visits may not be a favourable option for the client even though some transaction costs can be saved through a reduced travel budget. In this respect, it is relevant to keep in mind that transaction costs are the "costs of running the economic system" (Arrow, 1969, p. 48) and the aim should be to minimise friction (Williamson, 1981). Instead of simply talking about reducing or removing transaction costs in a project, the discussion should rather be about optimising transaction costs while looking at the total sum of the transaction costs and production costs in the project as a whole.

> "*The object is to economize on the sum of production and transaction costs*"
> *(Williamson, 1979, p. 245)*

Even though both existing research and this thesis show that significant benefits can be achieved through improved collaboration, there are also costs related to implementing mechanisms to foster the desired collaborative behaviour. This side of the equation is less studied by previous research and in that respect, the findings from this thesis raise some interesting paradoxes. During the interviews conducted for this thesis several respondents mentioned that even though the intentions were good, sometimes the mechanisms applied in the project may have cost more than the benefits that were harvested.

What is common to many of the mechanisms to achieve collaboration is that they require some kind of investment or effort to be made, in terms of both time and money. For example, in paper 3 it was found that the most frequently used collaboration mechanism in the studied projects was: *holding kick-off meetings to establish ground rules for collaboration and to clarify expectations*. Arranging such a kick-off meeting may require booking cost for a venue, potential travel costs, as well as time spent. That is, time and money spent to build collaboration are transaction costs themselves. However, one can argue that such costs may still be small compared to the benefits achieved and it is therefore a wise investment.

Following this analogy, it may be tempting to jump to the conclusion that the answer for a project that is struggling with poor performance and high transaction costs is simply to invest in more collaboration mechanisms. However, simply flooding the project with well-intended initiatives to improve the collaboration quality in the project may in some cases cost more than the positive benefits that can be harvested. From a transaction cost perspective, this discussion is particularly interesting as costs associated with investing in collaboration are transaction costs themselves (Rajeh et al., 2013). This perspective is something that is less studied in existing research on collaboration as most of this research is focused on what can be gained and success factors to achieve better collaboration. In the transaction cost framework, collaborative mechanisms enable benefits such as higher trust (Bond-Barnard et al., 2018; Kadefors, 2004), but this comes at a cost. The task is therefore to balance the cost vs benefit and implement those mechanisms that give the highest benefits with the lowest cost.

Chapter 5.2 of this thesis outlined how transaction cost can be optimised by increased awareness of the cost and benefits offered by various collaborative mechanisms and balancing these with the benefits that they offer. A key contribution from the research in this thesis is therefore that it takes into account both sides of the picture and emphasises why it is important to apply the most efficient mechanisms for collaboration so that transaction costs can be further optimised. To address this issue, the *Collaboration Compass* has been developed as a tool that project managers can apply to determine which mechanisms may be most suitable for their specific project.

### Following the Collaboration Compass

The Collaboration Compass that was presented in Figure 4-10 (page 177) applies the framework developed by Shenhar and Dvir (2004) to categorise different projects based on their novelty, complexity, technology and pace. Following this compass, a project manager may identify which mechanisms other project managers from similar projects have used most successfully in the past. By applying the Collaboration Compass, the project manager can ensure that resources are spent on those collaboration mechanisms that give the most benefits compared to its investment cost for his or her project. In other words, the compass can help project managers to navigate towards the sweet spot offering the lowest project transaction costs based on the specific characteristic of the project.

Following the course indicated by the Collaboration Compass also raises other paradoxes that deserve some attention. For example, it was found that frequent travelling and face-to-face meetings were a commonly used mechanism to achieve good collaboration in projects governed by the novelty dimension. However, the time spent and the cost of travelling are examples of transaction costs (da Fonseca et al., 2018). Such costs are easily kept track of in the project balance sheet by the project controller. In other words, it is easy to quantify the investment cost of this mechanism (the blue line in Figure 5-8 on page 216).

However, what is not equally easy is to quantify the positive effect harvested by applying this mechanism (the red line in Figure 5-8 on page 216). Such benefits are more difficult to measure and in practice, it may therefore be difficult to compare the cost of travelling with the benefits harvested. One way to measure such benefits is to measure the collaboration quality in the project as outlined in paper 2. Here, an indicator was constructed that measures the collaboration quality in a project based on its level of trust, communication, teamwork and coordination. These measurements can be conducted throughout the project to monitor the collaboration quality in the project during its life cycle.

Since the Collaboration Compass is based on previous experience from similar projects, a project manager of a project with high novelty can follow this compass and be more certain that it is wise to apply this specific mechanism (increasing the travel budget) in his/her project. Project managers from similar projects in the past have reported that this was a particular efficient mechanism for this type of project even though it may be difficult to directly quantify the benefits harvested by this mechanism.

### Video conferences versus travelling

One particular finding from this thesis that deserves some attention is that when investigating which collaborative mechanisms were most commonly used in projects it was found that the mechanism *use advanced communication tools and video conferencing system* only ranked eleventh in out of total twelve different collaboration mechanisms. This seemed odd, as even research published more than a decade ago, such as Erdogan et al. (2008), identified the use of online meetings in projects as an efficient way to reduce the need for travelling. The development of advanced new solutions for communication between sites is rapidly evolving. For example, today's technology makes it possible to participate in meetings remotely through video conference systems with advanced screen sharing possibilities and even virtual reality that enhances collaboration in meetings although participants are at different locations (Karis et al., 2016). It therefore came as a surprise that this mechanism was found second from the bottom in Table 4-4 (page 176) where collaboration mechanisms were ranked based on interviews conducted for this thesis.

Even though such methods were highlighted as important by a few respondents, most respondents used less advanced systems and claimed that they often experienced technical problems with the more advanced systems. This issue has also been identified by Aljuwaiber (2019) who found that although face-to-face meetings are superior in terms of communication richness, video meetings can often be a pragmatic solution in projects where high workload and tight schedules limit the possibilities to travel and meet face-to-face. However, it is crucial to have top management support when establishing the video conference system and allocate resources to quickly resolve any technical issues, in particular in the implementation phase. It is worth mentioning that those interview respondents who described the benefits of such systems appeared to have been proactive and invested both time and money to ensure that the full benefits could be harvested. Those project managers who had taken active initiatives to ensure that the systems worked properly and used the systems frequently themselves described more benefits of the system compared to the project managers who appeared to be more sceptical of such video conferencing systems in the first place. Some respondents also mentioned that there is often a power balance in the client-contractor relationship dictating who has to conduct the travelling. This may suggest that clients have less incentive to spend time to set up and familiarise themselves with video conference systems, as it may be easier to just request that the contractor "comes in for a meeting".

Only a few of the respondents described the use of more advanced video conference systems as a good way to achieve collaboration; most respondents simply considered them as an adequate tool to reduce the need for travelling. This also corresponds well with what Blenke et al. (2017) found, as they identified that less than 4% of their respondents preferred virtual communication over face-to-face meetings. Even with modern video portals with live video streams between locations, travelling is still needed to achieve good collaboration quality. However, after one face-to-face meeting, the quality of remote collaboration is multiplied by 10 as a result of trust achieved from a first face-to-face meeting (Karis et al., 2016). This indicates that video conferencing systems can be well suited when the parties have already established a relationship upfront.

The need to travel raises a paradox related to project transaction costs. High quality collaboration in the client-contractor relationship has a positive effect on transaction costs in projects (Dietrich et al., 2010; Ahola, 2009). As trust increases with collaboration (Kadefors, 2004) there is less need for the parties to safeguard their own interests against opportunism and transaction costs are reduced (Williamson, 1996). It is therefore a paradox that one of the mechanisms to achieve collaboration, and reduce transaction costs, is to increase the travel budget, which is also a project transaction cost itself (Li et al., 2015). In other words, frequent travelling may lead to lower safeguarding costs through increased collaboration and trust, but this travelling itself has a cost that must be weighed up against the benefits. In terms of optimising project transaction costs, balancing the use of travelling versus video conferencing systems is an example of such an exercise where the project manager searches for the sweet spot in Figure 5-9.

However, in addition to the transaction cost aspect, travelling should also be discussed related to project sustainability. There is an increased focus on sustainable project management in terms of both what the project delivers and sustainable processes in the project (Sabini et al., 2019; Schipper and Silvius, 2018). To achieve sustainable projects, the environmental effects caused by the project should be minimised (Aarseth et al., 2017). Extensive use of air travel has a negative impact on the environment through increased emissions to the atmosphere. It is therefore challenging for a project manager who aims to deliver the project with a minimum of negative environmental impact to at the same time encourage frequent travelling, in particular air travel. This can be a particularly challenging paradox for the project manager who wants to minimise environmental impact through reduced travelling, but at the same time wants to build collaborative relations and trust between people, which is difficult to achieve without meeting face to face.

For society, reduced travelling in projects has positive effects as it reduces negative environmental impact. It is therefore a paradox that increased travelling and face-to-face meetings are still identified as key mechanisms to achieve collaboration in projects with high novelty.

The above discussion related to use of video conferencing system versus travelling becomes particularly relevant following the outbreak of the Covid-19 pandemic. In 2020, travel restrictions apply worldwide to reduce spreading of the disease. Business trips are banned, or reduced to a minimum, and many people conduct their work from home offices. As a consequence, project practitioners around the world find new ways to collaborate. Many project participants, and their managers, are now probably "forced" to master communication tools and video conferencing systems that they previously were reluctant to use. At the time being, it is not clear what the world will look like after the pandemic is over, but as human beings we are able to adapt to new situations and it may not be surprising if our behaviour in terms of how people collaborate in projects changes following the pandemic.

It will therefore be interesting to learn how the outbreak of the Covid-19 pandemic affects the balance between travelling and the use of video conferencing systems in projects in the future. It would therefore be particularly interesting if the research on collaborative mechanisms in this thesis is repeated in a few years' time to learn how practitioners' views on collaborative mechanisms has evolved following the Covid-19 pandemic.

### Collaborative project delivery methods

A decade ago, Bygballe et al. (2010) found that the use of collaborative delivery methods in general are less common in the Nordic construction industry compared to other regions such as the UK and South-East Asia. In Norwegian construction industry, the use of IPD appears to gradually be becoming more popular and IPD has received some attention in recent years from scholars and media. Recent case studies from IPD projects in Norway include the study following the construction of a large hospital (Bygballe and Swärd, 2019) and a complex laboratory research building (Engebø et al., 2020a).

Although gradually becoming more popular in Norway, the use of for example IPD still appears to be limited to a few big construction and infrastructure projects. This is also reflected by the dataset in this thesis and the findings presented in Table 4-4 (page 176). Here, *use collaborative procurement methods* was found third from the bottom in this table of collaborative mechanisms applied by the interviewed project managers. Similarly, only two of the 142 projects found in the Nordic 10-10 dataset used IPD or other collaborative delivery methods. Within the Norwegian oil and gas industry there appears to be a trend towards the use of more collaborative project delivery methods. For example, several of the major oil companies have established project alliances with their contractors during the last few years.

Even though the use of formal collaborative delivery methods may not yet be widespread in Norway, and most projects in the Norwegian construction industry use more traditional methods, many elements from collaborative delivery methods are found across the projects studied in this thesis. For example, looking back at Table 4-4 (page 176), it is interesting to notice that the top five ranked mechanisms found in this thesis are all mechanisms that Walker and Lloyd-Walker (2015) emphasise as salient for projects using high-order collaboration delivery methods. In other words, even though only a few of the projects studied in this thesis "formally" use IPD, partnering or alliancing, they still apply many collaborative mechanisms that are associated with such collaborative delivery methods. In this respect, Engebø et al. (2020a) emphasised how the use of collaborative delivery methods is a starting point to achieve a collaboration, but for collaboration to unfold, cultural and organisational elements are just as important as the contractual elements themselves. Using a collaborative procurement arrangement, such as partnering or alliancing, does not necessarily contribute to better project performance itself unless the parties manage to develop a real collaborative relationship (Suprapto et al., 2016).

## 6.3 The quality dimension of the puzzle

In the following sub-chapter, the findings related to the quality dimension of the three dimensional model will be discussed (see Figure 5-12 on page 222).

The positive relationship between collaboration and quality performance has, to some extent, been established by others before and most of the cited research in Table 6-2 suggests that there is a relationship between collaboration quality in a project and the quality of the deliverables.

***Table 6-2: Relationship between collaboration and project performance***

| Author | Performance dimension | | |
|---|---|---|---|
| | Cost | Schedule | Quality |
| This thesis (paper 2) | no | no | yes |
| (Eriksson and Westerberg, 2011) | yes | yes | yes |
| (Iyer and Jha, 2005) | yes | | |
| (Chan et al., 2003) | yes | yes | yes |
| (Silva and Harper, 2018) | yes | no | |
| (Ibrahim et al., 2018) | yes | yes | yes |
| (Franz et al., 2017) | yes | yes | yes |
| (Suprapto et al., 2016) | yes | yes | yes |
| (Dietrich et al., 2010) | yes | yes | yes |
| (Cho and Ballard, 2011) | yes | yes | |
| (Asmar et al., 2013) | no | yes | yes |
| (Hanna, 2016) | no | yes | no |
| (Bond-Barnard et al., 2018) | yes | yes | yes |
| | | | |
| Yes: author(s) found a relationship with collaboration | | | |
| No: author(s) did not find a relationship with collaboration | | | |
| Blank cell: author(s) did not study this dimension | | | |

Projects with a high level of collaboration are expected to experience fewer errors and deviations, more often meet requirements and more often have satisfied clients than projects with poor collaboration. The research in this thesis shows similar results with a clear correlation between collaboration quality in projects and how well these projects deliver in terms of quality of the deliverables.

Consequently, findings in this thesis contribute to further validation of existing research, as they provide more empirical support in a field where several authors have highlighted the need for more empirical studies (Bond-Barnard et al., 2018; Silva and Harper, 2018; Meng and Gallagher, 2012). The findings are similar to those of Eriksson and Westerberg (2011) and Bond-Barnard et al. (2018), who found a correlation between collaboration and quality performance.

The positive relationship between collaboration and quality performance, identified by other researchers as well as in this thesis, is not surprising. For example, participants in construction projects where there is a high level of trust are more likely to actively search for improvements and innovative solutions than in projects with less trust (Kadefors, 2004). Similarly, good communication and teamwork is important to ensure that all parties understand the goals for the projects and avoid misunderstandings (Li et al., 2015). If specifications and expectations are not clearly communicated, an opportunistic contractor may choose to reduce quality to increase profit or recoup costs for under-pricing (Liu et al., 2016). Trust, communication, teamwork and coordination are all important elements for collaboration (Dietrich et al., 2010).

For example, Josephson and Saukkoriipi (2005) published a report of waste in Swedish construction projects and found that 10% of the total construction cost for projects at the time was related to control and repair of poor quality. Hwang et al. (2009) claimed that direct costs related to rework are on average 5% of the construction cost. It is claimed by Barbosa et al. (2017) and Fulford and Standing (2014) that large benefits can be achieved if the quality of the project deliverables is improved through collaboration, something that is supported by the findings from this thesis.

In this thesis, an indicator has been established to measure collaboration quality in a project. Project managers can use this indicator to measure the collaboration quality in their project. Due to the strong correlation between collaboration and the quality of the project deliverables, project managers can use this collaboration quality indicator as an early warning sign for the level of quality of the project deliverables from their project. If projects score low on the collaboration quality indicator in an early phase of the project, this may be a warning sign that the project may be heading in a direction where the deliverables may not be in accordance with specifications and client expectations. Hence, the project manager can take necessary actions at this stage to ensure that the desired quality level is achieved upon delivery of the project.

**Collaboration and the (lack of) correlation with cost and schedule performance**

The findings in this thesis also raise a question related to the relationship between client-contractor collaboration and project performance in terms of the remaining two sides of the iron triangle, i.e. the lack of correlation with cost and schedule performance. With the exception of Silva and Harper (2018), Asmar et al. (2016) and Asmar et al. (2013), all the literature in Table 6-1 suggests that projects with good collaboration in general also perform better in terms of both cost and schedule.

However, research paper 2 in this thesis revealed only weak correlations between collaboration and project performance in terms of cost and schedule. None of these were statistically significant. This does not mean that collaboration is bad for cost and schedule performance but shows that for the projects investigated in this study no clear correlations were found either way.

There may be several reasons for this that are worth discussing. The first obvious reason that needs to be discussed is the quality of the quantitative data itself. The distribution in Figure 4-5 (page 170) shows how many of the projects reported a cost or schedule performance within +-5% of the planned value. These were therefore excluded from the dataset to explore how this affected the correlations. However, after these were removed there was still no significant correlation with cost growth or schedule growth.

Another possible reason for the lack of correlation found in this thesis between client-contractor collaboration and performance in terms of cost and schedule is that there may be several independent factors that affect cost and schedule performance that do not necessarily correlate with collaboration. There are many different factors affecting project success (Fortune and White, 2006). One example of a factor that may affect project cost and time performance is how well the scope of work was defined (Iyer and Jha, 2005). Projects may experience a growth in scope as a result of new requirements from the client. This will lead to cost growth and schedule growth as the project will cost more and take longer to complete. However, the quality of the deliverables will not suffer if the scope of work increases and the duration and budget are increased to accommodate the increased work scope. It is also worth mentioning that although this thesis focusses on performance within the iron triangle there are other aspects that determine if a project is a success or not. A project may still be considered as a success as long as the stakeholders are satisfied, and the user gets the desired effect from the project even though the project performance isolated to the iron triangle may have been poor (Samset, 2014).

# 7 Conclusions

This chapter contains the concluding remarks of the thesis. First, answers to the thesis research questions are provided, followed by a description of how this thesis contributes to theory and practice. Furthermore, the main limitations of the thesis are summarised and avenues for future research are proposed.

## 7.1 Answer to thesis research questions

The objective for this thesis was to investigate project transaction costs and the potential to optimise these and achieve better performance in projects through better collaboration. By combining the research stream of project transaction costs with the research stream of client-contractor collaboration this thesis investigated three research questions.

### Answer to research question I

**RQ I:** What is the magnitude of transaction costs in construction projects?

**Answer**: On average, project transaction cost is found to be at least 18% of the total cost in a project. Here the transaction costs are measured as the cost associated with managing the project in the client's and contractor's organisation, as shown in Figure 7-1. If other elements of transaction costs are added, this number will increase further. This value varies between projects with different characteristics such as size, duration, complexity and burn rate. The correlation between transaction costs and the different characteristics is complex and not two-dimensional. That is, to see correlations between transaction costs and different characteristics, one must look at a combination of several dimensions at the same time. The size of the project value chain also influences the transaction costs in a project. If significant work is carried out on a low level in a supply chain with many tiers, higher transaction costs are expected as more resources are spent on managing the work conducted by the tier below. As the size of the supply chain grows and becomes fragmented, transaction costs are expected to increase further.

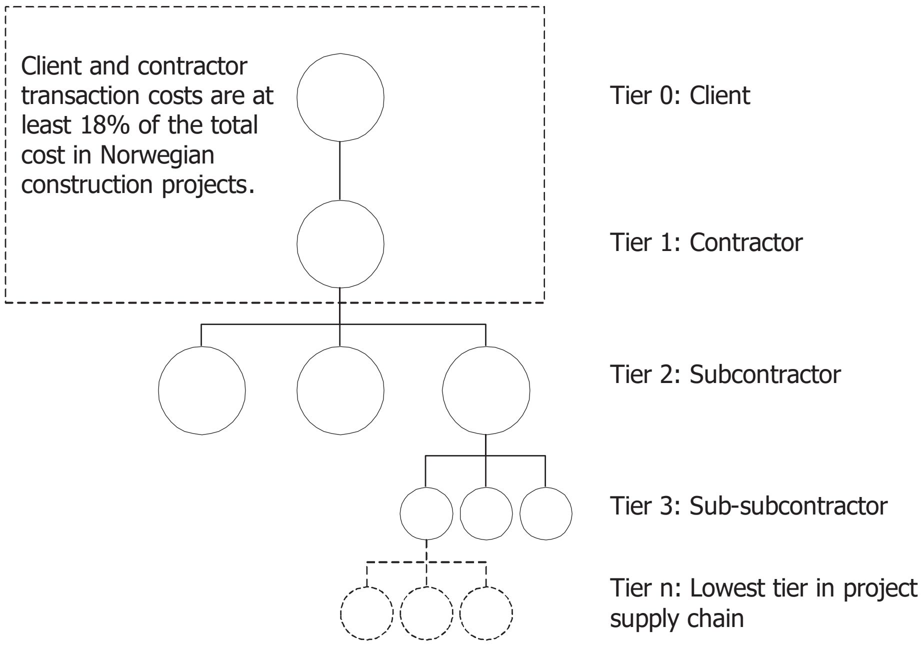



*Figure 7-1: Answering RQ I – Client and contractor transaction costs found from study of 134 Norwegian construction projects*

### Answer to research question II

**RQ II**: What is the relationship between transaction costs and client-contractor collaboration in projects?

**Answer**: Projects with good collaboration in the relationship between client and contractors outperform other projects in terms of the quality of their project deliverables. There are fewer errors and mistakes that have to be corrected. Good communication, few change orders, less uncertainty, and more trust are all factors that have a positive effect on project transaction costs. The relationship between a project's transaction costs and the level of collaboration between a client and its contractor is synthesised in Figure 7-2. Increased collaboration generates several positive effects such as better solutions, better communication, less uncertainty, fewer change orders, and more trust. Hence, the need for detailed specifications and extensive monitoring and control is reduced and the number of conflicts and disputes is reduced. At the same time, many mechanisms that are used to foster collaboration require some kind of investment in terms of time or money. A paradox may therefore occur if a project manager spends more money on mechanisms than the value of the benefits harvested. A theoretical sweet spot is found at the point where maximum benefits are achieved with a minimum of investments. To navigate towards this sweet spot, this thesis provides project managers with a *Collaboration Compass* that can be used to identify which collaboration mechanisms are most appropriate to invest in for projects with different characteristics.

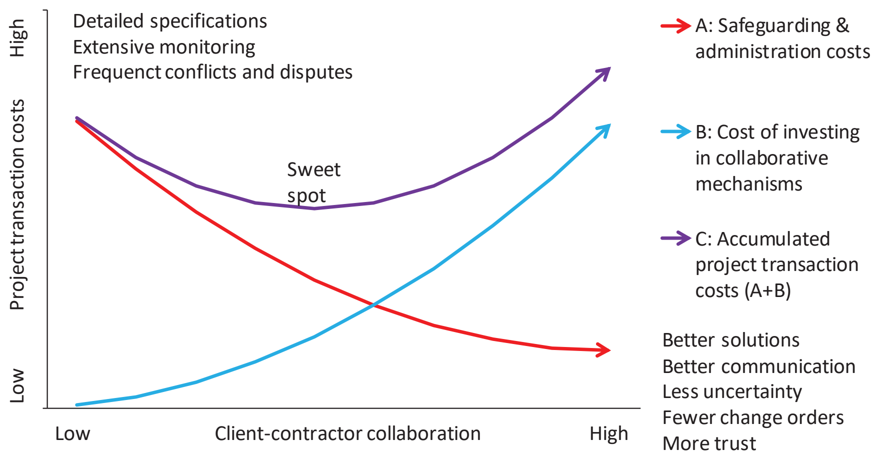



***Figure 7-2: Answering RQ II – Relationship between project transaction costs and client-contractor collaboration***

### Answer to research question III

**RQ III**: How can connecting the research field of project transaction costs with the research field of client contractor collaboration contribute to improved performance in future projects?

**Answer**: The aim is to minimise this total sum of a project's production costs and transaction costs. Poor quality of project deliverables affects both the project transaction costs and the project production costs. Doing things right the first time reduces repairs, rework, and costs associated with poor quality. Good quality can be achieved through applying a strict control regime with extensive monitoring and control, but this generates increased transaction costs. Alternatively, good quality can also be achieved in a collaborative environment with less need for control. Hence, the quality performance in a project is related to both the dimension of project transaction costs and the dimension of client-contractor collaboration.

A new holistic three-dimensional model has therefore been proposed to capture these three dimensions as shown in Figure 7-3. The model is called *The Puzzle of Project Transaction Costs* and it expresses the relationship between project transaction costs, client-contractor collaboration and quality of project deliverables, and how all these dimensions relate to each other. Changes made in one dimension also affect the two other dimensions. Hence, a holistic approach, considering all three dimensions, is required when trying to improve the performance in a project. If the focus is only on improving one of the dimensions, others may suffer.

For example, a client may want to cut the transaction costs in the project by reducing the project's travel budget. As a consequence, the travel costs in the project may be reduced. However, a reduced travel budget may result in fewer face-to-face meetings and work site inspections, leading to less collaboration and potentially increasing the risk of errors and mistakes.

The aim is to solve the puzzle and position the project in the optimal place in the model. At this ideal spot, the project transaction costs are low, client-contractor collaboration is high and the quality of the deliverables is good. Project managers can assess the status of their project and monitor the effect of initiatives taken to improve performance by measuring indicators in all three dimensions.

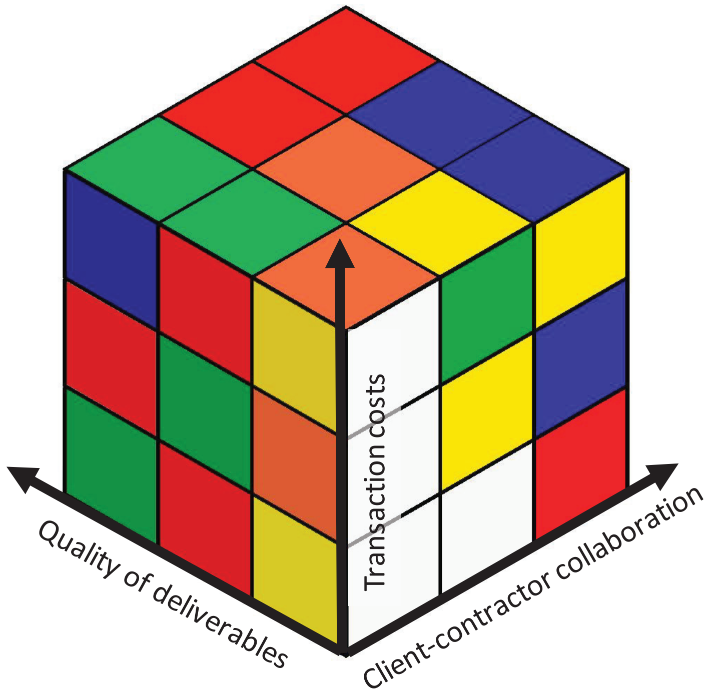



***Figure 7-3: Answering RQ III – The puzzle of Project Transaction Costs***

## 7.2 Thesis contributions

The main contributions of this thesis can be summarised as follows:

- Connecting the research stream of project transaction costs with the research stream of client-contractor collaboration
- Introducing the *Puzzle of Project Transaction Costs:* a three-dimensional performance model expressing the relationship between project transaction costs, quality of deliverables and client-contractor collaboration
- Providing increased understanding of the monetary size of transaction costs in construction projects
- Introducing the concept of the project *head-to-body* ratio to illustrate the size of a project's transaction costs compared to its production costs
- Introducing the *Collaboration Compass*, which can be used to identify which collaborative mechanisms are best suited for projects with different characteristics

### Exploring the relationship between collaboration and project transaction costs

This thesis makes a theoretical contribution by connecting the research field of collaboration with transaction cost economics within the context of project management. By connecting these research fields, this thesis identifies common factors affecting both collaboration and project transaction costs and it shows how transaction costs can be optimised in a project by balancing costs and benefits offered by different mechanisms that foster collaboration.

### Introducing a holistic three-dimensional model towards better performance

This thesis introduces a three-dimensional holistic model that connects project transaction costs, client-contractor collaboration and quality of project deliverables. This thesis has shown why it is important to take a holistic approach and not only focus on improvements in one of the dimensions, as changes in one dimension affect the two other dimensions.

In terms of practical implications, three separate indicators have been proposed that project managers can apply to measure the project performance along each of the three axes of the model. This thesis shows how such metrics can be applied and plotted into the model as a tool for project managers to monitor the position of their project in the model.

### Quantifying project transaction costs

Findings from this thesis have implications for both theory and practice when it comes to quantifying project transaction costs. The research presented in this thesis contributes to increasing knowledge about the size of project transaction costs. Currently, only a handful of empirical studies exist that attempt to quantify project transaction costs, and these are mainly limited to certain aspects. Existing studies are either limited to certain phases, such as pre-contract or post-contract, or to one perspective (either client or contractor). In that respect, this thesis claims to contribute with empirical data that cover both pre-contract and post-contract transaction costs experienced from both the client and the contractor perspective.

### Understanding the project anatomy by measuring the size of the project head

For practitioners, this thesis introduces the term *project head size* as a way to illustrate the relative size of a project's transaction costs (the head) compared to the size of the project body where production occurs. Furthermore, the thesis contains a set of data that project managers may find useful. Instead of simply scaling data from their previous projects, project managers can now look at the project head size from other projects with similar characteristics in terms of complexity, cost, duration and burn rate to refine and benchmark their own project estimates.

### Navigating with the collaboration compass

Another contribution that may be useful for both scholars and practitioners is the introduction of the collaboration compass that project managers can follow in their daily practice. This involves first using Shenhar and Dvir (2004) to map the main dimension (novelty, complexity, technology or pace) and then applying the compass to this map. Following the compass, project managers can prioritise which collaborative mechanisms are optimal to implement in their project. If the project is governed by two dimensions, the project manager can plot a course combining collaboration mechanisms from these two directions.

## 7.3 Limitations and opportunities for further research

In this section, the main limitations of the research are summarised and some opportunities for further research are proposed.

### Further investigation of project transaction costs

It would be of great value if more empirical studies that quantify transaction costs are conducted. Even though this thesis contributes with new empirical data, there is a general need for more empirical research to further generalise findings. The quantification of project transaction costs found in this thesis reflects only part of the total picture, as it only covers the top two tiers in the project value chain. The dataset does not cover transaction costs spent by subcontractors, advisors and architects further down in the value chain. Such transaction costs in the organisations lower down in the value chain will contribute to increasing the total project transaction costs. It would be very useful if future empirical studies of transaction cost included details about these lower tiers in the value chain to complete a larger part of the picture.

### Further investigation of other types of transaction costs

Project management is not the only transaction cost in a project. The figure for project management costs does include some indirect cost in addition to the salary paid to the project management team, but there are several other transaction costs that are not covered at all, or only partly covered, in the 18% that was found in this thesis. For example, some projects may purchase external services to cover for advisors and subject matter experts. Such costs may not be covered in the data analysed in this thesis unless these resources have been registered as part of the project management team. This may vary between the projects in the dataset. Some of the projects probably have a higher degree and width of in-house capabilities than others. In particular, projects with high complexity may use more external advisors and experts than less complex projects. Other examples are the transaction costs associated with conflict resolutions and rework (Love et al., 2019; Wang et al., 2019). In some cases, conflicts are taken to court with significant legal fees (Lu et al., 2015). Many such transaction costs are not covered in the dataset and the total level of transaction costs is therefore most likely higher than the 18% found in this thesis.

#### Expand the research outside the Norwegian context

The dataset in this thesis is based only on projects in Norway. One can argue that the findings can be generalised outside the Norwegian context, at least to a certain extent, as many of the respondents worked in international companies or global projects and most projects in the dataset are typical projects that are not unique to Norway. Some of the respondents had been working abroad and many of the projects included international partners. Still, the findings in this thesis must be seen within the Scandinavian project context and expanding the research from this thesis to other parts of the world would be useful. For example, all compasses need to be calibrated, and it would be particularly interesting to apply the collaboration compass in projects in different parts of the world to calibrate it for different contexts and cultures. Further calibration of the compass would make it more accurate for project managers to follow.

#### Apply the models from this thesis to projects that use collaborative project delivery methods

Another relevant aspect is related to project delivery methods. The majority of the projects studied in this thesis used traditional project delivery methods, with some exceptions, as a few projects used alliances or IPD. In general, it would therefore be particularly interesting if future studies included more projects that use high-order collaborative project delivery methods such as partnering, alliances or IPD. For example, it would be interesting if the three-dimensional model proposed in this thesis was applied to longitudinal case studies of projects that use IPD, partnering or alliances. Through such case studies, it would be possible to monitor the effect that collaborative mechanisms applied to the project have over time and see how this affects the project in the following three dimensions: quality of deliverables, client-contractor collaboration and project transaction costs.

## 7.4 Closing personal remarks – the power of collaboration

I was motivated to conduct this PhD research project by curiosity to learn how we can work better together and avoid spending time and money to fight conflicts and secure our interests against opportunism. Through this PhD project, I found that the key to understanding this was to combine two research domains: The domain of transaction cost theory to understand **why** this problem occurs and the domain of collaboration theory to understand **how** the problem can be solved. Working with this thesis has opened my eyes. Going back into the field as a practitioner, I now have a better understanding of how we can do better in our projects by collaborative working and harvesting benefits such as more trust and better quality.

The year of 2020 represents extraordinary times as the Covid-19 pandemic spread disease and misery to every corner of the world. However, it also has shown the ability that humans have to adjust to new situations and come together to find solutions. This may be the first time in history that the entire world has worked together on a project with a common goal: to fight the virus. Information and medical studies are shared between industry and researchers at an impressive rate across borders. This is really a reminder of how strong the power of collaboration can be. When we all collaborate towards the same goal instead of putting our own interests first, extraordinary achievements can be reached.

Here in Norway, the word *collaboration* is strongly associated with Nils Arne Eggen, a successful football coach that led his team, Rosenborg, to international success between 1988 and 2002. His philosophy was that every player should play in such a way that his teammates became better. Only then would the team succeed.

> *It is important to do your best when you enter the playing field. However, it is much more important that you act such that your teammates can do their best! (translated from Eggen, 1999, p. 226)*

# 8 References


Aarseth, W. 2014. *Project Management - a New Mindset for Success : Collaborative Business and Global Mindset,* Bergen, Norway, Fagbokforlaget.

Aarseth, W., Ahola, T., Aaltonen, K., Økland, A. & Andersen, B. 2017. Project sustainability strategies: A systematic literature review. *International Journal of Project Management,* Vol. 35(6)**,** pp**.** 1071-1083. https://doi.org/10.1016/j.ijproman.2016.11.006

Aarseth, W., Rolstadås, A. & Klev, R. 2016. *Project Leadership Challenges : Their Nature and How They are Managed,* Bergen, Fagbokforlaget.

Abdel-Wahab, M. & Vogl, B. 2011. Trends of productivity growth in the construction industry across Europe, US and Japan. *Construction Management and Economics,* Vol. 29(6)**,** pp**.** 635-644. 10.1080/01446193.2011.573568

Ackroyd, S. 2009. Research Design for Realist Research. *In:* BUCHANAN, D. & BRYMAN, A. (eds.) *The SAGE Handbook of Organizational Research Methods.* Thousand Oaks, California: SAGE Publications.

Adler, P. A. & Adler, P. 2001. The reulctant respondent. *In:* GUBRIUM, J. F. & HOLSTEIN, J. A. (eds.) *Handbook of Interview Research.* 1st ed. Thousand Oaks, California: SAGE Publications.

Ahmad, S. B. S., Mazhar, M. U., Bruland, A., Andersen, B. S., Langlo, J. A. & Torp, O. 2018. Labour productivity statistics: a reality check for the Norwegian construction industry. *International Journal of Construction Management,* Vol. 20(1)**,** pp**.** 39-52. 10.1080/15623599.2018.1462443

Ahola, T. 2009. *Efficiency in project networks: the role of inter-organizational relationships in project implementation.* Doctoral PhD Thesis, Helsinki Universtiy of Technology.

Ahola, T., Vuori, M. & Viitamo, E. 2017. Sharing the burden of integration: An activity-based view to integrated solutions provisioning. *International Journal of Project Management,* Vol. 35(6)**,** pp**.** 1006-1021. https://doi.org/10.1016/j.ijproman.2017.05.002

Akerlof, G. A. 1970. The market for "lemons": quality uncertainty and the market mechanism. *The Quarterly Journal of Economics,* Vol. 84(3)**,** pp**.** 488-500. 10.2307/1879431

Alchian, A. A. & Demsetz, H. 1972. production, information costs, and economic organization. *The American Economic Review,* Vol. 62(5)**,** pp**.** 777-795.

Alchian, A. A. & Woodward, S. 1988. The Firm Is Dead; Long Live The Firm a Review of Oliver E. Williamson's The Economic Institutions of Capitalism. *Journal of Economic Literature,* Vol. 26(1)**,** pp**.** 65-79.

Aliakbarlou, S., Wilkinson, S. & Costello, S. B. 2018. Rethinking client value within construction contracting services. *International Journal of Managing Projects in Business,* Vol. 11(4)**,** pp**.** 1007-1025. doi:10.1108/IJMPB-07-2017-0076

Aljuwaiber, A. 2019. Technology-based vs. face-to-face interaction for knowledge sharing in the project teams. *International Journal of Project Organisation and Management,* Vol. 11(3)**,** pp**.** 227-242.

Alvesson, M. & Sköldberg, K. 2009. *Reflexive Methodology : New Vistas for Qualitative Research,* London, SAGE Publications.

Andersen, B. & Langlo, J. Productivity and performance measurement in the construction sector. Proceedings of the CIB World Building Congress, 2016.

Andersen, B., Samset, K. & Welde, M. 2016. Low estimates–high stakes: underestimation of costs at the front-end of projects. *International Journal of Managing Projects in Business,* Vol. 9(1)**,** pp**.** 171-193.

Andersen, E. S. 2016. Do project managers have different perspectives on project management? *International Journal of Project Management,* Vol. 34(1)**,** pp**.** 58-65. https://doi.org/10.1016/j.ijproman.2015.09.007

Arditi, D. & Chotibhongs, R. 2009. Detection and prevention of unbalanced bids. *Construction Management and Economics,* Vol. 27(8)**,** pp**.** 721-732. 10.1080/01446190903117785

Arditi, D. & Gunaydin, H. M. 1997. Total quality management in the construction process. *International Journal of Project Management,* Vol. 15(4)**,** pp**.** 235-243.

Argyris, C. 1995. Action science and organizational learning. *Journal of managerial psychology,* Vol. 10(6)**,** pp**.** 20-26.

Arrow, K. J. 1963. Uncertainty and the Welfare Economics of Medical Care. *The American Economic Review,* Vol. 53(5)**,** pp**.** 941-973.

Arrow, K. J. 1969. The Organization of Economic Activity: Issues Pertinent to the Choice of Market Versus Nonmarket Allocation. *The Analysis and Evaluation of Public Expenditures: The PPB System. Joint Economic Committee, 91st Congress, 1st Session.* Washington DC: Government Prtinting Office.

Arrow, K. J. 1991. The Economics of Agency. *In:* PRATT, J. W. & ZECKHAUSER, R. (eds.) *Principals and Agents: The Structure of Business.* 2 ed. USA: Harvard Business School Press.

Asmar, M. E., Hanna, A. S. & Loh, W.-Y. 2013. Quantifying Performance for the Integrated Project Delivery System as Compared to Established Delivery Systems. *Journal of Construction Engineering and Management,* Vol. 139(11)**,** pp**.** 04013012. doi:10.1061/(ASCE)CO.1943-7862.0000744

Asmar, M. E., Hanna, A. S. & Loh, W.-Y. 2016. Evaluating Integrated Project Delivery Using the Project Quarterback Rating. *Journal of Construction Engineering and Management,* Vol. 142(1)**,** pp**.** 04015046. doi:10.1061/(ASCE)CO.1943-7862.0001015

Azanha, A., Argoud, A. R. T. T., Camargo Junior, J. B. D. & Antoniolli, P. D. 2017. Agile project management with Scrum: A case study of a Brazilian pharmaceutical company IT project. *International Journal of Managing Projects in Business,* Vol. 10(1)**,** pp**.** 121-142. doi:10.1108/IJMPB-06-2016-0054

Badi, S. M. & Pryke, S. D. 2015. Assessing the quality of collaboration towards the achievement of Sustainable Energy Innovation in PFI school projects. *International Journal of Managing Projects in Business,* Vol. 8(3)**,** pp**.** 408-440. doi:10.1108/IJMPB-09-2014-0060

Bagozzi, R. P. & Yi, Y. 1988. On the evaluation of structural equation models. *Journal of the academy of marketing science,* Vol. 16(1)**,** pp**.** 74-94.

Baiden, B. K., Agyekum, K. & Atuahene, B. T. 2018. Client-contractor relations on construction projects in Ghana. *International Journal of Project Organisation and Management,* Vol. 10(4)**,** pp**.** 333-351.

Ballard, G. & Howell, G. 2003. Lean project management. *Building Research & Information,* Vol. 31(2), pp. 119-133.

Ballard, H. G. 2000. *The last planner system of production control.* Doctoral PhD Thesis, University of Birmingham.

Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M., Bertram, N. & Brown, S. 2017. Reinventing construction through a productivity revolution. *McKinsey Global Institute.*

Bayliss, R., Cheung, S.-O., Suen, H. C. H. & Wong, S.-P. 2004. Effective partnering tools in construction: a case study on MTRC TKE contract 604 in Hong Kong. *International Journal of Project Management,* Vol. 22(3), pp. 253-263. https://doi.org/10.1016/S0263-7863(03)00069-3

Bhaskar, R. 1978. *A realist theory of science,* Sussex, John Spiers.

Biong, H., Nes, E. B. & Sande, J. B. 2016. *Markedsføring på Bedriftsmarkedet,* Oslo, Norway, Universitetsforlaget.

Bititci, U., Martinez, V., Albores, P. & Parung, J. 2004. Creating and managing value in collaborative networks. *International Journal of Physical Distribution & Logistics Management,* Vol. 34(3/4), pp. 251-268. doi:10.1108/09600030410533574

Bititci, U., Turner, T., Mackay, D., Kearney, D., Parung, J. & Walters, D. 2007. Managing synergy in collaborative enterprises. *Production Planning & Control,* Vol. 18(6), pp. 454-465. doi: 10.1080/09537280701494990

Blenke, L. R., Gosavi, A. & Daughton, W. 2017. Attitudes towards face-to-face meetings in virtual engineering teams: perceptions from a survey of defence projects. *International Journal of Project Organisation and Management,* Vol. 9(2), pp. 95-112.

Bond-Barnard, T. J., Fletcher, L. & Steyn, H. 2018. Linking trust and collaboration in project teams to project management success. *International Journal of Managing Projects in Business,* Vol. 11(2), pp. 432-457. 10.1108/IJMPB-06-2017-0068

Bond-Barnard, T. J., Steyn, H. & Fabris-Rotelli, I. 2013. The impact of a call centre on communication in a programme and its projects. *International Journal of Project Management,* Vol. 31(7), pp. 1006-1016. https://doi.org/10.1016/j.ijproman.2012.12.012

Bosch-Sijtsema, P. M. & Tjell, J. 2017. The concept of project space: Studying construction project teams from a spatial perspective. *International Journal of Project Management,* Vol. 35(7), pp. 1312-1321. https://doi.org/10.1016/j.ijproman.2017.05.009

Braun, T. & Sydow, J. 2019. Selecting Organizational Partners for Interorganizational Projects: The Dual but Limited Role of Digital Capabilities in the Construction Industry. *Project Management Journal,* Vol. 50(4), pp. 398-408. 10.1177/8756972819857477

Bresnen, M. & Marshall, N. 2000. Building partnerships: case studies of clientcontractor collaboration in the UK construction industry. *Construction Management and Economics,* Vol. 18(7), pp. 819-832. 10.1080/014461900433104

Bresnen, M. & Marshall, N. 2002. The engineering or evolution of co-operation? A tale of two partnering projects. *International Journal of Project Management,* Vol. 20(7), pp. 497-505. https://doi.org/10.1016/S0263-7863(01)00043-6

Bryman, A. 2016. *Social Research Methods,* Oxford, Oxford University Press.

Buchanan, D. A. & Bryman, A. 2009. The organizational research context: properties and implications. *In:* BUCHANAN, D. A. & BRYMAN, A. (eds.) *The SAGE Handbook of Organizational Research Methods.* 1st ed. London: SAGE Publications.

Buvik, M. P. & Rolfsen, M. 2015. Prior ties and trust development in project teams – A case study from the construction industry. *International Journal of Project Management,* Vol. 33(7), pp. 1484-1494. https://doi.org/10.1016/j.ijproman.2015.06.002

Bygballe, L. E., Jahre, M. & Swärd, A. 2010. Partnering relationships in construction: A literature review. *Journal of Purchasing and Supply Management,* Vol. 16(4), pp. 239-253. https://doi.org/10.1016/j.pursup.2010.08.002

Bygballe, L. E. & Swärd, A. 2019. Collaborative Project Delivery Models and the Role of Routines in Institutionalizing Partnering. *Project Management Journal,* Vol. 50(2), pp. 161-176. 10.1177/8756972818820213

Børve, S. 2019. *Project partnering defined and implications thereof.* 2019:308, Norwegian University of Science and Technology, Faculty of Engineering, Department of Mechanical and Industrial Engineering, Trondheim, 2019.

Caniëls, M. C. J., Chiocchio, F. & Van Loon, N. P. a. A. 2019. Collaboration in project teams: The role of mastery and performance climates. *International Journal of Project Management,* Vol. 37(1), pp. 1-13. https://doi.org/10.1016/j.ijproman.2018.09.006

Cassell, C. 2009. Interviews in organizational research. *In:* BUCHANAN, D. A. & BRYMAN, A. (eds.) *The SAGE Handbook of Organizational Research Methods.* 1st ed. London: SAGE Publications.

Chachere, J., Kunz, J. & Levitt, R. 2004. Observation, theory, and simulation of integrated concurrent engineering: Grounded theoretical factors that enable radical project acceleration - CIFE Working paper 87. Stanford University.

Chakkol, M., Selviaridis, K. & Finne, M. 2018. The governance of collaboration in complex projects. *International journal of operations & production management,* Vol. 38(4), pp. 997-1019.

Chan, A. P. C., Chan, D. W. M., Chiang, Y. H., Tang, B. S., Chan, E. H. W. & Ho, K. S. K. 2004. Exploring Critical Success Factors for Partnering in Construction Projects. *Journal of Construction Engineering and Management,* Vol. 130(2), pp. 188-198. doi:10.1061/(ASCE)0733-9364(2004)130:2(188)

Chan, A. P. C., Chan, D. W. M. & Ho, K. S. K. 2003. An empirical study of the benefits of construction partnering in Hong Kong. *Construction Management and Economics,* Vol. 21(5), pp. 523-533. 10.1080/0144619032000056162

Che Ibrahim, C. K. I., Costello, S. B., Wilkinson, S. & Walker, D. 2017. Innovation in alliancing for improved delivery of road infrastructure projects. *International Journal of Managing Projects in Business,* Vol. 10(4), pp. 700-720. doi:10.1108/IJMPB-11-2016-0088

Chen, Q., Jin, Z., Xia, B., Wu, P. & Skitmore, M. 2016. Time and Cost Performance of DesignBuild Projects. *Journal of Construction Engineering and Management,* Vol. 142(2), pp. 04015074. doi:10.1061/(ASCE)CO.1943-7862.0001056

Cheung, S. N. S. 1983. The Contractual Nature of the Firm. *The Journal of Law & Economics,* Vol. 26(1), pp. 1-21.

Chiu, J., Chung, H. & Yang, Y.-N. 2016. The impact of a conglomerate merger on its vendors and rivals – a case study of Google's acquisition of Motorola. *Technology Analysis & Strategic Management,* Vol. 28(2), pp. 176-189. 10.1080/09537325.2015.1093105

Cho, S. & Ballard, G. 2011. Last planner and integrated project delivery. *Lean Construction Journal,* Vol. 7(1), pp. 67-78.

Choong, K. K. 2014. Has this large number of performance measurement publications contributed to its better understanding? A systematic review for research and applications. *International Journal of Production Research,* Vol. 52(14), pp. 4174-4197. 10.1080/00207543.2013.866285

Christensen, R. M. 2008. *Development Practically Speaking, Learning processes in the Danish Construction Industry.* PhD thesis, Aalborg University.

Cicmil, S. & Marshall, D. 2005. Insights into collaboration at the project level: complexity, social interaction and procurement mechanisms. *Building Research & Information,* Vol. 33(6), pp. 523-535. 10.1080/09613210500288886

Coase, R. H. 1937. The nature of the firm. *Economica,* Vol. 4(16), pp. 386-405. 10.1111/j.1468-0335.1937.tb00002.x

Coase, R. H. 1988. The nature of the firm: Meaning. *Journal of Law, Economics, and Organization,* Vol. 4(1), pp. 19-32. 10.1093/oxfordjournals.jleo.a036944

Cook, D. J., Mulrow, C. D. & Haynes, R. B. 1997. Systematic reviews: synthesis of best evidence for clinical decisions. *Annals of Internal Medicine,* Vol. 126(5), pp. 376-380.

Cooper, D. R. & Schindler, P. S. 2008. *Business Research Methods,* New York, McGraw-Hill.

Costa E Silva, S., Bradley, F. & Sousa, C. M. P. 2012. Empirical test of the trust–performance link in an international alliances context. *International Business Review,* Vol. 21(2), pp. 293-306. https://doi.org/10.1016/j.ibusrev.2011.03.006

Cronbach, L. J. 1951. Coefficient alpha and the internal structure of tests. *psychometrika,* Vol. 16(3), pp. 297-334.

Crouch, M. & Mckenzie, H. 2006. The logic of small samples in interview-based qualitative research. *Social science information,* Vol. 45(4), pp. 483-499.

Crowley, L. G. & Hancher, D. E. 1995. Risk assessment of competitive procurement. *Journal of Construction Engineering and Management,* Vol. 121(2), pp. 230-237. doi:10.1061/(ASCE)0733-9364(1995)121:2(230)

D'alpaos, C., Moretto, M., Valbonesi, P. & Vergalli, S. 2013. Time overruns as opportunistic behavior in public procurement. *Journal of Economics,* Vol. 110(1), pp. 25-43. 10.1007/s00712-013-0352-6

Da Fonseca, F. B., Vanalle, R. M. & Camarotto, J. A. 2018. Identification of ex-ante and ex-post transaction costs in industrial construction engineering projects. *Journal of Civil Engineering and Management,* Vol. 24(5), pp. 424-436.

David, R. J. & Han, S.-K. 2004. A Systematic assessment of the empirical support for transaction cost economics. *Strategic Management Journal,* Vol. 25(1), pp. 39-58.

Davies, A., Gann, D. & Douglas, T. 2009. Innovation in megaprojects: systems integration at London Heathrow Terminal 5. *California Management Review,* Vol. 51(2), pp. 101-125.

De Rezende, L. B., Blackwell, P. & Pessanha Goncalves, M. D. 2018. Research focuses, trends, and major findings on Project Complexity: a bibliometric network analysis of 50 years of project complexity research. *Project management journal,* Vol. 49(1)**,** pp**.** 42-56.

De Schepper, S., Haezendonck, E. & Dooms, M. 2015. Transaction cost analysis of public infrastructure delivery. *International Journal of Managing Projects in Business,* Vol. 8(3)**,** pp**.** 441-456. doi:10.1108/IJMPB-10-2014-0075

De Wit, A. 1988. Measurement of project success. *International journal of project management,* Vol. 6(3)**,** pp**.** 164-170.

Dietrich, P., Eskerod, P., Dalcher, D. & Sandhawalia, B. 2010. The dynamics of collaboration in multipartner projects. *Project Management Journal,* Vol. 41(4)**,** pp**.** 59-78. 10.1002/pmj.20194

Dozzi, S. P. & Abourizk, S. M. 1993. *Productivity in construction*, Institute for Research in Construction, National Research Council Ottawa.

Dudkin, G. & Välilä, T. 2006. Transaction costs in public-private partnerships: A first look at the evidence. *Competition and Regulation in Network Industries,* Vol. 1(2)**,** pp**.** 307-330. doi:10.1177/178359170600100209

Eggen, N. A. 1999. *Godfoten - Samhandling, veien til sucess,* Oslo, H. Aschehoug & Co.

Eisenhardt, K. M. 1985. Control: Organizational and economic approaches. *Management Science,* Vol. 31(2)**,** pp**.** 134-149. 10.1287/mnsc.31.2.134

Eliasson, J. & Fosgerau, M. 2013. Cost overruns and demand shortfalls – Deception or selection? *Transportation Research Part B: Methodological,* Vol. 57(pp**.** 105-113. http://dx.doi.org/10.1016/j.trb.2013.09.005

Ely, M., Vinz, R., Downing, M. & Anzul, M. 1997. *On writing Qualitative Reseearch - Living by Words,* London, The Falmer Press.

Engebø, A., Klakegg, O. J., Lohne, J. & Lædre, O. 2020a. A collaborative project delivery method for design of a high-performance building. *International Journal of Managing Projects in Business,* Vol. 13(6)**,** pp**.** 1141-1165.

Engebø, A., Lædre, O., Young, B., Larssen, P. F., Lohne, J. & Klakegg, O. J. 2020b. Collaborative project delivery methods: a scoping review. *Journal of Civil Engineering and Management,* Vol. 26(3)**,** pp**.** 278-303.

Engström, S. & Stehn, L. 2016. Barriers to client-contractor communication: implementing process innovation in a building project in Sweden. *International journal of project organisation and management,* Vol. 8(2)**,** pp**.** 151-171.

Erdogan, B., Anumba, C. J., Bouchlaghem, D. & Nielsen, Y. 2008. Collaboration environments for construction: Implementation case studies. *Journal of Management in Engineering,* Vol. 24(4)**,** pp**.** 234-244.

Eriksson, E., Brian, A. & Torbjörn, N. 2009. Overcoming barriers to partnering through cooperative procurement procedures. *Engineering, Construction and Architectural Management,* Vol. 16(6)**,** pp**.** 598-611. doi:10.1108/09699980911002593

Eriksson, P. E. 2010. Partnering: what is it, when should it be used, and how should it be implemented? *Construction Management and Economics,* Vol. 28(9)**,** pp**.** 905-917. 10.1080/01446190903536422

Eriksson, P. E. & Westerberg, M. 2011. Effects of cooperative procurement procedures on construction project performance: A conceptual framework. *International*

*Journal of Project Management,* Vol. 29(2), pp. 197-208. https://doi.org/10.1016/j.ijproman.2010.01.003

Farajian, M. 2010. *Transaction Cost Estimation Model for US Infrastructure Public Private Partnerships.* MSc. thesis, University of Maryland.

Fleetwood, S. 2005. Ontology in organization and management studies: A critical realist perspective. *Organization,* Vol. 12(2), pp. 197-222.

Flyvbjerg, B. 2005. Design by deception: The politics of megaproject approval. *Harvard Design Magazine.* Harvard University Graduate School of Design.

Flyvbjerg, B. 2009. Survival of the unfittest: Why the worst infrastructure gets built—and what we can do about it. *Oxford Review of Economic Policy,* Vol. 25(3), pp. 344-367. 10.1093/oxrep/grp024

Flyvbjerg, B. & Budzier, A. 2011. Why your IT project may be riskier than you think. *Harvard Business Review,* Vol. 2011(September), pp. 1-4.

Flyvbjerg, B., Garbuio, M. & Lovallo, D. 2009. Delusion and deception in large infrastructure projects: two models for explaining and preventing executive disaster. *California management review,* Vol. 51(2), pp. 170-194.

Flyvbjerg, B., Holm, M. S. & Buhl, S. 2002. Underestimating costs in public works projects: Error or lie? *Journal of the American Planning Association,* Vol. 68(3), pp. 279-295. 10.1080/01944360208976273

Flyvbjerg, B. & Stewart, A. 2012. Olympic proportions: Cost and cost overrun at the Olympics 1960-2012. *In:* SCHOOL, S. B. (ed.). Oxford.

Fornell, C. & Larcker, D. F. 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research,* Vol. 18(1), pp. 39-50.

Forsythe, P., Sankaran, S. & Biesenthal, C. 2015. How far can BIM reduce information asymmetry in the Australian construction context? *Project Management Journal,* Vol. 46(3), pp. 75-87. 10.1002/pmj.21504

Fortune, J. & White, D. 2006. Framing of project critical success factors by a systems model. *International Journal of Project Management,* Vol. 24(1), pp. 53-65. https://doi.org/10.1016/j.ijproman.2005.07.004

Franz, B., Leicht, R., Molenaar, K. & Messner, J. 2017. Impact of Team Integration and Group Cohesion on Project Delivery Performance. *Journal of Construction Engineering and Management,* Vol. 143(1), pp. 04016088. doi:10.1061/(ASCE)CO.1943-7862.0001219

Fulford, R. & Standing, C. 2014. Construction industry productivity and the potential for collaborative practice. *International Journal of Project Management,* Vol. 32(2), pp. 315-326. https://doi.org/10.1016/j.ijproman.2013.05.007

Fuller, R. B. 1963. *Ideas and integritie: a spontaneous autobiographical disclosure,* Englewood Cliffs, New Jersey, Prentice-Hall.

Geyskens, I., Steenkamp, J.-B. E. M. & Kumar, N. 2006. Make, buy, or ally: A transaction cost theory meta-analysis. *The Academy of Management Journal,* Vol. 49(3), pp. 519-543. 10.2307/20159779

Ghoshal, S. & Moran, P. 1996. Bad for Practice: A Critique of the Transaction Cost Theory. *The Academy of Management Review,* Vol. 21(1), pp. 13-47. 10.2307/258627

Glaser, B. G. & Strauss, A. L. 1967. *The Discovery of Grounded Theory,* London, Weidenfield and Nicolson.

Goldberg, V. P. 1976. Regulation and administered contracts. *The Bell Journal of Economics,* Vol. 7(2), pp. 426-448. 10.2307/3003265

Granovetter, M. 1985. Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology,* Vol. 91(3), pp. 481-510. 10.1086/228311

Guest, G., Bunce, A. & Johnson, L. 2006. How many interviews are enough? An experiment with data saturation and variability. *Field methods,* Vol. 18(1), pp. 59-82.

Guo, L., Li, H., Li, P. & Zhang, C. 2016. Transaction costs in construction projects under uncertainty. *Kybernetes,* Vol. 45(6), pp. 866-883. 10.1108/K-10-2014-0206

Haaskjold, H., Andersen, B., Langlo, J. & Aarseth, W. 2020a. Follow the Collaboration Compass. *International Journal of Project Organisation and Management,* Vol. (forthcoming)(pp.

Haaskjold, H., Andersen, B. & Langlo, J. A. 2020b. In search of Empirical Evidence for the Relationship Between Collaboration and Project Performance. *The Journal of Modern Project Management,* Vol. 7(4), pp. 120-152.

Haaskjold, H., Andersen, B., Lædre, O. & Aarseth, W. 2019. Factors affecting transaction costs and collaboration in projects. *International Journal of Managing Projects in Business,* Vol. 13(1), pp. 197-230.

Haddadi, A. & Johansen, A. 2019. Value Proposition in Different Types of Buildings-Characteristics and Means. *The Journal of Modern Project Management,* Vol. 6(3), pp. 73-86.

Hair, J., Black, W., Babin, B. & Anderson, R. 2014. *Multivariate Data Analysis (new int. ed.),* Essex, Harlow: Pearson Education.

Hanna, A. S. 2016. Benchmark performance metrics for integrated project delivery. *Journal of Construction Engineering and Management,* Vol. 142(9), pp. 04016040-1-9. doi:10.1061/(ASCE)CO.1943-7862.0001151

Hans, R. T. & Mnkandla, E. 2019. A framework for improving the recognition of project teams as key stakeholders in information and communication technology projects. *International Journal of Project Organisation and Management,* Vol. 11(3), pp. 199-226.

Haq, S. U., Liang, C., Gu, D., Du, J. T. & Zhao, S. 2018. Project governance, project performance, and the mediating role of project quality and Project Management risk: an agency theory perspective. *Engineering Management Journal,* Vol. 30(4), pp. 274-292.

Harley, J. 2011. Collaboration and the use of online collaborative toolsets in the project management environment. *International Journal of Managing Projects in Business,* Vol. 4(2), pp. 345-354. doi:10.1108/17538371111120289

Hauck, A. J., Walker, D. H. T., Hampson, K. D. & Peters, R. J. 2004. Project alliancing at national museum of australia - collaborative Process. *Journal of Construction Engineering and Management,* Vol. 130(1), pp. 143-152. doi:10.1061/(ASCE)0733-9364(2004)130:1(143)

Henderson, L. S., Stackman, R. W. & Lindekilde, R. 2016. The centrality of communication norm alignment, role clarity, and trust in global project teams. *International Journal of Project Management,* Vol. 34(8), pp. 1717-1730. https://doi.org/10.1016/j.ijproman.2016.09.012

Herzog, H. 2005. On home turf: Interview location and its social meaning. *Qualitative Sociology,* Vol. 28(1)**,** pp**.** 25-47. 10.1007/s11133-005-2629-8

Hietajärvi, A.-M. & Aaltonen, K. 2018. The formation of a collaborative project identity in an infrastructure alliance project. *Construction Management and Economics,* Vol. 36(1)**,** pp**.** 1-21. 10.1080/01446193.2017.1315149

Hietajärvi, A.-M., Aaltonen, K. & Haapasalo, H. 2017. What is project alliance capability? *International Journal of Managing Projects in Business,* Vol. 10(2)**,** pp**.** 404-422. doi:10.1108/IJMPB-07-2016-0056

Ho, S. P., Levitt, R., Tsui, C.-W. & Hsu, Y. 2015. Opportunism-focused transaction cost analysis of public-private partnerships. *Journal of Management in Engineering,* Vol. 31(6)**,** pp**.** 04015007-1-10. doi:10.1061/(ASCE)ME.1943-5479.0000361

Ho, S. P. & Liu, L. Y. 2004. Analytical model for analyzing construction claims and opportunistic bidding. *Journal of Construction Engineering and Management,* Vol. 130(1)**,** pp**.** 94-104. 10.1061/(ASCE)0733-9364(2004)130:1(94)

Hoegl, M. & Gemuenden, H. G. 2001. Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence. *Organization Science,* Vol. 12(4)**,** pp**.** 435-449. 10.1287/orsc.12.4.435.10635

Hosseini, A., Wondimu, P. A., Bellini, A., Henriktune, Haugseth, N., Andersen, B. & Lædre, O. Project Partnering in Norwegian Construction Industry. Sustainable Built Environment, SBE16, 5th - 7th October 2016 2016 Tallin and Helsinki. Energy Procedia, 241-252.

Hosseini, M. R., Chileshe, N., Baroudi, B., Izadpanahi, P. & Zuo, J. 2017. Virtuality of hybrid design teams within the construction context: a conceptual model. *International Journal of Project Organisation and Management,* Vol. 9(1)**,** pp**.** 1-17.

Hwang, B.-G., Thomas, S. R., Haas, C. T. & Caldas, C. H. 2009. Measuring the Impact of Rework on Construction Cost Performance. *Journal of Construction Engineering and Management,* Vol. 135(3)**,** pp**.** 187-198. doi:10.1061/(ASCE)0733-9364(2009)135:3(187)

Hyari, K. H. 2016. Handling Unbalanced Bidding in Construction Projects: Prevention Rather Than Detection. *Journal of Construction Engineering and Management,* Vol. 142(2)**,** pp**.** 04015060. doi:10.1061/(ASCE)CO.1943-7862.0001045

Ibrahim, M., Hanna, A. & Kievet, D. 2018. Comparative Analysis between Project Delivery Systems through Quantitative Assessment of Project Performance. *Construction Research Congress 2018.*

Icw 2017. Insight into ISO 44001. London: Institute for Collaborative Working.

Ikuabe, M., Oke, A. E. & Aigbavboa, C. 2020. Impact of contractors' opportunism on construction project transaction costs. *Journal of Financial Management of Property and Construction,* Vol. 25(1)**,** pp**.** 125-141.

Iso 2012. ISO 21500 - Guidance on Project Management. Geneva, Switzerland: ISO - the International Organization for Standardization.

Iyer, K. C. & Jha, K. N. 2005. Factors affecting cost performance: evidence from Indian construction projects. *International Journal of Project Management,* Vol. 23(4)**,** pp**.** 283-295. https://doi.org/10.1016/j.ijproman.2004.10.003

Izam, C. I. C. K., B., C. S. & Suzanne, W. 2015. Key indicators influencing the management of team integration in construction projects. *International Journal of*

*Managing Projects in Business,* Vol. 8(2), pp. 300-323. doi:10.1108/IJMPB-04-2014-0028

Jackson, J. 2008. Approved Judgement - Multiplex vs Cleveland Bridge. London: Royal Court of Justice.

Jensen, M. C. 1983. Organization Theory and Methodology. *The Accounting Review,* Vol. 58(2), pp. 319-339.

Jensen, M. C. & Meckling, W. H. 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics,* Vol. 3(4), pp. 305-360. http://dx.doi.org/10.1016/0304-405X(76)90026-X

Jonasson, H. I. & Ingason, H. T. 2015. Ethical considerations in project management research. *In:* PASIAN, B. (ed.) *Designs, Methods and Practices for Research of Project Management*

Surrey: Gower Publishing Ltd.

Josephson, P.-E. & Saukkoriipi, L. 2005. Slöseri i byggprojekt: behov av förändrat synsätt. External organization.

Juran, J. & Godfrey, A. B. 1999. *Quality handbook,* New York, McGraw-Hill.

Kadefors, A. 2004. Trust in project relationships-inside the black box. *International Journal of Project Management,* Vol. 22(3), pp. 175-182. 10.1016/S0263-7863(03)00031-0

Kadefors, A., Björlingson, E. & Karlsson, A. 2007. Procuring service innovations: Contractor selection for partnering projects. *International Journal of Project Management,* Vol. 25(4), pp. 375-385. 10.1016/j.ijproman.2007.01.003

Kaplan, R. M. & Saccuzzo, D. P. 2009. *Psychological testing: Principles, applications, and issues,* Belmont, CA, Wadsworth, Cengage Learning.

Karis, D., Wildman, D. & Mané, A. 2016. Improving Remote Collaboration With Video Conferencing and Video Portals. *Human–Computer Interaction,* Vol. 31(1), pp. 1-58. 10.1080/07370024.2014.921506

Kitchenham, B. 2004. Procedures for performing systematic reviews. Eversleigh, Australia: Keel Universtity.

Klakegg, O. J. 2016. Ontology and Epistemology. *In:* PASIAN, B. (ed.) *Designs, Methods and Practices fro Research on Project Management.* New York: Routledge.

Klein, B. 1988. Vertical Integration as Organizational Ownership: The Fisher Body-General Motors Relationship Revisited. *Journal of Law, Economics, & Organization,* Vol. 4(1), pp. 199-213.

Klein, B., Crawford, R. G. & Alchian, A. A. 1978. Vertical integration, appropriable rents, and the competitive contracting process. *The Journal of Law and Economics,* Vol. 21(2), pp. 297-326. 10.1086/466922

Klein, G. & Müller, R. 2020. Literature Review Expectations of Project Management Journal®. *Project Management Journal,* Vol. 51(3), pp. 239-241. 10.1177/8756972820916340

Kokkonen, A. & Vaagaasar, A. L. 2018. Managing collaborative space in multi-partner projects. *Construction Management and Economics,* Vol. 36(2), pp. 83-95. 10.1080/01446193.2017.1347268

Kreiner, K. 2020. Conflicting Notions of a Project: The Battle Between Albert O. Hirschman and Bent Flyvbjerg. *Project Management Journal,* Vol. 51(4), pp. 400-410.

Kunglege-Vetenskaps-Akademien 2009. Scientific Bacground on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2009.

Kvålshaugen, R. & Sward, A. R. 2018. Sluttrapport "Samhandling og prosessledelse". Oslo: Handelshøyskolen BI.

Kwofie, T. E., Aigbavboa, C. O. & Matsane, Z. S.-S. 2018. Dimensions of social barriers to effective collaborative working in construction supply chain. *International Journal of Project Organisation and Management,* Vol. 10(1)**,** pp**.** 37-53.

Lafontaine, F. & Slade, M. 2007. Vertical integration and firm boundaries: The evidence. *Journal of Economic Literature,* Vol. 45(3)**,** pp**.** 629-685.

Lahdenperä, P. 2012. Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery. *Construction Management and Economics,* Vol. 30(1)**,** pp**.** 57-79. 10.1080/01446193.2011.648947

Langlo, J. A., Bakken, S., Karud, O. J., Landet, R., Smidt Olsen, A., Andersen, B. & Hajikazemi, S. 2017. Sluttrapport - Prestasjonsmåling i norsk BAE-næring.

Lappi, T. & Aaltonen, K. 2017. Project governance in public sector agile software projects. *International Journal of Managing Projects in Business,* Vol. 10(2)**,** pp**.** 263-294. doi:10.1108/IJMPB-04-2016-0031

Lee, H.-S., Seo, J.-O., Park, M., Ryu, H.-G. & Kwon, S.-S. 2009. Transaction-cost-based selection of appropriate general contractor-subcontractor relationship type. *Journal of Construction Engineering and Management,* Vol. 135(11)**,** pp**.** 1232-1240.

Levy, D. T. 1985. The Transactions cost approach to vertical integration: An empirical examination. *The Review of Economics and Statistics,* Vol. 67(3)**,** pp**.** 438-445. 10.2307/1925972

Li, H., Arditi, D. & Wang, Z. 2013. Factors that affect transaction costs in construction projects. *Journal of Construction Engineering and Management,* Vol. 139(1)**,** pp**.** 60-68.

Li, H., Arditi, D. & Wang, Z. 2014. Transaction costs incurred by construction owners. *Engineering, Construction and Architectural Management,* Vol. 21(4)**,** pp**.** 444-458. doi:10.1108/ECAM-07-2013-0064

Li, H., Arditi, D. & Wang, Z. 2015. Determinants of transaction costs in construction projects. *Journal of Civil Engineering and Management,* Vol. 21(5)**,** pp**.** 548-558. 10.3846/13923730.2014.897973

Ling, F. Y. Y., Ning, Y., Ke, Y. & Kumaraswamy, M. M. 2013. Modeling relational transaction and relationship quality among team members in public projects in Hong Kong. *Automation in Construction,* Vol. 36(2013)**,** pp**.** 16-24. https://doi.org/10.1016/j.autcon.2013.08.006

Liu, L., Bannerman, P. L., Ding, X., Elliott, E.-J., Ewart, G. & Kong, X. 2016. The Motives for and Consequences of Underpricing for Construction Contractors—Evidence from Australia. *The Journal of Modern Project Management,* Vol. 3(3)**,** pp**.** 36-45.

Lloyd-Walker, B. M., Mills, A. J. & Walker, D. H. T. 2014. Enabling construction innovation: the role of a no-blame culture as a collaboration behavioural driver in project alliances. *Construction Management and Economics,* Vol. 32(3)**,** pp**.** 229-245. 10.1080/01446193.2014.892629

Lo, W., Lin, C. L. & Yan, M. R. 2007. Contractor's opportunistic bidding behavior and equilibrium price level in the construction market. *Journal of Construction Engineering and Management,* Vol. 133(6), pp. 409-416. doi:10.1061/(ASCE)0733-9364(2007)133:6(409)

Love, P. E. D., Ika, L. A., Ahiaga-Dagbui, D. D., Locatelli, G. & Sing, M. C. P. 2019. Make-or-break during production: shedding light on change-orders, rework and contractors margin in construction. *Production Planning & Control,* Vol. 30(4), pp. 285-298. 10.1080/09537287.2018.1535675

Lu, W., Zhang, L. & Pan, J. 2015. Identification and analyses of hidden transaction costs in project dispute resolutions. *International Journal of Project Management,* Vol. 33(3), pp. 711-718. 10.1016/j.ijproman.2014.08.009

Lumineau, F. & Quélin, B. V. 2012. An empirical investigation of interorganizational opportunism and contracting mechanisms. *Strategic Organization,* Vol. 10(1), pp. 55-84. 10.1177/1476127011434798

Lædre, O. 2009. *Er Det Noen Sak?,* Bergen, Norway, Fagbokforlaget.

Lædre, O. 2014. *Kontraktstrategi for Bygg- og Anleggsprosjekter,* Bergen, Norway, Fagbokforlaget.

Macher, J. T. & Richman, B. D. 2008. Transaction cost economics: An assessment of empirical research in the social sciences. *Business and Politics,* Vol. 10(1), pp. 1-63.

Majava, J., Haapasalo, H. & Aaltonen, K. 2019. Elaborating factors affecting visual control in a big room. *Construction Innovation,* Vol. 19(1), pp. 34-47. doi:10.1108/CI-06-2018-0048

Mandell, S. & Nyström, J. 2013. Too much balance in unbalanced bidding. *Studies in Microeconomics,* Vol. 1(1), pp. 23-35. doi:10.1177/2321022213488845

Manu, E., Ankrah, N., Chinyio, E. & Proverbs, D. 2015. Trust influencing factors in main contractor and subcontractor relationships during projects. *International Journal of Project Management,* Vol. 33(7), pp. 1495-1508. http://dx.doi.org/10.1016/j.ijproman.2015.06.006

Marshall, A. 1890. *Principles of Economics,* London, MacMillan And Co.

Mason, M. 2010. Sample size and saturation in PhD studies using qualitative interviews. *Forum: qualitative social research,* Vol. 11(3), pp. Art. 8.

Masten, S. E., Meehan, J. W. & Snyder, E. A. 1991. The Costs of Organization. *Journal of Law, Economics, & Organization,* Vol. 7(1), pp. 1-25.

Matthews, J., Love, P. E. D., Mewburn, J., Stobaus, C. & Ramanayaka, C. 2018. Building information modelling in construction: insights from collaboration and change management perspectives. *Production Planning & Control,* Vol. 29(3), pp. 202-216. 10.1080/09537287.2017.1407005

Mcallister, D. J. 1995. Affect-and cognition-based trust as foundations for interpersonal cooperation in organizations. *Academy of management journal,* Vol. 38(1), pp. 24-59.

Meng, X. & Gallagher, B. 2012. The impact of incentive mechanisms on project performance. *International Journal of Project Management,* Vol. 30(3), pp. 352-362. https://doi.org/10.1016/j.ijproman.2011.08.006

Merschbrock, C. & Munkvold, B. E. 2015. Effective digital collaboration in the construction industry – A case study of BIM deployment in a hospital construction project. *Computers in Industry,* Vol. 73(1), pp. 1-7. https://doi.org/10.1016/j.compind.2015.07.003

Mitnick, B. M. 1973. Fiduciary rationality and public policy: The theory of agency and some consequences. Pittsburgh: University of Pittsburgh.

Mohamed, K. A., Khoury, S. S. & Hafez, S. M. 2011. Contractor's decision for bid profit reduction within opportunistic bidding behavior of claims recovery. *International Journal of Project Management,* Vol. 29(1), pp. 93-107. http://dx.doi.org/10.1016/j.ijproman.2009.12.003

Molenaar, K. R., Songer, A. D. & Barash, M. 1999. Public-Sector Design/Build Evolution and Performance. *Journal of Management in Engineering,* Vol. 15(2), pp. 54-62. doi:10.1061/(ASCE)0742-597X(1999)15:2(54)

Monsen, L. 2019. *Mitt liv,* Oslo, Norway, Cappelen Damm.

Mukaka, M. M. 2012. A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal,* Vol. 24(3), pp. 69-71.

Muller, R. 2009. *Project governance,* Surrey, Gower Publishing.

Murphy, K. R. & Davidshofer, C. O. 2005. *Psychological testing : principles and applications,* Upper Saddle River, N.J, Pearson/Prentice Hall.

Müller, R. & Jugdev, K. 2012. Critical success factors in projects: Pinto, Slevin, and Prescott–the elucidation of project success. *International Journal of Managing Projects in Business,* Vol. 5(4), pp. 757-775.

Müller, R. & Turner, J. R. 2005. The impact of principal–agent relationship and contract type on communication between project owner and manager. *International Journal of Project Management,* Vol. 23(5), pp. 398-403. http://dx.doi.org/10.1016/j.ijproman.2005.03.001

Nevstad, K., Børve, S., Karlsen, A. T. & Aarseth, W. 2018. Understanding how to succeed with project partnering. *International Journal of Managing Projects in Business,* Vol. 11(4), pp. 1044-1065. 10.1108/IJMPB-07-2017-0085

Ngai, S. C., Drew, D. S., Lo, H. P. & Skitmore, M. 2002. A theoretical framework for determining the minimum number of bidders in construction bidding competitions. *Construction Management and Economics,* Vol. 20(6), pp. 473-482. 10.1080/01446190210151041

Ning, Y. 2018. Impact of quality performance ambiguity on contractor's opportunistic behaviors in person-to-organization projects: The mediating roles of contract design and application. *International Journal of Project Management,* Vol. 36(4), pp. 640-649. 10.1016/j.ijproman.2018.01.008

Ning, Y. & Ling, F. Y. Y. 2015. The effects of project characteristics on adopting relational transaction strategies. *International Journal of Project Management,* Vol. 33(5), pp. 998-1007. http://dx.doi.org/10.1016/j.ijproman.2014.12.006

Norway 2018. Stortingsmelding 22 (2018-2019). *In:* FISKERIDEPARTEMENT, D. K. N.-O. (ed.).

Nsd. 2020. *Norwegian Register for Scientific Journals, Series and Publishers* [Online]. Available: https://dbh.nsd.uib.no/publiseringskanaler/Forside.action?request_locale=en [Accessed 30.01.2020 2020].

Ntnu-Ivt. 2020. *Regulations concerning the degrees of Philosophiae*

*Doctor (PhD)* [Online]. Available: https://innsida.ntnu.no/documents/portlet_file_entry/10157/191217+Regulations

+concerning+the+degrees+of+Philosophiae+Doctor.pdf/9c10ed3c-6400-4e44-b497-ee290efdc63a?status=0 [Accessed 30.01.2020 2020].
Ntp 2018. Najsonal Transportplan 2018-2029.
Nunamaker Jr, J. F., Chen, M. & Purdin, T. D. 1990. Systems development in information systems research. *Journal of management information systems,* Vol. 7(3), pp. 89-106.
Nyström, J. 2015. The balance of unbalanced bidding. *Procedia Economics and Finance,* Vol. 21(pp. 97-103. http://dx.doi.org/10.1016/S2212-5671(15)00155-0
Oakland, J. S. 2012. *Oakland on quality management,* New York, Routledge.
Padalkar, M. & Gopinath, S. 2016. Six decades of project management research: Thematic trends and future opportunities. *International Journal of Project Management,* Vol. 34(7), pp. 1305-1321.
Park, H.-S. 2006. Conceptual framework of construction productivity estimation. *KSCE Journal of Civil Engineering,* Vol. 10(5), pp. 311-317. 10.1007/BF02830084
Park, J.-G. & Lee, J. 2014. Knowledge sharing in information systems development projects: Explicating the role of dependence and trust. *International Journal of Project Management,* Vol. 32(1), pp. 153-165. https://doi.org/10.1016/j.ijproman.2013.02.004
Patel, H., Pettitt, M. & Wilson, J. R. 2012. Factors of collaborative working: A framework for a collaboration model. *Applied Ergonomics,* Vol. 43(1), pp. 1-26. https://doi.org/10.1016/j.apergo.2011.04.009
Petersen, O. H., Hansen, J. R., Villadsen, A. R. & Houlberg, K. Private Transaction Costs in Public Sector Contracting. XXII Annual IRSPM Conference, 2018.
Peterson, R. A. 1994. A meta-analysis of Cronbach's coefficient alpha. *Journal of consumer research,* Vol. 21(2), pp. 381-391.
Pinto, J. K. 2010. *Project Management : Achieving Competitive Advantage,* Boston, Pearson Prentice Hall.
Pinto, J. K. 2013. Lies, damned lies, and project plans: Recurring human errors that can ruin the project planning process. *Business Horizons,* Vol. 56(5), pp. 643-653. http://dx.doi.org/10.1016/j.bushor.2013.05.006
Pinto, J. K. & Slevin, D. P. 1988. Project success: definitions and measurement techniques. *Project management journal,* Vol. 19(1), pp. 67-72.
Pinto, J. K., Slevin, D. P. & English, B. 2009. Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management,* Vol. 27(6), pp. 638-648. http://dx.doi.org/10.1016/j.ijproman.2008.09.010
Pmi 2017. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide),* Newtown Square, Pennsylvania, Project Management Institute.
Porwal, A. & Hewage, K. N. 2013. Building Information Modeling (BIM) partnering framework for public construction projects. *Automation in Construction,* Vol. 31(pp. 204-214. https://doi.org/10.1016/j.autcon.2012.12.004
Pratt, J. W. & Zeckhauser, R. 1991. Principals and Agents: An Overview. *In:* PRATT, J. W. & ZECKHAUSER, R. (eds.) *Principals and Agents: The Structure of Business.* 2 ed. USA: Harvard Business School Press.
Rahmani, F., Khalfan, M. M. & Maqsood, T. 2018. A comparative study of early contractor involvement and project alliancing. *International Journal of Project Organisation and Management,* Vol. 10(2), pp. 93-108.

Rajeh, M., Tookey, J. & Rotimi, J. Determining the magnitude of transaction costs in construction procurement systems: An exploratory study. 2013. World Building Congress.

Rajeh, M., Tookey, J. E., Olabode, J. & Rotimi, B. 2015. Estimating transaction costs in the New Zealand construction procurement a structural equation modelling methodology. *Engineering, Construction and Architectural Management,* Vol. 22(2)**,** pp**.** 242-267. 10.1108/ECAM-10-2014-0130

Reed, M. 2009. Critical Realism: Philosophy, Method, or Philosophy in Search of a Method. *In:* BUCHANAN, D. & BRYMAN, A. (eds.) *The SAGE Handbook of Organizational Research Methods.* Thousands Oaks, California: SAGE Publications

Rezvani, A. & Khosravi, P. 2018. A comprehensive assessment of project success within various large projects. *The Journal of Modern Project Management,* Vol. 6(1)**,** pp**.** 115-123.

Richter, R. 2005. The New Institutional Economics: Its Start, its Meaning, its Prospects. *European Business Organization Law Review,* Vol. 6(2)**,** pp**.** 161-200. 10.1017/S1566752905001618

Rindfleisch, A. & Heide, J. B. 1997. Transaction cost analysis: Past, present, and future applications. *Journal of Marketing,* Vol. 61(4)**,** pp**.** 30-54. 10.2307/1252085

Riordan, M. H. 1995. What is Vertical Integration. *In:* WILLIAMSON, O. E. & MASTEN, S. E. (eds.) *Transaction Cost Economics.* Aldershot, England: Edward Elgar Publishing Limited.

Rooke, J., Seymour, D. & Fellows, R. 2004. Planning for claims: an ethnography of industry culture. *Construction Management and Economics,* Vol. 22(6)**,** pp**.** 655-662. 10.1080/0144619042000226324

Ross, S. A. 1973. The Economic Theory of Agency: The Principal's Problem. *The American Economic Review,* Vol. 63(2)**,** pp**.** 134-139.

Rothschild, M. & Stiglitz, J. 1976. Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information. *The Quarterly Journal of Economics,* Vol. 90(4)**,** pp**.** 629-649. 10.2307/1885326

Rousseau, D. M., Sitkin, S. B., Burt, R. S. & Camerer, C. 1998. Not So Different After All: A Cross-Discipline View Of Trust. *Academy of Management Review,* Vol. 23(3)**,** pp**.** 393-404. 10.5465/amr.1998.926617

Sabini, L., Muzio, D. & Alderman, N. 2019. 25 years of 'sustainable projects'. What we know and what the literature says. *International Journal of Project Management,* Vol. 37(6)**,** pp**.** 820-838. https://doi.org/10.1016/j.ijproman.2019.05.002

Samset, K. 2014. *Projsekt i tidligfasen* Bergen, Fagbokforlaget.

Sarhan, S., Pasquire, C., Manu, E. & King, A. 2017. Contractual governance as a source of institutionalised waste in construction: A review, implications, and road map for future research directions. *International Journal of Managing Projects in Business,* Vol. 10(3)**,** pp**.** 550-577. doi:10.1108/IJMPB-07-2016-0058

Saunders, M., Lewis, P. & Adrian, T. 2019. *Research Methods for Business Students,* Harlow, UK, Pearson Education

Schipper, R. R. & Silvius, A. G. 2018. Towards a conceptual framework for sustainable project portfolio management. *International Journal of Project Organisation and Management,* Vol. 10(3)**,** pp**.** 191-221.

Schmitt, N. 1996. Uses and abuses of coefficient alpha. *Psychological Assessment,* Vol. 8(4), pp. 350-353. 10.1037/1040-3590.8.4.350

Schoorman, F. D., Mayer, R. C. & Davis, J. H. 2007. An integrative model of organizational trust: Past, present, and future. Academy of Management Briarcliff Manor, NY 10510.

Sebastian, R. 2011. Changing roles of the clients, architects and contractors through BIM. *Engineering, Construction and Architectural Management,* Vol. 18(2), pp. 176-187. doi:10.1108/09699981111111148

Shelanski, H. A. & Klein, P. G. 1995. Empirical research in transaction cost economics: A review and assessment. *Journal of Law, Economics, & Organization,* Vol. 11(2), pp. 335-361.

Shenhar, A. J. & Dvir, D. 2004. How projects differ and what to do about it. *In:* MORRIS, P. W. G. & PINTO, J. K. (eds.) *The Wiley Guide to Managing Projects.* Hoboken, New Jersey: John Wiley and Sons.

Shepherd, M. 2015. Interview methods for project management research. *In:* PASIAN, B. (ed.) *Designs, Methods and Practices for Research of Project Management.* 1st ed. Surrey: Gower Publishing Ltd.

Shi, C., Chen, Y., You, J. & Yao, H. 2018. Asset specificity and contractors' opportunistic behavior: moderating roles of contract and trust. *Journal of management in engineering,* Vol. 34(5), pp. 04018026.

Shuy, R. 2002. In-person versus telephone interviewing. *In:* GUBRIUM, J. F. & HOLSTEIN, J. A. (eds.) *Handbook of Interview Research.* 1st ed. Thousand Oaks, California: SAGE Publications.

Silva, A. & Harper, C. 2018. Using Project Team Integration to Predict Cost and Schedule Performance in Public Transportation Projects. *Construction Research Congress 2018.*

Simatupang, T. M. & Sridharan, R. 2005. The collaboration index: a measure for supply chain collaboration. *International Journal of Physical Distribution & Logistics Management,* Vol. 35(1), pp. 44-62. doi:10.1108/09600030510577421

Simon, H. A. 1957. *Administrative Behavior,* New York, The Macmillian Company.

Simon, H. A. 1969. *The sciences of artificial* Cambridge, Massachusetts, M.I.T.

Simon, H. A. 1991. Organizations and Markets. *The Journal of Economic Perspectives,* Vol. 5(2), pp. 25-44.

Singh, V., Gu, N. & Wang, X. 2011. A theoretical framework of a BIM-based multi-disciplinary collaboration platform. *Automation in Construction,* Vol. 20(2), pp. 134-144. https://doi.org/10.1016/j.autcon.2010.09.011

Smits, K. & Van Marrewijk, A. 2012. Chaperoning: practices of collaboration in the Panama Canal Expansion Program. *International Journal of Managing Projects in Business,* Vol. 5(3), pp. 440-456. doi:10.1108/17538371211235317

Snowden, D. J. & Boone, M. E. 2007. A leader's framework for decision making. *Harvard business review,* Vol. 85(11), pp. 68.

Snyder, H. 2019. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research,* Vol. 104(pp. 333-339. https://doi.org/10.1016/j.jbusres.2019.07.039

Soliño, A. S. & Gago De Santos, P. 2010. Transaction Costs in Transport Public–Private Partnerships: Comparing Procurement Procedures. *Transport Reviews,* Vol. 30(3), pp. 389-406. 10.1080/01441640903037941

Spitzer, D. R. 2007. *Transforming Performance Measurement,* New York, AMACOM books.

Ssb. 2019. *Næringenes økonomiske utvikling* [Online]. Available: https://www.ssb.no/statbank/table/12817/tableViewLayout1/ [Accessed 17.01 2020].

Strand, R. & Freeman, R. E. 2015. Scandinavian Cooperative Advantage: The Theory and Practice of Stakeholder Engagement in Scandinavia. *Journal of Business Ethics,* Vol. 127(1)**,** pp**.** 65-85. 10.1007/s10551-013-1792-1

Sullivan, J., Asmar, M. E., Chalhoub, J. & Obeid, H. 2017. Two decades of performance comparisons for design-build, construction manager at risk, and design-bid-build: quantitative analysis of the state of knowledge on project cost, schedule, and quality. *Journal of Construction Engineering and Management,* Vol. 143(6)**,** pp**.** 04017009.

Suprapto, M., Bakker, H. L. M., Mooi, H. G. & Hertogh, M. J. C. M. 2016. How do contract types and incentives matter to project performance? *International Journal of Project Management,* Vol. 34(6)**,** pp**.** 1071-1087. https://doi.org/10.1016/j.ijproman.2015.08.003

Suprapto, M., Bakker, H. L. M., Mooi, H. G. & Moree, W. 2015a. Sorting out the essence of owner-contractor collaboration in capital project delivery. *International Journal of Project Management,* Vol. 33(3)**,** pp**.** 664-683. 10.1016/j.ijproman.2014.05.001

Suprapto, M., Bakker, H. L. M., Mooi, H. G. & Moree, W. 2015b. Sorting out the essence of owner–contractor collaboration in capital project delivery. *International Journal of Project Management,* Vol. 33(3)**,** pp**.** 664-683. https://doi.org/10.1016/j.ijproman.2014.05.001

Svejvig, P. & Andersen, P. 2015. Rethinking project management: A structured literature review with a critical look at the brave new world. *International Journal of Project Management,* Vol. 33(2)**,** pp**.** 278-290. https://doi.org/10.1016/j.ijproman.2014.06.004

Takeuchi, H. & Nonaka, I. 1986. The new new product development game. *Harvard business review,* Vol. 64(1)**,** pp**.** 137-146.

Tan, Y.-T., Shen, L.-Y., Khalid, A. G. & Song, S.-C. 2008. An examination of the factors affecting contractors' competition strategy: a Hong Kong study. *International Journal of Project Organisation and Management,* Vol. 1(1)**,** pp**.** 4-23.

Tang, Y., Chen, Y., Hua, Y. & Fu, Y. 2020. Impacts of risk allocation on conflict negotiation costs in construction projects: Does managerial control matter? *International Journal of Project Management,* Vol. 38(3)**,** pp**.** 188-199.

Taylor, R. 1990. Interpretation of the Correlation Coefficient: A Basic Review. *Journal of Diagnostic Medical Sonography,* Vol. 6(1)**,** pp**.** 35-39. 10.1177/875647939000600106

Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I. & Ferreira, M. 2019. Project Management Practices in Private Organizations. *Project Management Journal,* Vol. 50(1)**,** pp**.** 6-22. 10.1177/8756972818810966

Todsen, S. 2018. *Produktivitetsfall i bygg og anlegg* [Online]. Statistics Norway. Available: https://www.ssb.no/bygg-bolig-og-eiendom/artikler-og-publikasjoner/produktivitsfall-i-bygg-og-anlegg [Accessed 20.08.2018 2018].

Tranfield, D., Denyer, D. & Smart, P. 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management,* Vol. 14(3), pp. 207-222.

Tuckman, B. W. 1965. Developmental sequence in small groups. *Psychological bulletin,* Vol. 63(6), pp. 384.

Turner, J. R. 2004. Farsighted project contract management: incomplete in its entirety. *Construction Management and Economics,* Vol. 22(1), pp. 75-83.

Turner, J. R., Lecoeuvre, L., Sankaran, S. & Er, M. 2019. Marketing for the project: project marketing by the contractor. *International Journal of Managing Projects in Business,* Vol. 12(1), pp. 211-227. doi:10.1108/IJMPB-10-2017-0118

Turner, J. R. & Müller, R. 2003. On the nature of the project as a temporary organization. *International Journal of Project Management,* Vol. 21(1), pp. 1-8. http://dx.doi.org/10.1016/S0263-7863(02)00020-0

Turner, J. R. & Müller, R. 2004. Communication and co-operation on projects between the project owner as principal and the project manager as agent. *European Management Journal,* Vol. 22(3), pp. 327-336. https://doi.org/10.1016/j.emj.2004.04.010

Um, K. H. & Kim, S. M. 2018. Collaboration and opportunism as mediators of the relationship between NPD project uncertainty and NPD project performance. *International Journal of Project Management,* Vol. 36(4), pp. 659-672. 10.1016/j.ijproman.2018.01.006

Vaaland, T. I. & Håkansson, H. 2003. Exploring interorganizational conflict in complex projects. *Industrial Marketing Management,* Vol. 32(2), pp. 127-138. https://doi.org/10.1016/S0019-8501(02)00227-4

Van Aken, J. E. 2005. Management Research as a Design Science: Articulating the Research Products of Mode 2 Knowledge Production in Management. *British Journal of Management,* Vol. 16(1), pp. 19-36. 10.1111/j.1467-8551.2005.00437.x

Velayudhan, D. P. & Thomas, S. 2018. Role of technological uncertainty, technical complexity, intuition and reflexivity in project planning–a study on software development projects. *International Journal of Project Organisation and Management,* Vol. 10(1), pp. 82-92.

Vogl, B. & Abdel-Wahab, M. 2015. Measuring the Construction Industry’s Productivity Performance: Critique of International Productivity Comparisons at Industry Level. *Journal of Construction Engineering and Management,* Vol. 141(4), pp. 04014085. doi:10.1061/(ASCE)CO.1943-7862.0000944

Von Danwitz, S. 2018. Managing inter-firm projects: A systematic review and directions for future research. *International Journal of Project Management,* Vol. 36(3), pp. 525-541.

Walker, A. 1999. The relationship between construction project management theory and transaction cost economics. *Engineering, Construction and Architectural Management,* Vol. 6(2), pp. 166-176. 10.1108/eb021109

Walker, A. & Kwong Wing, C. 1999. The relationship between construction project management theory and transaction cost economics. *Engineering Construction and Architectural Management,* Vol. 6(2), pp. 166-176.

Walker, D. & Lloyd-Walker, B. 2016a. Rethinking project management: Its influence on papers published in the international journal of managing projects in business. *International Journal of Managing Projects in Business,* Vol. 9(4), pp. 716-743.

Walker, D. & Lloyd-Walker, B. M. 2015. *Collaborative Project Procurement Arrangements,* Newton Square, Pennsylvania, USA, Project Management Institute.

Walker, D. H. T., Davis, P. R. & Stevenson, A. 2017. Coping with uncertainty and ambiguity through team collaboration in infrastructure projects. *International Journal of Project Management,* Vol. 35(2), pp. 180-190. https://doi.org/10.1016/j.ijproman.2016.11.001

Walker, D. H. T. & Lloyd-Walker, B. M. 2016b. Understanding the motivation and context for alliancing in the Australian construction industry. *International Journal of Managing Projects in Business,* Vol. 9(1), pp. 74-93. doi:10.1108/IJMPB-07-2015-0065

Wang, C., Yap, J. B. H., Wood, L. C. & Abdul-Rahman, H. 2019. Knowledge modelling for contract disputes and change control. *Production Planning & Control,* Vol. 30(8), pp. 650-664. 10.1080/09537287.2019.1572247

Warren, C. A. 2002. Qualitative interviewing. *In:* GUBRIUM, J. F. & HOLSTEIN, J. A. (eds.) *Handbook of interview research; Context & method.* 1st ed. Thousand oaks: SAGE Publications.

Webster, J. & Watson, R. T. 2002. Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly,* Vol. 26(2), pp. xiii-xxiii.

Whittington, J. M. 2008. *The transaction cost economics of highway project delivery: design-build contracting in three states*, University of California, Berkeley.

Wilkinson, P. 2005. *Construction collaboration technologies: An extranet evolution,* New York, Taylor & Francis.

Williams, T. 2017. The nature of risk in complex projects. *Project management journal,* Vol. 48(4), pp. 55-66.

Williams, T., Vo, H., Samset, K. & Edkins, A. 2019. The front-end of projects: a systematic literature review and structuring. *Production Planning & Control,* Vol. 30(14), pp. 1137-1169. 10.1080/09537287.2019.1594429

Williamson, O. E. 1971. The vertical integration of production: Market failure considerations. *The American Economic Review,* Vol. 61(2), pp. 112-123.

Williamson, O. E. 1975. *Markets and Hierarchies: Analysis and Antitrust Implications : A Study in the Economics of Internal Organization,* New York, Free Press.

Williamson, O. E. 1979. Transaction-Cost Economics: The Governance of Contractual Relations. *The Journal of Law & Economics,* Vol. 22(2), pp. 233-261.

Williamson, O. E. 1981. The economics of organization: the transaction cost approach. *American Journal of Sociology,* Vol. 87(3), pp. 548-577. doi:10.1086/227496

Williamson, O. E. 1983. Credible Commitments: Using Hostages to Support Exchange. *The American Economic Review,* Vol. 73(4), pp. 519-540.

Williamson, O. E. 1985. *The Economic Institutions of Capitalism : Firms, Markets, Relational Contracting,* New York, Free Press.

Williamson, O. E. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. *Administrative Science Quarterly,* Vol. 36(2), pp. 269-296. 10.2307/2393356

Williamson, O. E. 1996. *The Mechanisms of Governance,* New York, Oxford University Press.

Williamson, O. E. 2009. Prize Lecture - Transaction Cost Economics: The Natural Progression. *In:* GRANDIN, K. (ed.) *Les Prix Nobel. The Nobel Prizes 2009.* Stockholm: Nobel foundation.

Winch, G. M. 2001. Governing the project process: a conceptual framework. *Construction Management and Economics,* Vol. 19(8)**,** pp**.** 799-808.

Winter, M., Smith, C., Morris, P. & Cicmil, S. 2006. Directions for future research in project management: The main findings of a UK government-funded research network. *International Journal of Project Management,* Vol. 24(8)**,** pp**.** 638-649. http://dx.doi.org/10.1016/j.ijproman.2006.08.009

Wondimu, P. A., Hosseini, A., Lohne, J., Hailemichael, E. & Lædre, O. Early Contractor Involvement in Public Infrastructure Projects. Proc. 24th Ann. Conf. of the Int'l. Group for Lean Construction, , 2016 Boston, MA, USA. 13-22.

Xiang, P., Huo, X. & Shen, L. 2015. Research on the phenomenon of asymmetric information in construction projects — The case of China. *International Journal of Project Management,* Vol. 33(3)**,** pp**.** 589-598. http://dx.doi.org/10.1016/j.ijproman.2014.10.007

Yap, J. B. H., Abdul-Rahman, H. & Chen, W. 2017. Collaborative model: Managing design changes with reusable project experiences through project learning and effective communication. *International Journal of Project Management,* Vol. 35(7)**,** pp**.** 1253-1271. 10.1016/j.ijproman.2017.04.010

Yeung, J. F. Y., Chan, A. P. C. & Chan, D. W. M. 2007. The definition of alliancing in construction as a Wittgenstein family-resemblance concept. *International Journal of Project Management,* Vol. 25(3)**,** pp**.** 219-231. https://doi.org/10.1016/j.ijproman.2006.10.003

Yeung, J. F. Y., Chan, A. P. C., Chan, D. W. M., Chiang, Y. H. & Yang, H. 2013. Developing a Benchmarking Model for Construction Projects in Hong Kong. *Journal of Construction Engineering and Management,* Vol. 139(6)**,** pp**.** 705-716. doi:10.1061/(ASCE)CO.1943-7862.0000622

Yin, R. K. 2014. *Case Study Research : Design and Methods,* Los Angeles, SAGE.

Yin, Y., Xu, Z. & Qiu, Y. 2014. Study on countermeasures to contractor's opportunistic behaviors in public project based on evolutionary game theory. *Tumu Gongcheng Xuebao/China Civil Engineering Journal,* Vol. 47(6)**,** pp**.** 138-144.

You, J., Chen, Y., Wang, W. & Shi, C. 2018. Uncertainty, opportunistic behavior, and governance in construction projects: The efficacy of contracts. *International Journal of Project Management,* Vol. 36(5)**,** pp**.** 795-807. https://doi.org/10.1016/j.ijproman.2018.03.002

Young, M. 2015. Project management research: social dimensions and organisational contex. *In:* PASIAN, B. (ed.) *Designs, Methods and Practices for Research of Project Management.* 1st ed. Surrey: Gower Publishing Ltd.

Young, R. R. 2006. *Project Requirements, A Guide to Best Practices,* Virginia, USA, Management Concepts.

Yun, S., Choi, J., De Oliveira, D. P. & Mulva, S. P. 2016. Development of performance metrics for phase-based capital project benchmarking. *International Journal of Project Management,* Vol. 34(3)**,** pp**.** 389-402. https://doi.org/10.1016/j.ijproman.2015.12.004

Zack, J. G. 1993. Claimsmanship: Current Perspective. *Journal of Construction Engineering and Management,* Vol. 119(3), pp. 480-497. doi:10.1061/(ASCE)0733-9364(1993)119:3(480)

Zarei, B., Sharifi, H. & Chaghouee, Y. 2018. Delay causes analysis in complex construction projects: a Semantic Network Analysis approach. *Production Planning & Control,* Vol. 29(1), pp. 29-40. 10.1080/09537287.2017.1376257

Zhang, S., Fu, Y. & Kang, F. 2018a. How to foster contractors' cooperative behavior in the Chinese construction industry: Direct and interaction effects of power and contract. *International Journal of Project Management,* Vol. 36(7), pp. 940-953. 10.1016/j.ijproman.2018.05.004

Zhang, X., Azhar, S., Nadeem, A. & Khalfan, M. 2018b. Using building information modelling to achieve Lean principles by improving efficiency of work teams. *International Journal of Construction Management,* Vol. 18(4), pp. 293-300. 10.1080/15623599.2017.1382083

# 9 Appendices

## 9.1 Interview guide (In Norwegian language)

## *Samtykke om deltakelse i forskningsprosjekt gjennom intervju*

*Hvor stor andel av sluttregningen i et prosjekt skyldes at vi ikke alltid har sammenfallende interesser eller stoler på hverandre? Hva skyldes det at noen prosjekter opplever god samhandling mens andre ender med tvister og mistillit? Tretten år med spennende og krevende prosjekter i Nordsjøen har motivert meg tilbake til skolebenken som doktorgradsstudent for å forske på dette»*

**Nøkkelinformasjon om intervjuet**

- Intervjuet varer maksimum 1 time
- Det vil ikke bli brukt opptaksutstyr
- Jeg vil notere mye underveis på papir
- Jeg vil signere konfidensialitetserklæring og garantere for anonymisering av informasjon og personopplysninger
- Det er frivillig å delta og du kan når som helst trekke deg uten å oppgi noen grunn
- Studien har blitt vurdert av personvernombudet hos norsk senter for forskningsdata (NSD)
- Forskningen er finansiert av NTNU – stiftelsen for etter og videreutdanning

**Hvordan blir formatet på intervjuet? Hva spør jeg om?**

Jeg har forberedt noen få åpne spørsmål hvor jeg vil be deg fortelle om dine erfaringer knyttet til samhandling i prosjekter du har vært involvert i.

Jeg vil også spørre om nøkkeltall fra prosjektene for å danne meg et bilde av konteksten. Jeg vil komme med oppfølgingsspørsmål underveis for å sjekke at jeg har forstått deg riktig og gjerne spørre deg om å utdype spesielle tema underveis.

«*Har jeg forstått deg riktig hvis jeg sier at ….»*?.

«*Du nevnte at……kan du fortelle litt mer om dette?»*

**Hvordan sikres din anonymitet?**

Hverken du, din bedrift, dine kunder eller samarbeidspartnere skal kunne bli identifisert.

Det vil ikke bli brukt direkte sitater som kan identifisere deg. I den grad sitater brukes vil disse være generalisert og anonymisert.

**Hvem er jeg?**

Haavard Haaskjold (39) fra Stord.
Trebarnsfar bosatt på Ranheim.

Siv.ing fra NTNU (2004). Arbeidet med olje-og-gass prosjekter frem til 2017. Nå doktorgrads-stipendiat i prosjektledelse.

haavard.haaskjold@ntnu.no / 41 14 77 31 /
www.linkedin.com/in/haavard-haaskjold

**Hva er hensikten med intervjuet?**

For å forske på prosjektledelse kan jeg ikke gjemme meg bak bøker og teori. Jeg må ut og snakke med dere som jobber i store og små **virkelige prosjekter**, i ulike bransjer. Lytte til dine erfaringer og lære mer om **din** prosjekthverdag.

**Hva skal dette doktorgradsarbeidet bidra med i praksis?**

Finne konkrete løsninger på hvordan og hvor mye bedrifter kan spare på bedre samhandling i prosjekter.

> *«Hvordan, og hvor mye, kan vi spare i prosjekter ved å samhandle enda bedre med våre kunder, leverandører og interessenter?»*

Jeg vil i ettertid besøke bedrifter som har deltatt for å presentere resultatene. Resultatene blir også presentert i tidsskrifter, kronikker osv.

**Hva skjer med referatet fra intervjuet?**

For å forsikre meg om at jeg forstått deg riktig vil jeg sende et referat (kun) til deg og be deg lese gjennom og gjøre eventuelle rettelser før du godkjenner det. Navnet ditt/bedriftens navn vil ikke stå på referatet. Koblingen mellom din e-post adresse og referatet blir deretter slettet. Referatet vil bli brukt til analyse og det vil ikke bli publisert (eller lagt ved publikasjoner) i sin helhet.

Jeg har mottatt informasjon om studien og er villig til å delta.

--------------------------------------------------

(Signert av deltaker, dato)

## *Intervjuguide - Samhandling i prosjekter og tilhørende transaksjonskostnader*

*Intervjutype: semi-strukturert*

| | |
|---|---|
| **Fase 1: Oppstart**<br>**5 mim** | **Løs og uformell prat. Hente kaffe osv.**<br><br>**Informere deltageren**<br>• Beskrive formålet med intervjuet<br>• Forventningsavklaring<br>• Beskrive formatet på intervjuet, konfidensialitet og anonymisering<br>• Spør deltaker om han/hun har spørsmål til intervjuet<br>• Samle inn signer samtykkeskjema |
| **Fase 2. Bakgrunn**<br>**5 min** | **Kartlegge deltagernes prosjektbakgrunn**<br>• Antall års erfaring fra prosjekter og prosjektledelse<br>• Erfaring fra hvilke bransjer<br>• Overordnet beskrivelse av prosjekter som deltageren har vært med på.<br>• Spør om nøkkeltall og varighet for å få riktig kontekst på prosjektene<br>• Relevante oppfølgingsspørsmål og overgang til hoveddel |
| **Fase 3: Hoveddel**<br>**40-60 min** | **Lytte til deltagerens erfaringer fra samhandling i prosjekter**<br><u>Åpne spørsmål:</u><br>• Eget ark med spørsmål<br><br><u>Oppfølgingsspørsmål underveis for å sikre korrekt forståelse og for å få deltakeren til å utdype interessante tema:</u><br>• Har jeg forstått deg riktig hvis jeg sier at……?<br>• Du nevnte at…..kan du fortelle litt mer om dette? |
| **Fase 4: Avslutting**<br>**10 min** | **Oppsummering, sjekk og tilbakeblikk**<br>- Oppsummere hovedfunn<br>- Sjekke om jeg har forstått deltageren riktig<br>- Spør om deltageren har noe å legge til.<br>- Takke for intervjuet |

# Spørsmål - Leverandør

1. Bakgrunnsinformasjon
    a. Hva er din bakgrunn fra prosjektarbeid?
    b. Hvor mange år har du jobbet i prosjekter?
    c. Hva er din nåværende rolle?
    d. Hvilke type prosjekter er du nå involvert i?
    e. Hvilke andre prosjekter har du vært involvert i tidligere?

2. Kan du fortelle meg om noen prosjekter som etter din mening gikk skikkelig bra?
    a. Kan du gi meg noen nøkkeltall om prosjektet som sier noe om konteksten? Omsetning, varighet, deltagere
    b. Hvorfor tror du dette prosjektet lykkes så bra?
    c. Hvordan var samarbeidet med kunden i dette prosjektet?

3. Hva legger du i begrepet samhandling

4. Kan du beskrive hvordan du opplever samhandling med kunder?

5. Kan du gi meg noen eksempler fra prosjekter hvor samhandling med kunden var krevende.

6. Hva skal etter din mening til for å få god samhandling med kunder?
    a. Hva gjør du for å oppnå god samhandling med kunden?
    b. Hvor mye tid bruker du på dette?
    c. I hvilken grad opplever du å få noe igjen for tiden du bruker på å skape god samhandling.

7. Hva mener du mangel på samhandling fører til?

8. Opplever du at konfliktnivået forskjellig i ulike faser av prosjektet?
    a. I såfall kan du beskrive dette?
    b. Hva mener du mangel på samhandling fører til?

9. Hva bruker du tid på i løpet av en typisk arbeidsuke?

    F.eks;

    a. Dokumentere krav til kunder
    b. administrasjon og rapportering
    c. vente på beslutninger fra kunde
    d. avklaringer med kunde
    e. møter
    f. håndtere endringer fra kunde
    g. tilbudsarbeid

10. Kan du si noe om hvor mye tid du bruker på å sikre at ditt firma sine interesser blir ivaretatt i relasjoner med kunden og underleverandører?

# Spørsmål – Kunde/byggherre

1. Bakgrunnsinformasjon
   a. Hva er din bakgrunn fra prosjektarbeid?
   b. Hvor mange år har du jobbet i prosjekter?
   c. Hva er din nåværende rolle?
   d. Hvilke type prosjekter er du nå involvert i?
   e. Hvilke andre prosjekter har du vært involvert i tidligere?

2. Kan du fortelle meg om noen prosjekter som etter din mening gikk skikkelig bra?
   a. Kan du gi meg noen nøkkeltall om prosjektet som sier noe om konteksten? Omsetning, varighet, deltagere
   b. Hvorfor tror du dette prosjektet lykkes så bra?
   c. Hvordan var samarbeidet med kunden i dette prosjektet?

3. Hva legger du i begrepet samhandling?

4. Kan du beskrive hvordan du opplever samhandling med leverandører?

5. Kan du gi meg noen eksempler fra prosjekter hvor samhandling med leverandøren var krevende.

6. Hva skal etter din mening til for å få god samhandling med leverandører?
   a. Hva gjør du for å oppnå god samhandling med leverandører?
   b. Hvor mye tid bruker du på dette?
   c. I hvilken grad opplever du å få noe igjen for tiden du bruker på å skape god samhandling.

7. Hva mener du mangel på samhandling fører til?

8. Opplever du at konfliktnivået forskjellig i ulike faser av prosjektet?
   a. I såfall kan du beskrive dette?
   b. Hva mener du mangel på samhandling fører til?

9. Hva bruker du tid på i løpet av en typisk arbeidsuke?

   F.eks;

   a. Spesifisere krav og lage underlag til leverandører
   b. administrasjon og rapportering
   c. vente på beslutninger
   d. avklaringer med leverandører
   e. møter
   f. endringshåndtering
   g. håndtere krav fra leverandører

10. Kan du si noe om hvor mye tid du bruker på å sikre at ditt firma sine interesser blir ivaretatt i relasjoner med leverandører?

## 9.2 Questionnaires applied by CII 10-10 benchmarking tool

The questionnaires used for data collection with the CII 10-10 benchmarking tool can be downloaded from the following website:

https://wikis.utexas.edu/display/CII1010/10-10+Questionnaires

# Part 2

## Scientific Papers

| ID | Paper | Publication status |
|---|---|---|
| Paper 1 | Haaskjold, H., Andersen, B., Lædre, O. & Aarseth, W. 2019.<br><br>“Factors affecting transaction costs and collaboration in projects” | Published in:<br><br>International Journal of Managing Projects in Business, Vol. 13(1), pp.197-230 |
| Paper 2 | Haaskjold, H., Andersen, B. & Langlo, J.A. 2020<br><br>“In search of Empirical Evidence for The Relationship between Collaboration and Project Performance” | Published in:<br><br>The Journal of Modern Project Management, Vol. 7(4), pp. 120-152 |
| Paper 3 | Haaskjold, H., Andersen, B., Langlo, J.A. & Aarseth, W. 2020.<br><br>“Follow the collaboration compass” | Accepted for publication (article in press) in:<br><br>International Journal of Project Organisation and Management |
| Paper 4 | Haaskjold, H., Andersen, B. & Langlo, J.A. 2020<br><br>“Dissecting the Project Anatomy: Understanding the Cost of Managing Construction Projects” | Revision submitted to:<br><br>Production Planning and Control |

# Paper 1

The current issue and full text archive of this journal is available on Emerald Insight at:
**www.emeraldinsight.com/1753-8378.htm**



# Factors affecting transaction costs and collaboration in projects

Haavard Haaskjold and Bjørn Andersen
*Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Trondheim, Norway*
Ola Lædre
*Department of Civil and Environmental Engineering, Norwegian University of Science and Technology, Trondheim, Norway, and*
Wenche Aarseth
*Business School, Nord University, Bodø, Norway*

Received 27 September 2018
Revised 5 February 2019
Accepted 13 March 2019

## Abstract

**Purpose** – Transaction costs in projects can be reduced through improved collaboration between contractors and clients. The purpose of this paper is to respond to the call for further research on the framework suggested by Li *et al.* (2015) who presented 26 factors that determine project transaction costs. The objective is to empirically test the framework to identify factors that have the greatest influence on project collaboration so that practitioners can prioritize their efforts on the most salient factors that will improve collaboration and reduce transaction costs.

**Design/methodology/approach** – The paper employed interviews with 38 project practitioners from three different industries in Norway. The respondents had in average 20 years of professional experience.

**Findings** – The quality of communication, project uncertainty, owner's organizational efficiency, change orders and trust were the five most frequently found factors that influence both project transaction costs and collaboration level. When the authors compared findings between different industries the authors found that the quality of communication was important for all industries. The owner's organizational efficiency was also highly important in oil and gas and ICT projects. Trust was particularly important in oil and gas projects while frequency of claims was particularly important in construction projects.

**Practical implications** – This paper identifies the five most important factors for project practitioners to prioritize in order to reduce transaction costs through improved collaboration.

**Originality/value** – The paper contributes to the conceptual theory of transaction costs and collaboration as it empirically tests and extends the framework developed by Li *et al.* (2015).

**Keywords** Transaction cost economics, Collaboration, Project management

**Paper type** Research paper

## 1. Introduction

On May 19, 2007, Chelsea footballer Didier Drogba scored the winning goal in the first FA cup final played at the new Wembley Stadium in London. If every 1 of the 90,000 spectators watching the game that day had donated £10 each, it would not be enough to even cover the cost of photocopying the legal documents of what became a notorious dispute between the main contractor responsible for building the stadium and its subcontractor. The case was finally settled in September 2008 after more than two years of hearings. At this point, the photocopying bill alone for printing case documents was £1m, and the total legal costs paid by the involved parties had risen to £22m. In the concluding section, Justice Jackson expresses his concern about the amount of resources spent:

> The final result of this litigation is such that, when costs are taken into account, neither party has gained any significant financial benefit. Instead large sums of costs and a large amount of management time have been expended on both sides for no useful purpose. (Jackson, 2008, p. 220)

This is a reminder that the cost of taking disputes to court can be high, as the parties invest significant resources in preparations for the hearings. The aim should be to prevent disputes and to resolve disagreement as soon as possible. The potential for reaching an agreement

International Journal of Managing Projects in Business
Vol. 13 No. 1, 2020
pp. 197-230
© Emerald Publishing Limited
1753-8378
DOI 10.1108/IJMPB-09-2018-0197

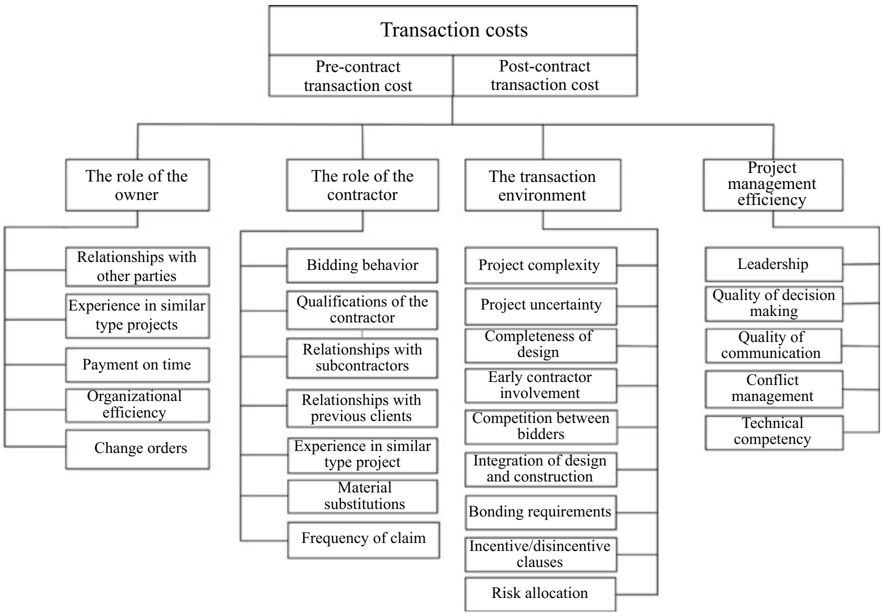
quickly is reduced proportionally to the amount of resources the parties invest in the dispute (CII, 1995). Money spent on dispute resolution is an example of transaction costs that do not add value and should be avoided (Lu *et al.*, 2015; Rajeh *et al.*, 2015; Lumineau and Quélin, 2012). Transaction costs are the "costs of running the economic system" (Arrow, 1969, p. 48) and Williamson describes this with the following illustration:

> In mechanical systems, we look for frictions: do the gears mesh, are the parts lubricated, is there needless slippage or other loss of energy? The economic counterpart of friction is transaction cost: do the parties to the exchange operate harmoniously, or are there frequent misunderstandings and conflicts that lead to delays, breakdowns and other malfunctions? (Williamson, 1981, p. 552)

The ability to prevent and resolve potential conflicts efficiently is related to the level of collaboration between the actors in the project (Dietrich *et al.*, 2010). The term collaboration has been defined by the Institute for Collaborative Working (ICW, 2017, p. 29): "Collaboration is a commitment between two or more parties to create value by striving to achieve shared competitive goals and operational benefit through a spirit of mutual trust and openness."

The purpose of this paper is to respond to the call for further research on the existing framework published by Li *et al.* (2015) of factors that determine transaction costs. The reason for using this framework is that it is based on a comprehensive literature review of existing project transaction cost research. Within this framework, shown in Figure 1, we will identify which of the 26 factors that determine transaction costs have the greatest influence on collaboration. This will help project practitioners to prioritize their efforts on factors that they can expect to have the most significant effect on collaboration leading to reduced transaction costs.

Through interviews with experienced project practitioners we address the three research questions listed below. We have chosen respondents from three different industries.




**Source:** Li *et al*. (2015, p. 550)

**Figure 1.** Determinants of transaction costs in construction projects

Hence, we follow the recommendation given by von Danwitz (2018) who has identified the need for more cross-industry research in future project management research:

*RQ1*. Which of the 26 transaction cost factors presented by Li *et al.* (2015) have the largest influence on collaboration in projects?

*RQ2*. What are the differences and similarities in the findings from projects in the construction industry, the ICT industry and oil and gas industry?

*RQ3*. What are the differences and similarities of the findings between the contractor perspective and the client perspective?

The research objective is to empirically test the framework developed by Li *et al.* (2015) to identify which factors that have the greatest influence on project collaboration so that practitioners can prioritize their efforts on the most salient factors that will improve collaboration and reduce transaction costs.

In the following sections of the paper we present the theoretical background followed by a description of the research method. Furthermore, we report, analyze and discuss findings followed by a conclusion where we describe implications and contributions from the research.

## 2. Theoretical background and literature review

The following section summarizes existing research on transaction cost theory and collaboration. Existing research on transaction costs in projects is limited and we identify a specific research gap related to factors that affect both transaction costs and collaboration.

### *2.1 Transaction costs*

The term transaction cost was introduced by Coase (1937) in The nature of the firm as the reason for why firms exists, and it is a foundation of the "New Institutional Economics" paradigm (Rindfleisch and Heide, 1997; Shelanski and Klein, 1995; Simon, 1991). Transaction cost theory was later expanded by Williamson (1971), who pointed out that people are sometimes opportunistic and will perform actions that are only in their own interest. Opportunism leads to transaction costs when it is combined with bounded rationality, uncertainty or high asset specificity (Williamson, 1985). Although transaction costs theory has had some critics, it has later been validated by strong empirical evidence (Macher and Richman, 2008; Lafontaine and Slade, 2007; Geyskens *et al.*, 2006; David and Han, 2004; Rindfleisch and Heide, 1997; Shelanski and Klein, 1995). In 2009 Oliver Williamson received the Nobel Prize in Economics for his work on the transaction cost theory (Kunglege-Vetenskaps-Akademien, 2009).

The transaction cost framework, shown in Figure 2, is based on a set of human factors and a set of environmental factors which are referred to as behavioral assumptions and transaction dimensions (Rindfleisch and Heide, 1997; Williamson, 1985).

Asset specificity describes the uniqueness, i.e. to which extent investments are locked and specific to a certain transaction (Williamson, 1981; Klein *et al.*, 1978). Bounded rationality relates to the limited capacity the human mind has to process information and solve complex problems (Simon, 1957), and opportunism is defined as "[…] Self-interest seeking with guile: agents who are skilled at dissembling realize transactional advantages" (Williamson, 1971, p. 255).

If bounded rationality and uncertainty are linked with opportunism, problems occur. Opportunistic agents can then exploit uncertainty to deceive others while pursuing their own interest (Williamson, 1975, 1985, 1996) by:

- provide incomplete information;
- disclosure of information; and
- calculated efforts to mislead, distort or confuse.

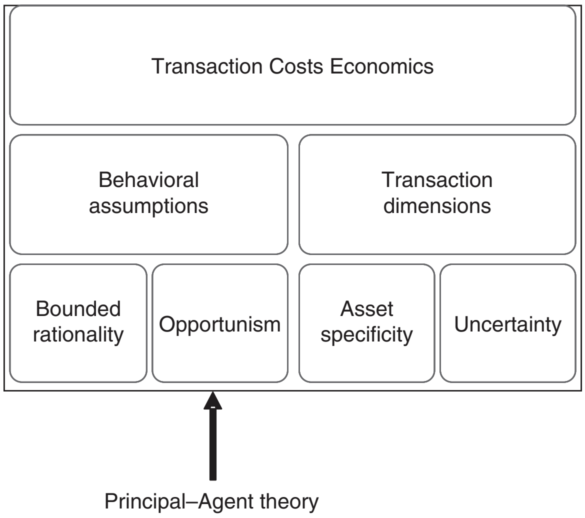



**Figure 2.**
Transaction cost framework

One should safeguard transactions against the threats from opportunism, and Williamson (1996) clarifies the assumption of opportunistic behavior by stating that:

> To assume, moreover, that human agents are opportunistic does not mean that all are continually given to opportunism. Rather, the assumption is that some individuals are opportunistic some of the time and that it is costly to ascertain differential trustworthiness *ex ante*. (Williamson, 1996, p. 48)

A summary of identified research on opportunistic behavior in projects after 1990 is presented in Table I. Opportunistic behavior has a negative effect on collaboration (Ning, 2018) and cause transaction costs (Ho *et al.*, 2015). Some contractors may choose to prepare opportunistic bids to win a job only to file a high number of claims to the client later (Mohamed *et al.*, 2011; Rooke *et al.*, 2004).

A low level of trust was found by Kadefors (2004) in client–contractor relationships in Swedish construction projects. These contractors were often found to be opportunistic and took advantage of mistakes, changes and omissions in contract documents in order to claim additional payment from the client. To prevent contractor opportunism, clients prepared detailed specifications in contract documents and closely monitored contractors during the

**Table I.**
Research published after 1990 on opportunistic behavior in client–contractor relations in projects

| Opportunistic behavior | Discussed by |
|---|---|
| *Opportunistic bidding*<br>Reduce margins in bids and seek profit recovery by claims<br>Submit unbalanced bids by exploiting information asymmetry | Nyström (2015), Mohamed *et al.* (2011), Arditi and Chotibhongs (2009), Tan *et al.* (2008), Lo *et al.* (2007), Ho and Liu (2004), Rooke *et al.* (2004), Ngai *et al.* (2002), Crowley and Hancher (1995), Zack (1993) |
| *Take advantage of uncertainty or mistakes by others*<br>Search for mistakes and omissions in principal's documentation to build claim<br>Take advantage of changes and variations to scope | You *et al.* (2018), Ho *et al.* (2015), Manu *et al.* (2015), Mandell and Nyström (2013), Pinto *et al.* (2009), Kadefors (2004) |
| *Strategic misrepresentation*<br>Use of false or misleading information to get acceptance for project<br>Withhold information on purpose | Andersen *et al.* (2016), Pinto (2013), Flyvbjerg (2005, 2009), Flyvbjerg *et al.* (2002) |

execution of the project. This lead to high transaction costs for the client. Similar findings are also presented by Pinto *et al.* (2009) who performed an empirical study of large construction projects in Canada and found that trust between actors contributes to reduced transaction costs.

With reference to the principal–agent theory, the term adverse selection is commonly used to describe the situation where information asymmetry between a principal and its agent leads to decisions that do not give the optimal result (Akerlof, 1970; Arrow, 1969). Such information asymmetry in a project may lead the client (principal) to choose a contractor (agent) that may in fact not turn out to be the best contractor for the job (Forsythe *et al.*, 2015; Müller and Turner, 2005). Often the contractor offering the lowest price is not the most favorable contractor for the client to choose in the long run (Lædre, 2014). In order to select the best contractor, both the organizational culture and the trustworthiness of potential bidders must be considered (Kadefors *et al.*, 2007). Another example of a situation where the client may need to safeguard its interests is small number bargaining. If the number of alternative contractors is low, a contractor may choose to utilize its bargaining power to claim a superior price (Levy, 1985; Klein *et al.*, 1978). Once a relationship between two parties exists, hold up-problems can occur as the contractor may try to hold up the client and re-negotiate a better deal (Klein *et al.*, 1978). Goldberg (1976) illustrates this with the mechanic who takes apart your car and then demands three times the agreed price to put it back together. Furthermore, incomplete contracts where the principal is not able to specify all details may lead to haggling problems with the contractor (Williamson, 1996). To safeguard its interest against a contactor that underperform or conduct work with poor quality, the client may need to monitor the execution of the contractor's work closely. This leads to shirking costs (Alchian and Demsetz, 1972).

Based on a review of existing literature, Li *et al.* (2015) synthesize factors that determine potential project transaction costs that the project owner may have to bear. These factors are grouped in four categories which are the role of the owner, the role of the contractor, the transaction environment and project management efficiency. In total, 26 determinants of transaction costs in projects are shown in Figure 1.

The owner's behavior affects the direct transaction costs but also has an indirect effect, as it has an impact on the uncertainty in the transaction environment. By involving contractors early, clearly defining the work scope, harmonizing relationships and making sure that risk allocation is fair between the parties, transaction costs borne by the owner can be reduced (Guo *et al.*, 2016; Li *et al.*, 2013). The contractor's behavior when bidding and executing the work is also found to impact the transaction costs borne by the owner (Li *et al.*, 2013).

Furthermore, high project management efficiency through leadership, good decision making, effective communication, proper conflict management and a high degree of technical competence helps to reduce these transaction costs (Li *et al.*, 2013).

### *2.2 Collaboration*

Project performance is positively related to collaboration (Um and Kim, 2018). Projects more often fail due to conflicts and cooperation issues rather than due to technical issues (Aarseth, 2014). The importance of organizational relations in projects has also been identified by others, such as (Ning and Ling, 2015; Young, 2015; Pinto, 2010; Davies *et al.*, 2009; Winter *et al.*, 2006).

Collaboration should create win–win situations and ensure that all parties gain economic advantages by participating. According to the synergy model by Bititci *et al.* (2007), the collaborating parties need to have a sufficient maturity level in order to be able to collaborate successfully and achieve such win–win situations.

The importance of carrying out self-assessment to verify an organization's readiness for collaboration is also recognized in the ISO 44001 Collaborative Business Relationships Management Systems standard, which was launched in 2017. This is the first international standard that addresses collaborative business relationships, and it supersedes the previous British standard "BS 11000 Collaborative Business Relations" (ICW, 2017). Empirical research presented by Chakkol *et al.* (2018) reveal how using such collaborative standards is useful to formalize the collaboration practices between clients and contractors in complex projects.

Collaborative project approaches include several types of relationship-based procurement methods such as partnering, integrated project delivery and alliancing. Among these approaches, alliancing is the highest order of relational contracting, and has a high level of both pain-share/gain-share incentives and early contractor involvement (Walker and Lloyd-Walker, 2015; Lahdenperä, 2012). In addition, soft elements such as trust, long-term commitment, cooperation and communication are also important to achieve a high extent of collaboration (Yeung *et al.*, 2007).

Relational aspects play an important role in the cooperation level between project actors (Benítez-Ávila *et al.*, 2018) and contractors are more willing to cooperate if they perceive the contract as fair (Song *et al.*, 2018). Recent research on client–contractor relations has found that success factors are cooperation, sharing of knowledge, mutual ability to adapt and learn, openness and trust (Biong *et al.*, 2016).

Contracts should be designed so that the interest of the client and the contractor is aligned in order to prevent opportunism (Eisenhardt, 1985). Contracts with fixed-price or cost-plus mechanism often have a negative impact on project collaboration between a principal and its agent (Müller and Turner, 2005). To foster cooperative behavior from its contractor(s), the client should use contract mechanisms that also take into account what contractors need and not only focus on what is best for themselves (Zhang, Fu and Kang, 2018).

The collaborative tool model follows the principle that information should be shared between parties, to better manage organizational complexity (Aarseth, 2014). Formal barriers that hinder parties from communicating can lead to conflicts (Vaaland and Håkansson, 2003), and proper communications is critical for project success (PMI, 2017; Kerzner, 1995).

### *2.3 Research gap – transaction costs and collaboration in projects*

Empirical research on transaction costs in projects is limited as shown in Table II. The number of studies is small and more research is needed (Guo *et al.*, 2016; De Schepper *et al.*, 2015; Li *et al.*, 2015; Rajeh *et al.*, 2015).

Pinto *et al.* (2009) encourage researchers to further investigate the relationship between trust and project transaction costs, and Li *et al.* (2015) call for further empirical research on the framework which contains factors that determine project transaction costs.

While there exists a fair amount of research on the various collaborative approaches (Eriksson, 2010; Yeung *et al.*, 2007), we have identified a research gap related to the relationship between collaboration and transaction costs in projects. We have not identified any existing research investigating which transaction cost factors in projects that influence collaboration the most.

**Table II.** Empirical research on transaction costs in projects

| Transaction costs in projects | Discussed by |
|---|---|
| Factors influencing transaction costs in projects | Guo *et al.* (2016), Li *et al.* (2015), Li *et al.* (2013), Ho and Tsui (2009), Lu *et al.* (2015) |
| Quantification of transaction costs in projects | Rajeh *et al.* (2015), De Schepper *et al.* (2015), Li *et al.* (2014), Dudkin and Välilä (2006), Antinori and Sathaye (2007), Farajian (2010), Halvorsen and Andersen (2015) |

In addition, von Danwitz (2018), who performed an extensive literature review of existing project management research, identified the need for more cross-industry research in the future, as most studies today are industry specific. Therefore, we believe it would be particularly useful to perform the study from a cross-industry perspective.

## 3. Methodology

The point of departure for our research is based on theory as we investigate an existing framework published by Li *et al.* (2015). We collect empirical data to explore and validate this framework through deduction (Bryman, 2016; Alvesson and Sköldberg, 2009).

In this paper, we explore the research questions through semi-structured interviews. Interviews allow the researcher to explore the research question in depth (Cassell, 2009). The reason for choosing a qualitative strategy using interviews instead of a quantitative strategy using a survey is that the interview gives us greater insight into the reason why the various respondents consider different factors important for collaboration. Through follow up questions we can explore the argumentation of the respondents and get a more meaningful understanding of the reason for their responses. Qualitative interviews are well-suited to explore experience of practice when opinions and experience are important for the research question (Bryman, 2016; Shepherd, 2015; Cassell, 2009). Interviews also give us the opportunity to identify if there are other factors that are important outside the 26 factors in the existing framework by Li *et al.* (2015). In a study of recent published articles on project management von Danwitz (2018) found that both qualitative and quantitative methods are commonly used as 49 percent of the contributions were qualitative, 31 percent quantitative, 15 percent conceptual, 4 percent mixed methods and 1 percent other used other methods.

### *3.1 Respondents*

Recruitment of respondents was mainly performed using purposive sampling (Bryman, 2016). The reason for using purposive sampling is to identify respondents that are relevant for our research questions rather than to recruit respondents on a random basis (Bryman, 2016). In addition, we used elements of snowball sampling (Bryman, 2016) as some respondents suggested names of other potential respondents that they claim have experience that is relevant to the research.

We searched for experienced practitioners that can explain matters comprehensively based on their own experience from many projects. From a total of 38 respondents, 34 held a role as a project manager or a project director. The respondents had on average 20 years of professional experience. All respondents were currently located in Norway, but several had international experience and most of the companies where respondents work operate in an international market.

In order to find answers to our second research question, we ensured that we recruited respondents from three different industries (Figure 3). We also ensured that we recruited respondents from both contractors and clients, thus making it possible to investigate both perspectives to find answers to our third research question. The respondents came from 13 different companies in Norway and worked in ICT projects, construction projects or oil and gas projects. From the total of 38 respondents, 29 worked for seven different companies categorized as contractors while 9 respondents worked for six different companies categorized as clients.

### *3.2 Saturation*

Following the idea of theoretical saturation by Glaser and Strauss (1967), we should perform interviews until we see that additional interviews do not provide any significant new theoretical understanding (Bryman, 2016). In an experiment performed by Guest *et al.* (2006),

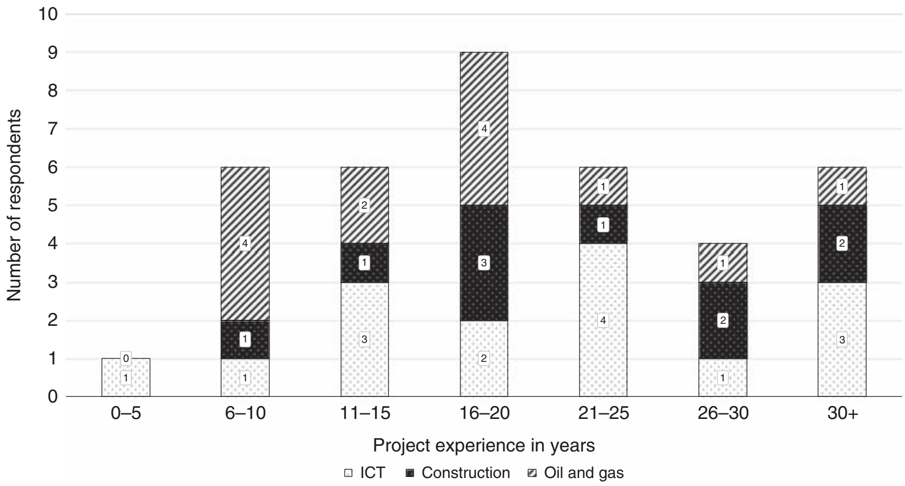
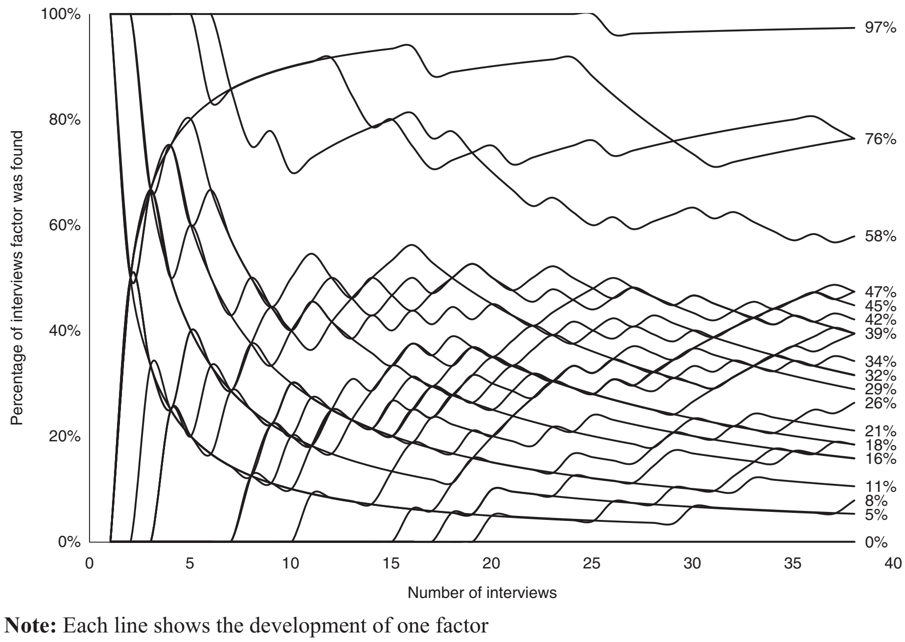



**Figure 3.**
Demographic distribution of respondents

it was found that saturation occurred after only 12 interviews and Crouch and McKenzie (2006) argue that a small number of cases (fewer than 20) is often sufficient. In a sample of 560 studies that used qualitative interviews, the average number of interviews was 31 (Mason, 2010).

In Figure 4 we present how our results saturated as the number of interview increased. Each line in the plot shows the development of 1 of the 26 factors. The vertical scale indicate percentage of interviews where factor was found. The purpose with this plot is not to show the results for all the 26 factors (detailed results are presented in section 4 of this paper),




**Note:** Each line shows the development of one factor

**Figure 4.**
How the results saturated as number of interviews increased

but rather to show how saturation occurred. Most results start to stabilize after the first 10–15 interviews. After 30 interviews, we have reached a point where it is fair to claim that most results are saturated. In total, we carried out interviews with 38 respondents.

### *3.3 Interview method*

An interview guide was established and two pilot interviews were conducted with colleagues to pre-test the questions in the interview guide (Bryman, 2016) as well as to practice interview skills (Buchanan and Bryman, 2009). Based on lessons learned from the pilot interviews, the interview guide was revised before interviews were initiated with the 38 respondents in this study.

The interviews were conducted as face-to-face meetings in order to get a more comprehensive impression (Bryman, 2016) and more accurate answers (Shuy, 2002) than what one could achieve through telephone or video calls. The location of the interview can affect the balance between the interviewer and the respondent (Herzog, 2005). Reluctant respondents may be more willing to share information if they are interviewed in an environment where they feel comfortable (Adler and Adler, 2001). Most of the interviews were therefore conducted in meeting rooms at the location where the respondents work.

Each interview lasted between 60 and 90 min. No audio-recording device was used and the interviewer took handwritten notes during the interview. Based on these notes, the interviewer wrote a summary of the interview and sent it to the respondent for verification the same day. All interviews were conducted by the same person in the period between October 2017 and January 2018.

There are many good reasons to audio-record interviews when performing qualitative research. Audio-recorded interviewing allows the researcher to examine the interviews in more detail. It also provides high accuracy and reduces the risk of bias from the interviewer. Furthermore, audio-recorded interviews allow other researchers to conduct secondary analysis later (Bryman, 2016). On the other hand, audio recording may cause respondents to be less willing to share information during the interview (Saunders *et al.*, 2009; Warren, 2002). Ultimately, the importance of interviewing respondents in a context where they were comfortable about sharing information was the main reason for choosing not to audio-record the interviews.

### *3.4 Ethical awareness and privacy*

Respondents who participate in interviews must be treated fairly (Bryman, 2016; Jonasson and Ingason, 2015). To protect the privacy of the participants, their identity and the name of their employer were anonymized. In addition, if respondents named specific clients, partners or shared confidential information, the interviewer ensured that such information was anonymized when writing the summary from the interview. This summary was submitted to the respondent for review and approval.

In Norway, the NSD Data Protection Official for Research is an agency that ensures that research is conducted according to Norwegian laws related to protection of the individual's right to privacy. The interview guide was therefore sent to the NSD Data Protection Official for Research for approval.

A one-page document with key information was sent to each participant prior to the interview. This document contained information about the purpose of the interview, details about the interview method and how anonymity would be ensured. Each respondent gave their written consent to participate in the interview based on these terms.

### *3.5 Data analysis and coding*

A written summary of each of the 38 interviews was stored in a database. These summaries were then imported into computer-assisted qualitative data analysis software (NVivo 11).

Such software is useful when coding data from a larger number of interviews. However, using such software may increase the risk of fragmentation and one should therefore have high awareness of the context when analyzing the data (Bryman, 2016). The process starts with basic coding by topic. We then then look for patterns and group codes across the interviews (Alvesson and Sköldberg, 2009; Ely *et al.*, 1997).

The 26 factors for transaction costs established by Li *et al.* (2015) were used for the coding. This framework was developed for determining transaction costs. In order to justify why these factors can be used for coding our interviews about collaboration we searched existing literature for factors affecting collaboration. As shown in Table III, we found that 25 of the 26 factors are discussed in existing literature. The only factor we could not find any supporting literature for was bonding requirements. Hence, we argue that the framework presented by Li *et al.* (2015) is suited for coding the interviews to study factors that affect collaboration.

This framework with 26 factors was not presented to the respondents before or during the interviews. The respondents were simply asked to describe factors that they regarded as influencing collaboration in their project(s), and what they did to protect their own interests from potential opportunistic behavior by others. Summaries from the interviews were then analyzed to identify sections where the respondents described factors influencing collaboration that corresponded with any of the 26 factors that determine transaction costs. Sections where such factors were found were then coded accordingly and we counted, for each code, the number of interviews in which each code occurred. For example, the code relationships with other parties occurred in 16 of the 38 interviews. This means that 16 of the 38 respondents discussed matters that fit this code when they described factors affecting collaboration in their projects.

### *3.6 Criticism of the research method*

With regard to validity and reliability, one can argue that the approach of analysis used has a potential for some source of error. There is a risk of misinterpretation since the researcher subjectively analyzed the interviews in a framework that was not presented to the respondents during the interview. On the other hand, if the framework had been presented to the respondents in the interview, and they had been asked to specifically rate each factor, for example by using a Likert scale, there is a risk that the respondents would have been influenced by this framework. Without the framework, and by answering open questions, respondents were more likely to describe factors that affected collaboration in their projects without being constrained by the existing framework. As a result of this, one new factor (that was not part of the existing framework) emerged from the interviews. Even though a subjective analysis creates a risk of misinterpretation, this approach was considered the best. Finally, to mitigate this potential source of error, findings from the interviews were later presented to two different groups of project managers. The first group consisted of 40 project managers working for an IT consulting company. The second group consisted of 18 project managers working for an oil company. Although we did not present the results for a specific group of construction project managers, some of the project managers in the two above mentioned groups had previously worked in the construction industry. The consensus from the feedback from the two groups was that the findings corresponded well with their experience as project practitioners, something that further validates our findings.

Quotations from the interviews have been used in the discussion section of this paper to underline important findings. Since no audio recording was used and the interviews were conducted in the Norwegian language, there are potential sources of error when presenting quotations from respondents.

Since the interviews were not audio recorded, there is increased risk of bias from the interviewer as well as potential lack of accuracy and misunderstandings. To mitigate this

| | Literature describing collaboration factors | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bond-Barnard *et al.* (2018) | Hietajärvi and Aaltonen (2018) | Hosseini *et al.* (2018) | Ahola *et al.* (2017) | Eriksson *et al.* (2017) | Hanna (2016) | Suprapto *et al.* (2015) | Walker and Lloyd-Walker (2015) | Boukendour and Hughes (2014) | Fulford and Standing (2014) | Jefferies *et al.* (2014) | Bond-Barnard *et al.* (2013) | Fellows and Liu (2012) |
| *Factors from Li et al. (2015)* | | | | | | | | | | | | | |
| The role of the owner | | | | | | | | | | | | | |
| Relationships with other parties | ✓ | | | | | | | ✓ | | | | | |
| Experience in similar type projects | | | | | | | | ✓ | | | | | |
| Payment on time | | | | | | | | | | | | | |
| Organizational efficiency | | ✓ | | ✓ | | | | | | | | | |
| Change orders | | | | | | | | ✓ | ✓ | ✓ | | | |
| The role of the contractor | | | | | | | | | | | | | |
| Bidding behavior | | | | | | | | | ✓ | | | | ✓ |
| Qualifications of the contractor | | | | ✓ | | | | | | | | | |
| Relationships with subcontractors | | | | | | | | ✓ | | ✓ | | | |
| Relationships with previous clients | | ✓ | | | | | | ✓ | | | | | |
| Experience in similar type project | | | | | | | | | | | ✓ | | |

(*continued*)

**Table III.** Literature where factors are found to influence collaboration

**Table III.**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material substitutions | | | | ✓ | | | | ✓ | | | | |
| Frequency of claims | | | | | | | | ✓ | ✓ | | | |
| The transaction environment | | | | | | | | | | | | |
| Project complexity | | ✓ | | | ✓ | | | ✓ | | | | |
| Project uncertainty | | | | | | | | ✓ | ✓ | | | ✓ |
| Completeness of design | | | | | | | | ✓ | ✓ | ✓ | | |
| Early contractor involvement | | | ✓ | | | | | ✓ | | | | |
| Competition between bidders | | | | | | | | | ✓ | | | |
| Integration of design and construction | | | | | | | | ✓ | | ✓ | | |
| Bonding requirements | | | | | | | | | | | | |
| Incentive/ disincentive clauses | ✓ | | | | | | | ✓ | ✓ | | | |
| Risk allocation | | | | | | | | ✓ | ✓ | | | |
| Project management efficiency | | | | | | | | | | | | |
| Leadership | | ✓ | | | | | ✓ | ✓ | | | | |
| Quality of decision making | | ✓ | | | | ✓ | | ✓ | | | | |
| Quality of communication | | ✓ | | | | | ✓ | ✓ | | | | ✓ |
| Conflict management | ✓ | | | | | | ✓ | ✓ | | | | |
| Technical competency | | | | ✓ | | | | ✓ | | ✓ | | |

(*continued*)

| | Literature describing collaboration factors | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Patel *et al.* (2012) | Cho and Ballard (2011) | Love *et al.* (2011) | Dietrich *et al.* (2010) | Eriksson (2010) | Bresnen (2007) | Kadefors *et al.* (2007) | Bayliss *et al.* (2004) | Kadefors (2004) | Duarte and Davies (2003) | Tjosvold *et al.* (2003) | Hoegl and Gemuenden (2001) |
| *Factors from Li et al. (2015)* | | | | | | | | | | | | |
| The role of the owner | | | | | | | | | | | | |
| Relationships with other parties | ✓ | | | | | ✓ | | | | | | |
| Experience in similar type projects | ✓ | | | | | ✓ | | | ✓ | | | |
| Payment on time | | | ✓ | | | | | | | | | |
| Organizational efficiency | ✓ | | | | | ✓ | | | | | | |
| Change orders | | | ✓ | | | | | | ✓ | | | |
| The role of the contractor | | | | | | | | | | | | |
| Bidding behavior | | | | | ✓ | | ✓ | | | | | |
| Qualifications of the contractor | ✓ | | | | | ✓ | | | | | | |
| Relationships with subcontractors | ✓ | | | | ✓ | ✓ | | | | | | |
| Relationships with previous clients | ✓ | | | | | ✓ | | | | | | |
| Experience in similar type project | ✓ | | | | | ✓ | | | | | | |

(*continued*)

**Table III.**

Table III.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Material substitutions | ✓ | | | | | | | | | | |
| Frequency of claims | | | | | | | ✓ | ✓ | | | |
| The transaction environment | | | | | | | | | | | |
| Project complexity | ✓ | | | | | | | | | | |
| Project uncertainty | ✓ | | | | | | | ✓ | | | |
| Completeness of design | | | | | | | | ✓ | | | |
| Early contractor involvement | | | | | | | | | | | |
| Competition between bidders | | | | | | ✓ | | | | | |
| Integration of design and construction | | ✓ | | | ✓ | | | | | | |
| Bonding requirements | | | | | | | | | | | |
| Incentive/disincentive clauses | ✓ | | ✓ | | ✓ | ✓ | ✓ | | | | |
| Risk allocation | ✓ | | ✓ | | | ✓ | | | | | |
| Project management efficiency | | | | | | | | | | | |
| Leadership | ✓ | | | | | | | | | | ✓ |
| Quality of decision making | ✓ | | | | | | | | | | |
| Quality of communication | ✓ | | | ✓ | | | | | | | ✓ |
| Conflict management | ✓ | | | ✓ | | | | | ✓ | ✓ | |
| Technical competency | ✓ | | | | | ✓ | | | | | |

weakness, the interviewer wrote a summary of the interview on the same day and returned it to the respondent for approval. Each respondent was asked to review the summary and correct mistakes or clarify misunderstandings.

The ratio of approximately 3:1 between respondents from the contractor perspective and the client perspective gives reason to expect that findings from this study are influenced more by contractors than by clients.

With regard to external validity, the study was only performed on Norwegian projects. However, several respondents had international experience and many of the companies where the respondents work operate in an international market.

## 4. Findings

The following section reports how frequently the 26 different factors, from the framework proposed by Li *et al.* (2015) are found in the interviews. Table IV shows the detailed finding from each interview.

We sort the results in Table IV as we in Sections 4.1 through 4.4 present detailed findings for each of the factors that describes the role of the owner (Figure 5), the role of the contractor (Figure 6), the transaction environment (Figure 7) and project management efficiency (Figure 8). Each of the above mentioned four figures contains three plots. The left bar chart shows the percentage from all 38 respondents that identified each factor (*RQ1*), while the two other charts separate the findings by industry (*RQ2*) and role (*RQ3*). In Section 4.5, we provide a summary of the findings as well as describing how one new factor emerged from the interviews.

### *4.1 The role of the owner*

Relationship with other parties describes the level of stability that the owner has in his/her relationship with other third parties (Li *et al.*, 2015). Sections found in 16 of the 38 interviews described this. It was most frequently identified in interviews with respondents from the oil and gas industry (54 percent). From respondents working in construction projects and ICT projects the numbers were 50 percent and 27 percent, respectively. For the contractor perspective, the number was 45 percent, and the number was 33 percent for the client perspective.

Experience in similar type projects relates to the ability the project owner has to implement lessons learned from previous projects, (Li *et al.*, 2015) and it was found in 11 of the 38 interviews. It was only identified in 1 of the 13 interviews with respondents from oil and gas projects, while it was identified in 40 percent of interviews related to ICT respondents. For construction projects, the number was also 40 percent. It was identified in 34 percent of the interviews with contractors and in 11 percent of the interviews with clients.

Payment on time is related to the owner's ability to pay contractors on time (Li *et al.*, 2015). This was not identified in any interviews with respondents in ICT or oil and gas projects, while it was found in two interviews with respondents from the construction industry. Consequently, only 5 percent of the 38 interviews included this factor, making it one of the least frequently found factors for collaboration. It was found in 3 percent of interviews with contractors and 11 percent of the interviews with clients.

Organizational efficiency describes the stability in the owner's organizations (Li *et al.*, 2015). In total, it was identified in 29 of the 38 interviews and it is one of the three factors most frequently found in the interviews. It was identified in all of the 13 interviews with respondents working in oil and gas projects, but only in 30 percent for construction projects. For ICT projects, it was found in 13 of 15 interviews. The number from the contractor perspective was 72 vs 89 percent from the client perspective.

Change orders will be issued more frequently by the owner if the scope of work is not clearly specified (Li *et al.*, 2015). This was identified in 58 percent of all the interviews.

| Respondents | | | Factors found in interview | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Respondent ID | Respondent Industry | Respondent Role | Relationships with other parties | Experience in similar type projects | Payment on time | Organizational efficiency | Change orders | Bidding behavior | Qualifications of the contractor | Relationships with subcontractors | Relationships with previous clients | Experience in similar type project | Material substitutions | Frequency of claims | Project complexity | Project uncertainty | Completeness of design | Early contractor involvement | Competition between bidders | Integration of design and construction | Bonding requirements | Incentive/disincentive clauses | Risk allocation | Leadership | Quality of decision making | Quality of communication | Conflict management | Technical competency | Trust |
| 1 | ICT | Contractor | | | | ✓ | ✓ | | | | | | | ✓ | | ✓ | ✓ | | | ✓ | | | | ✓ | | ✓ | | | |
| 2 | ICT | Contractor | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | | |
| 3 | ICT | Contractor | ✓ | | | ✓ | ✓ | ✓ | | ✓ | | | | | | ✓ | | ✓ | | | | | ✓ | ✓ | | ✓ | | | |
| 4 | ICT | Contractor | | | | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| 5 | ICT | Contractor | | | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | | | | | | | | ✓ | | ✓ | | | |
| 6 | ICT | Contractor | | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | | | | | | ✓ | ✓ | | |
| 7 | ICT | Contractor | | | | ✓ | | | | | | | | | | ✓ | | ✓ | | | | | | | | ✓ | | | ✓ |
| 8 | ICT | Contractor | | ✓ | | ✓ | | | ✓ | | | ✓ | | | ✓ | ✓ | | | | | | | ✓ | | | ✓ | | | |
| 9 | ICT | Contractor | | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | ✓ | | | |
| 10 | Oil and Gas | Client | | | | ✓ | | ✓ | | | | | | ✓ | | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 11 | Oil and Gas | Client | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | | ✓ | | | ✓ |
| 12 | Oil and Gas | Contractor | | | | ✓ | ✓ | ✓ | | | ✓ | | | | | ✓ | ✓ | | | ✓ | | | | | ✓ | ✓ | | | ✓ |
| 13 | Oil and Gas | Contractor | ✓ | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | | | | | ✓ | ✓ | | | ✓ |
| 14 | Oil and Gas | Contractor | ✓ | | | ✓ | ✓ | | ✓ | | | | | | | | ✓ | | | | | | | ✓ | | ✓ | | | ✓ |
| 15 | Oil and Gas | Contractor | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | | | | | ✓ | ✓ | ✓ | | ✓ | | | | | ✓ | ✓ | | | ✓ |
| 16 | ICT | Client | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | | ✓ | | | ✓ | | ✓ | ✓ | | | ✓ | | | ✓ |
| 17 | ICT | Client | | | | | | | | | ✓ | | | | | | | ✓ | | | | | | ✓ | | ✓ | ✓ | | ✓ |
| 18 | Construction | Client | | | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | ✓ | | ✓ | | | |
| 19 | Construction | Contractor | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | | | ✓ | | ✓ | | | | ✓ | | ✓ | | ✓ | | ✓ | | | ✓ |
| 20 | Construction | Client | | | ✓ | ✓ | | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | | | | ✓ | | ✓ | |
| 21 | ICT | Contractor | | ✓ | | ✓ | | | | | | | | | ✓ | | | ✓ | | ✓ | | ✓ | | | | ✓ | | | |
| 22 | ICT | Contractor | | ✓ | | ✓ | | | | | | | | | | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | | | |
| 23 | ICT | Contractor | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | | | | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | | ✓ | ✓ | | |
| 24 | ICT | Contractor | ✓ | ✓ | | ✓ | | | ✓ | ✓ | | | ✓ | | | ✓ | ✓ | | | | | | | | | ✓ | | | ✓ |
| 25 | Construction | Contractor | | | | | | | | | | | | | | ✓ | ✓ | | | ✓ | | | | | ✓ | ✓ | | | |
| 26 | Construction | Contractor | ✓ | ✓ | | | ✓ | ✓ | | | ✓ | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | | | | | | | ✓ |
| 27 | Construction | Contractor | ✓ | | | | | ✓ | ✓ | | | | | | | ✓ | | | | | | | | ✓ | | ✓ | | | |
| 28 | Construction | Contractor | | | | | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | | | | | | ✓ | | | |
| 29 | Construction | Contractor | | ✓ | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | | | | | | | ✓ | ✓ | | ✓ |
| 30 | Construction | Contractor | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | | | | ✓ | | | ✓ |
| 31 | Construction | Contractor | ✓ | | | | | | | | | | | | | ✓ | | ✓ | | | | ✓ | | | | ✓ | | | ✓ |
| 32 | Oil and Gas | Contractor | ✓ | | | ✓ | ✓ | | | | ✓ | | | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ |

**Table IV.**
Detailed findings from interviews (*RQ1*/*RQ2*/*RQ3*)

*continued*

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | Oil and Gas | Contractor | ✓ | | | ✓ | | | | ✓ | ✓ | | ✓ | | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | | | ✓ |
| 34 | Oil and Gas | Contractor | | | | ✓ | | ✓ | | | ✓ | | | | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | | | ✓ | | | ✓ |
| 35 | Oil and Gas | Client | ✓ | | | ✓ | | | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | | | ✓ |
| 36 | Oil and Gas | Client | | | | ✓ | ✓ | | | | ✓ | | | | | ✓ | | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | | | ✓ |
| 37 | Oil and Gas | Client | ✓ | | | ✓ | | | | | ✓ | | | | | | | | ✓ | ✓ | | ✓ | ✓ | | | ✓ | | | |
| 38 | Oil and Gas | Contractor | | | | ✓ | ✓ | | | | | | | | | | | | | | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ |
| *RQ1 – all respondents* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| All respondents (38) | | | 16 | 11 | 2 | 29 | 23 | 15 | 12 | 8 | 15 | 6 | 4 | 12 | 7 | 29 | 15 | 17 | 7 | 18 | 0 | 15 | 13 | 18 | 10 | 37 | 6 | 3 | 21 |
| *RQ2 – industory specific* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ICT respondents (15) | | | 4 | 6 | 0 | 13 | 9 | 5 | 6 | 3 | 5 | 2 | 1 | 3 | 5 | 11 | 7 | 5 | 0 | 4 | 0 | 4 | 7 | 7 | 1 | 15 | 4 | 1 | 4 |
| Construction respondents (10) | | | 5 | 4 | 2 | 3 | 5 | 5 | 4 | 4 | 3 | 2 | 2 | 6 | 2 | 9 | 3 | 5 | 2 | 5 | 0 | 5 | 1 | 3 | 1 | 9 | 1 | 1 | 5 |
| Oil and Gas respondents (13) | | | 7 | 1 | 0 | 13 | 8 | 5 | 2 | 1 | 7 | 2 | 1 | 3 | 0 | 9 | 5 | 7 | 5 | 9 | 0 | 6 | 5 | 8 | 8 | 13 | 1 | 1 | 12 |
| *RQ3 – role specific* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contractor respondents (29) | | | 13 | 10 | 1 | 21 | 18 | 11 | 8 | 8 | 10 | 4 | 2 | 7 | 4 | 23 | 13 | 13 | 5 | 12 | 0 | 10 | 9 | 12 | 7 | 28 | 4 | 2 | 15 |
| Client respondents (9) | | | 3 | 1 | 1 | 8 | 4 | 4 | 4 | 0 | 5 | 2 | 2 | 5 | 3 | 6 | 2 | 4 | 2 | 6 | 0 | 5 | 4 | 6 | 3 | 9 | 2 | 1 | 6 |

**Table IV.**

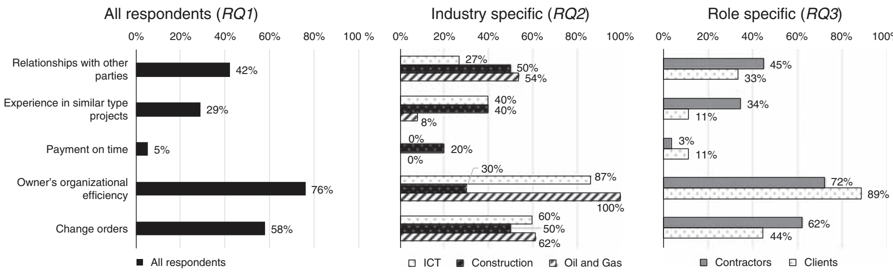



**Figure 5.** The role of the owner – percentage of interviews where factor was found

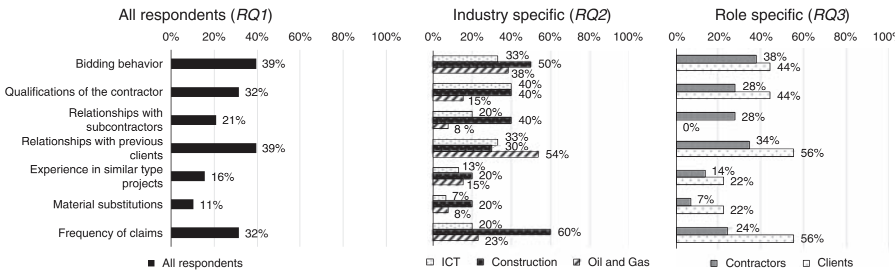



**Figure 6.** The role of the contractor – percentage of interviews where factor was found

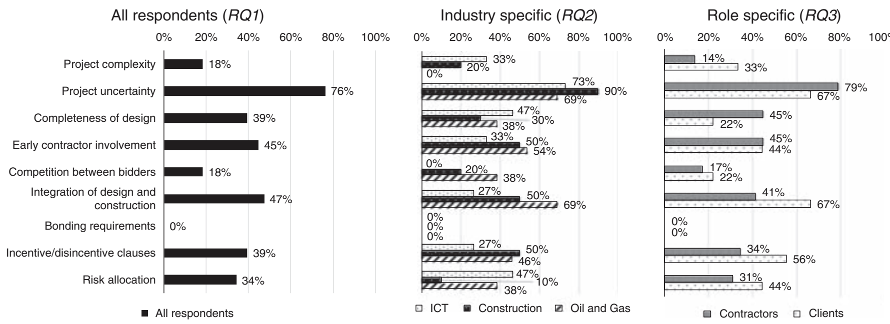



**Figure 7.** The transaction environment – percentage of interviews where factor was found

The variation between the respondents from ICT projects, construction projects and oil and gas projects was low as the numbers were 60, 50 and 62 percent, respectively. From the contractor side, 62 percent of interviews included this, while the corresponding number was 44 percent for the clients.

### 4.2 *The role of the contractor*

Bidding behavior is related to the issue if contractors speculate in bidding below cost to win a job (Li *et al.*, 2015) and it was discussed in 39 percent of all the interviews. There was some variation between the respondents from the three different industries. It was identified in 50 percent of construction projects, 33 percent of ICT projects and in 38 percent of the interviews with respondents working with oil and gas projects. The difference between the contractor perspective and the client perspective was small, 38 vs 44 percent.

Qualifications of the contractor describe the contractors' capability to do the work without the need for close monitoring by the owner (Li *et al.*, 2015). It was identified in 12 of the 38 interviews. However, it was only found in 15 percent of the interviews from oil and gas projects, as opposed to ICT projects and construction projects where this number was 40 percent. From the contractor perspective, the number was 28 percent while it was found in 44 percent of the interviews with respondents holding a client role.

Relationships with subcontractors refer to the question if the contractor has a long and stable relationship with its preferred subcontractors (Li *et al.*, 2015). This factor was identified in only 8 of the 38 interviews. It was most frequently found for construction projects (40 percent) followed by ICT projects (20 percent) and least frequently for oil and gas projects with only 8 percent. It was identified in 28 percent of the interviews with respondents working for contractor companies, but in none of the interviews with clients.

Relationships with previous clients refer to the track record for the contractor and how satisfied other clients have been when they used the contractor in the past (Li *et al.*, 2015). This factor was identified in 15 of the 38 interviews. It was most frequently found in oil and gas projects (54 percent). In comparison, this number was 33 percent for ICT projects and 30 percent for construction projects. It was identified in 34 percent of the interviews with contractors and in 56 percent of the interviews with clients.

Material substitutions refer to the flexibility the client gives to the contractor to identify its own solutions rather than what is specified by the client (Li *et al.*, 2015). This factor was only found in 4 of the 38 interviews. It was least frequently found in interviews with respondents from ICT projects (7 percent) and oil and gas projects (8 percent). For construction projects, the corresponding number was 20 percent. It was identified in 7 percent of interviews with contractors and in 22 percent of interviews with clients.

Frequency of claims refers to how often contractors claim extra payment from the client (Li *et al.*, 2015). This was identified in 32 percent of the interviews. The majority of these were found in interviews with respondents working in construction projects (60 percent).

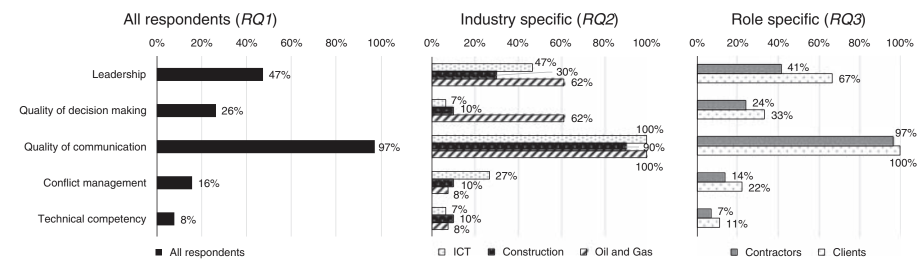



**Figure 8.**
Project management efficiency – percentage of interviews where factor was found

This is far more frequent than in the interviews with respondents in ICT projects or oil and gas projects where the corresponding numbers were 20 and 23 percent. From the contractor perspective, it was identified in 24 percent of the interviews while it was found in 56 percent of the interviews with clients.

*4.3 The transaction environment*

Project complexity refers to whether the environment in which the project is conducted is stable or not (Li *et al.*, 2015), and it was identified in only 18 percent of all the interviews. While it was not identified in any of the interviews with respondents from oil and gas projects, it was found in one-third of the interviews with respondents from ICT projects and in 20 percent of the construction projects. It was identified in 14 percent of the interviews with contractors and in 33 percent of the interviews with clients.

Project uncertainty relates to the amount of information, such as drawings and specifications that is available to perform the task (Li *et al.*, 2015). It was found in 29 of the 38 interviews there was some variation in frequency between the three industries. For respondents working in construction projects the number was 90 percent, compared to 73 percent for ICT projects and 69 percent for oil and gas projects. The number for contractors was 79 percent while the corresponding number for clients was 67 percent.

Completeness of design describes how well the client has defined the project (Li *et al.*, 2015). This was identified in 39 percent of the interviews. It occurred most frequently in interviews with respondents from ICT projects (47 percent). In oil and gas projects, this number was 38 percent and it was 30 percent in construction projects. This factor was identified in 45 percent of the interviews with contractors and in 22 percent of the interviews with clients.

Early contractor involvement relates to if the client includes the contractor at the design stage (Li *et al.*, 2015), and it was found in 45 percent of the interviews. It was identified in 54 percent of the interviews with respondents working with oil and gas projects and in 50 percent of the interviews with respondents from construction projects. For ICT projects, this number was 33 percent. There was only a minor difference between the contractor perspective and the client perspective on this matter, 45 vs 44 percent.

Competition between bidders describes whether there are several contractors bidding for the job or whether there are few or only one potential candidates (Li *et al.*, 2015). This factor was identified in 7 of the 38 interviews. It was not identified in any of the 15 interviews with people working with ICT projects as opposed to oil and gas projects, where this number was 38 percent. The corresponding number for construction projects was 20 percent. It was identified in 17 percent of the interviews with contractors and in 22 percent of the interviews with clients.

Integration of design and construction relates to how integrated the interface between design and construction is in a project (Li *et al.*, 2015). This topic was discussed in 47 percent of the interviews. It was found in 69 percent of the interviews with people working in oil and gas projects, while the corresponding number for ICT projects was less than half of this (27 percent). For construction projects, the number was 50 percent. It was identified in 41 percent of the interviews with contractors and in 67 percent of the interviews with client.

Bonding requirements refer to situations where the client uses financial instruments (third party guarantee) to buy protection against opportunistic behavior from contractors (Li *et al.*, 2015). This was not identified as a factor that influences collaboration in any of the 38 interviews.

Incentive/disincentive clauses relate to the use of contract clauses to encourage contractors to deliver as agreed (Li *et al.*, 2015). This was identified in 39 percent of the interviews. The variation between oil and gas projects and construction projects was small, 46 vs 50 percent. For respondents working with ICT projects this number was 27 percent.

This factor was found in 34 percent of the interviews with contractors and in 56 percent of the interviews with clients.

Risk allocation relates to how risk is allocated between client and contractor (Li *et al.*, 2015). This factor was identified for one-third of the 38 interviews. It was found in 47 percent of the interviews from ICT projects and in 38 percent of the oil and gas projects. However, for respondents working in construction projects, it was only found in 1 of the 10 interviews. The factor was found in 31 percent of the interviews with contractors and in 44 percent of the interviews with clients.

### *4.4 Project management efficiency*

Leadership refers to the skills of the project manager (Li *et al.*, 2015). This was identified in 47 percent of the interviews. The highest frequency was found in oil and gas projects (62 percent). In construction projects, the number was 30 percent, compared to 47 percent for ICT projects. It was found in 41 percent of interviews with contractors and in 67 percent of the interviews with clients.

Quality of decision making is related to the process of making good decisions in projects (Li *et al.*, 2015). It was mentioned in less than one-third of the interviews (26 percent). It occurred in only 1 of the 15 interviews from ICT projects and in only 1 of the 10 interviews from construction projects. However, in interviews with respondents working in oil and gas projects, it was identified in 62 percent of the interviews. The factor was found in 24 percent of the interviews with contractors and in 33 percent of the client interviews.

Quality of communication is the factor that was most frequently found, as it was identified in 37 of the 38 interviews. It was found in all the interviews with respondents working in oil and gas- or ICT projects, and in 90 percent of the interviews with respondents working in construction projects. The factor was identified in 97 percent of the interviews with contractors and in in all of the interviews with clients.

Conflict management describes the organization's capability of preventing and resolving conflicts (Li *et al.*, 2015). It was only identified in 16 percent of all the interviews. For construction projects, the number was only 10 percent, and for oil and gas projects, this number was even lower (8 percent). For ICT projects this number was approximately three times higher, as the factor was identified in 27 percent of the interviews. It was found in only 14 percent of the interviews with contractors and in 22 percent of the interviews with clients.

Technical competency is related to the technology and equipment available to the contractor (Li *et al.*, 2015). This was only identified in 3 of the 38 interviews and was the third least frequent factor found.

### *4.5 Summary of findings*

A summary of the findings is shown in Figure 9 and in more detail in Table IV. We see that 25 of the 26 factors from (Li *et al.*, 2015) were identified by two or more respondents. However, none of the respondents identified bonding requirements as a factor that influences collaboration. During the interviews, trust appeared as a factor although is not listed as an explicit factor in the framework by (Li *et al.*, 2015). In fact, 21 of our 38 respondents emphasized the importance trust has on collaboration.

## 5. Analysis and discussion

The purpose of conducting the interviews was to identify which factors that determine transaction costs that has the largest influence on collaboration. We analyzed 38 interviews and searched for sections where the respondents discussed topics that correspond with factors that, according to Li *et al.* (2015), determine transaction costs. In the following section, we will first discuss briefly one factor (bonding requirements) that vanished during

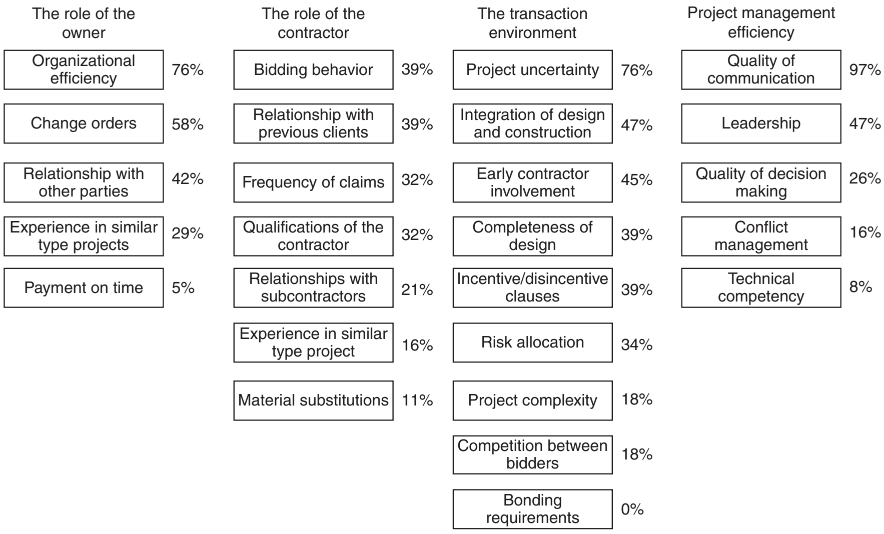



**Figure 9.**
*RQ1* – the percentage of interviews in which each factor from (Li *et al.*, 2015, p. 550) was found to influence project collaboration

the coding and the appearance of a new factor (trust) that was not in the original framework. We will then discuss findings related to each of the three research questions.

Bonding requirements was the only of the factors in the framework that did not occur in any of our interviews (Table IV). Li *et al.* (2015) describe bonding requirements as the use of financial instruments to purchase protection to secure own interests against opportunism. Costs associated with this are the examples of transaction costs. From Table III, we also see that we failed to find existing literature where other researchers have identified such bonding requirements as a factor affecting collaboration. Hence, it is not surprising that this factor vanished when we used a framework with transaction cost factors to investigate collaboration.

One can argue that trust is an underlying element of several of the factors in the framework shown in Figure 1. However, it is not considered as a separate factor by Li *et al.* (2015). The impact of trust in the relationship between clients and contractors has been established by others such as Pinto *et al.* (2009) and Kadefors (2004). We found that 21 of 38 interviewees in our study suggested trust as a factor that influences project collaboration. This is also in line with findings from previous research, which have found a strong relationship between trust and collaboration (Bond-Barnard *et al.*, 2018; Ibrahim *et al.*, 2015).

### *5.1 RQ1: most important factors*

The Pareto principle describes how only a few (of many) elements account for a large proportion of the effect. This is often referred to as the 80/20 principle, where 20 percent of the variables cause 80 percent of the results (Nisonger, 2008; Koch, 1997). This phenomenon is "universal" and is transferable to management planning and control (PMI, 2017; Juran, 1954). Based on the 80/20 principle, we present, in Figure 10, the 5 factors most frequently found from Table IV, as 5 factors corresponds to 20 percent of the 26 factors we investigated ($0.2 \times 26 = 5.2$)

Among the factors that determine transaction costs in projects, we found that quality of communication is the one that has the highest influence on project collaboration. This is in line with existing research, where effective communication has been identified as a factor which

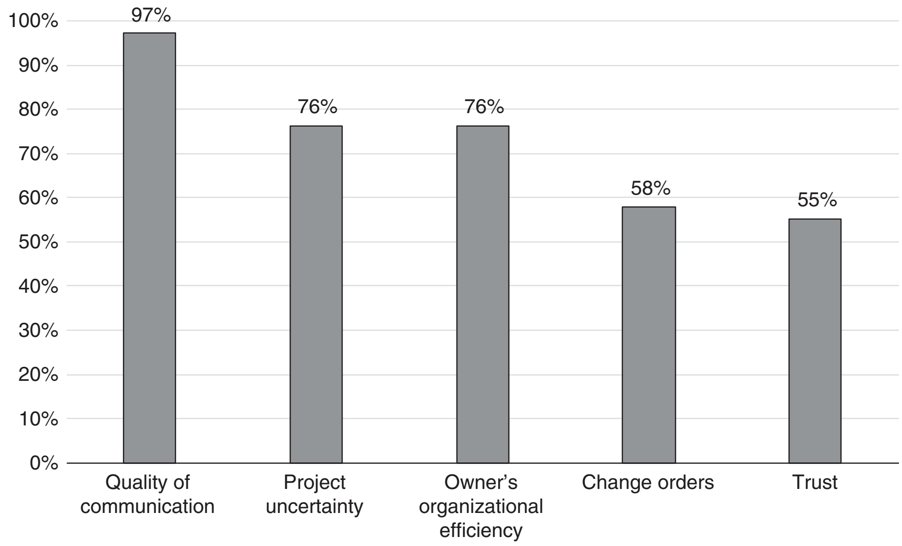



**Figure 10.**
*RQ1* – five most salient factors that influence collaboration

influence collaboration quality (Aliakbarlou *et al.*, 2018; Nevstad *et al.*, 2018; Yap *et al.*, 2017; Dietrich *et al.*, 2010). Incomplete or poor communication may cause misunderstandings and lead to potential conflicts (Lædre, 2009):

> We make a lot of assumptions. We even assume that the client is happy. And then when we receive the final evaluation report from the client when the project is complete we are criticized for not involving the client. Why do we wait until the end of the project to find out that the client preferred to be involved? We need to clarify expectations continuously but we are afraid to wake up the troll. We are afraid to ask! (contractor, construction project)

High communication willingness and formal project communication contribute to trust (Costa e Silva *et al.*, 2012) and project success (Wu *et al.*, 2017). Informal communication can be an effective manner to discuss and find solutions (Christensen, 2008). Turner and Müller (2004) argue that the best results occur by balancing formal and informal communication. This is in line with our findings where interviewees described how frequent the use of telephone and face-to-face meetings was often the preferred solution for resolving problems. The agreed solution was formalised through the use of formal project communication (i.e. e-mail, letter, memo) after the solution was found.

It is not surprising that project uncertainty affects project collaboration, as it is critical to have a clear understanding of the scope of work to achieve success in a project (PMI, 2017). High uncertainty increases the need to collaborate in order to prevent project actors from becoming opportunistic (Um and Kim, 2018; You *et al.*, 2018). In fact, several of the interviewees in our study gave examples of how uncertainty and unclear scope of work caused misunderstandings and extra work:

> Out of 1,000 hours spent on the project so far, 300 of these are wasted caused by an unclear scope. (contractor, ICT project)

In the early phase of a project, there is a lot of information that is not available. It was therefore particularly interesting to find that those of the interviewees who worked in projects with pain-share/gain-share models reported that such models helped to reduce information asymmetry and uncertainty, as they experienced a high level of openness and willingness to share information between the parties.

Another important finding was related to the owner's organizational efficiency. The need for the client to be actively involved in the project was highlighted by several respondents and, in particular, by those working in agile projects. One of the requirements for success in agile project management is to have dedicated clients on site that work closely with the contractor (Azanha *et al.*, 2017; Lappi and Aaltonen, 2017). Several of the interviewees confirmed this, as they reported how lack of active involvement from the client had a negative effect on the collaboration in their project:

> The sprint process requires the client to take important decisions on a daily basis in the projects. For this to work, persons with sufficient authority to make these decisions must be released from other tasks in the client's organization and participate full time in the project. (contractor, ICT project)

The client's representative must have the right mandate within his/her organization in order to allow the contractor to perform their task efficiently. Several of the contractor–respondents in the interviews described situations where they were in agreement with the representative from the client, only to find out later that this person did not have the mandate or authority within his or her own organization to make such decisions. Other examples of low organizational efficiency included examples of internal conflicts in the client's organization:

> In this project we learned that there were internal conflicts in the client's organization which was split between two cities. This was challenging as we were depending on a good relationship with the client in order to deliver a good solution. For example, some people in the client's organization requested that we should not work with specific persons in their organization located in another city, even though these persons had the key competence required in order to get a good result. (contractor, ICT project)

Opportunistic contractors may choose to lower their margins and reduce their price in order to increase their chances of winning the contract with a client (Mohamed *et al.*, 2011; Arditi and Chotibhongs, 2009; Tan *et al.*, 2008) and thus speculate that they will recover the loss later through change orders and claims (Lo *et al.*, 2007; Crowley and Hancher, 1995; Zack, 1993). Contractors with more detailed information and knowledge than the client may exploit this situation of asymmetric information (Mandell and Nyström, 2013) and issue many change orders during the project. Our findings are in line with existing research as we found that opportunistic change orders have a negative effect on the collaboration level in the contractor–client relationship:

> Some contractors take advantage of our lack of detailed knowledge about their field of expertise in order to earn extra money through change orders. (client, construction project)

### *5.2 RQ2: different industries*

From Table IV, we extract the three most frequently found factors for each industry and present this as a joint figure (Figure 11). For ICT projects, these were quality of communication, owner's organizational efficiency and project uncertainty. The three most frequent factors found for construction projects were quality of communication, project uncertainty and frequency of claims. For oil and gas projects these were quality of communication, owner's organizational efficiency and trust. While there seems to be a consensus between interviewees from all three industries that quality of communication is an important factor that influences collaboration, we will discuss further three findings where we found some interesting differences between the industries.

First, one can see that interviewees in the construction industry do not consider the owner's organizational efficiency a particularly important factor that influences project collaboration. In contrast, this factor was among the top three most frequently found factors

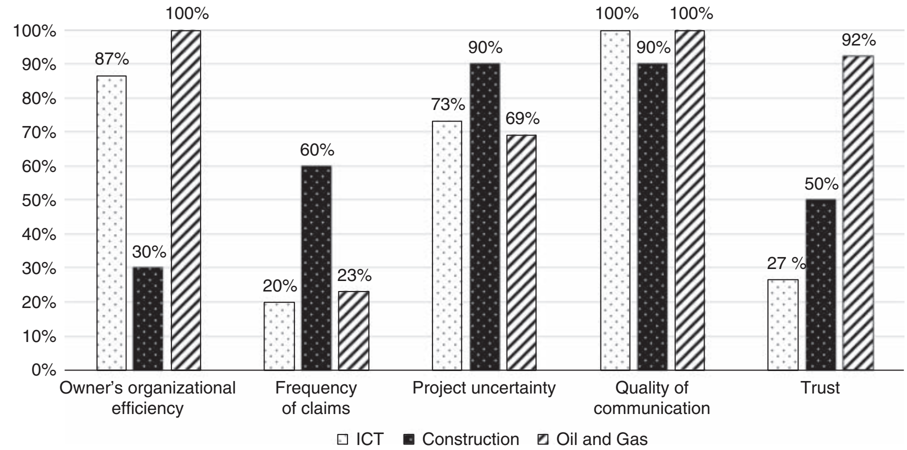



**Figure 11.**
*RQ2* – top three most frequent factors that influence collaboration in each industry

in the other two industries. For example, respondents who worked in ICT projects frequently described how their agile project models required efficient clients. If the owner did not allocate the right resources from its own organization to participate in these processes on a daily basis, it was difficult to be truly agile. The importance of the owner's behavior in order to achieve collaboration in construction projects has been presented by Davies *et al.* (2009) and Eriksson *et al.* (2009). We are therefore a little surprised that the owner's organizational efficiency was identified in so few of the interviews with our respondents in construction projects.

Second, we see that trust is considered a very important factor for collaboration in oil and gas projects, while it seems to be in particular less salient in ICT projects. In this discussion, we will emphasize that many of the interviewees from the oil and gas industry worked in projects with alliance collaboration models. Such models require trust and openness (Hietajärvi *et al.*, 2017; Walker and Lloyd-Walker, 2015; Hauck *et al.*, 2004) something several respondents underlined:

> In the alliance we share all our commercial details with the client and our partners. We really have to trust each other. (contractor, oil and gas project)

Respondents described how the alliance acts as a unity and is jointly responsible for the execution of the project. If the alliance fails, all members fail, if the alliance succeeds, all members succeed. Moving away from traditional procurement arrangements to alliancing often foster improved innovation (Ibrahim *et al.*, 2017) and productivity (Sarhan *et al.*, 2017). A project manager from the client perspective gave an example of how the turnaround time for handling change requests had been reduced from 30 days to 10 days when working in an alliance with the contractors. Another example of waste reduction is here described from the contractor perspective:

> Another saving is that we save a lot of hours by having the same team in all phases of the project. Furthermore, we have a much more efficient organization without double functions. There is less waste than before. We are running the project much more efficient than previously. (contractor, oil and gas project)

Third, we see that frequency of claims is found to be the third most important factor in construction projects, while this factor is significantly less salient in the two other industries. The conflict level in the Norwegian construction industry is high (Kvålshaugen and Sward, 2018) and this may be the reason why frequency of claims was found to be in particular important for projects in this industry. Opportunistic claims often have a negative effect on the client–contractor relationship (Mohamed *et al.*, 2011) and several of the interviewees from the construction industry gave examples of relations with a low level of trust:

> This time, we shall fool them since these guys fooled us last time. (contractor, construction project)

### 5.3 *RQ3: different perspectives*

We will now discuss further how the five factors most frequently found for *RQ1* (see Figure 10) vary between the client perspective and the contractor perspective. The result from this analysis is presented in Figure 12. Our findings do not suggest that there are any large differences between the contractor and the client perspective in how they view which factors influence collaboration in projects. In general, there seems to be a consensus between the contractor and client perspective about the importance of the various factors.

Keeping in mind that the number of interviewees from the contractor side is approximately three times the number of interviewees from the client side, this does not seem to have any significant impact on our findings related to *RQ1* and *RQ2*. If large differences had been found between the contractor and client perspective, one could have argued that our findings for *RQ1* and *RQ2* would be less valid.

As seen from Figure 12, both contractors and clients consider quality of communication to be the most salient factor that influences the collaboration level. The largest relative difference between the two perspectives is related to change orders. Contractors seem to consider issues related to change orders to be a somewhat more important factor on the collaboration level in the project than clients do. We also see that contractors, in particular, stress the importance of reducing uncertainty in order to collaborate better. Clients seem to be aware of the importance of their own role in projects, as they acknowledge that their own organizational efficiency is an important factor that influences collaboration:

> We can contribute by removing uncertainty and suggest solutions that are favourable also for the contractor. (client, construction project)

## 6. Conclusion, implications and avenues for further research

This paper answers the call from Li *et al.* (2015), who encouraged researchers to perform further empirical research within their framework of factors that determine transaction costs.

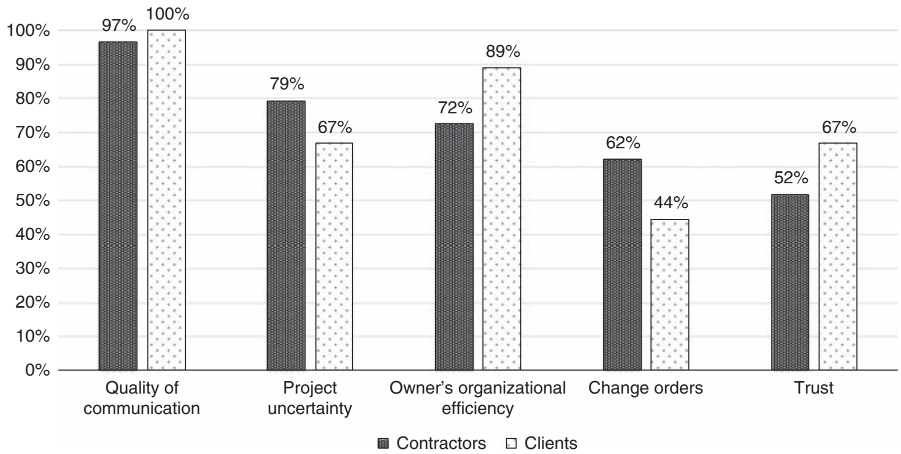



**Figure 12.** *RQ3* – five most salient factors that influence collaboration separated by roles

In particular, this paper expands this existing framework by exploring the relationship between transaction costs and collaboration as well as introducing trust.

Moreover, we have highlighted which factors that determine transaction costs in a project that has the largest influence on the level of collaboration in projects. Project practitioners should prioritize addressing these factors to achieve reduced transaction costs through improved collaboration. We have conducted the study in a cross-industry context that allows for increased learning for practitioners.

Through interviews with 38 experienced project practitioners from three different industries, we have answered the following research questions:

*RQ1.* Which of the 26 transaction cost factors presented by Li *et al.* (2015) have the largest influence on collaboration in projects?

Conclusion: we found that the five most important factors are quality of communication, project uncertainty, organizational efficiency in the owner's organization, change orders and trust. Trust is not listed an explicit factor by Li *et al.* (2015) but emerged as a factor when coding the interviews:

*RQ2.* What are the differences and similarities in the findings from projects in the construction industry, the ICT industry and oil and gas industry?

Conclusion: quality of communication was found to be important across the industries. The owner's organizational efficiency was also highly important in oil and gas and ICT projects. Trust was particularly important in oil and gas projects while frequency of claims was particularly important in construction projects:

*RQ3.* What are the differences and similarities of the findings between the contractor perspective and the client perspective?

Conclusion: we found no major differences between the contractor perspective and the client perspective.

### *6.1 Contribution to body of knowledge*

The main contribution to the body of knowledge is that we have explored Li *et al.*'s (2015) framework of factors that affect transaction costs and empirically tested how these factors influence project collaboration. Hence we make a contribution to theory connecting transaction costs and collaboration. From the 26 transaction cost factors presented by Li *et al.* (2015), we found that 25 of these to various degree influence collaboration. The only factor we found not to influence collaboration was bonding requirements. Even though trust is not listed an explicit transaction cost factor by Li *et al.* (2015), we found that trust was an important factor for collaboration. Trust should therefore be included in the discussion when connecting transaction cost factors with collaboration.

### *6.2 Practical implications*

The example given in the introduction of this paper reminds us about how conflicts can lead to significant transaction costs. The ability to prevent and resolve such conflicts increases with improved collaboration (Dietrich *et al.*, 2010). Our research identifies the top five factors that should have the most important effect on collaboration. Hence, project managers can expect to get the most effective impact on collaboration in their projects if they prioritize to work with the following five factors: improve the quality of communication, reduce uncertainty, have the right level of client involvement, handle change orders properly and build trust in the relationship. Practitioners should then expect to experience improved collaboration and hopefully avoid disputes that lead to extensive transaction costs for all parties.

Kadefors (2004) describes the client–contractor relationship in construction projects as a "black box." In the search for the key to unlock this "black box," we believe that our findings related to *RQ2* in this paper are particularly interesting from a cross-industry perspective. We see that trust is considered as a less important factor by those working in ICT- and construction projects compared with respondents from oil and gas projects. The frequency of claims appears to be a much more salient factor in the construction industry compared to other industries. This is particular interesting when we keep in mind that the construction industry has received some criticism for lagging behind other industries in terms of productivity (Zhang, Azhar, Nadeem and Khalfan, 2018; Fulford and Standing, 2014). An interesting point to note for practitioners may therefore be that the respondents in oil and gas projects, where most of the respondents worked in alliance arrangements, rated trust very high and frequency of claims low. High-order collaborative approaches, such as partnering or alliancing, were in 2010 less common in the Nordic construction industry compared to the UK and South-East Asian contexts (Bygballe *et al.*, 2010). Our findings do not give any indication that this has changed. In fact, none of the interviewees from construction projects utilized high-order collaboration models.

Clients in ICT projects may want to be aware of that it appear to be particular important that they make enough resources available so that they can effectively work together with the contractor. To achieve effective collaboration in agile projects the client need to allocate personnel with sufficient authority to take decisions and make sure that these people have sufficient time available.

### *6.3 Limitations and avenues for further research*

The study is somewhat more influenced by the contractor perspective than the client perspective as 29 of the 38 respondents held a role as contractor. The study has been performed in Norway, but many of the companies operate in an international market and several respondents had international experience.

We found that respondents from the construction industry consider the owner's organizational efficiency significantly less important than what is the case for the two other industries studied, as they consider frequency of claims to be much more significant. It would be particularly interesting to study if there is a relationship between these findings and the productivity level in construction projects.

Furthermore, we echo the call for more empirical research on transaction costs as suggested by (Guo *et al.*, 2016; De Schepper *et al.*, 2015; Pinto *et al.*, 2009). It would be particularly interesting to study transaction costs and trust in projects that use collaborative execution models.

## References

Aarseth, W. (2014), *Project Management – A New Mindset for Success: Collaborative Business and Global Mindset*, Fagbokforlaget, Bergen.

Adler, P.A. and Adler, P. (2001), "The reulctant respondent", in Gubrium, J.F. and Holstein, J.A. (Eds), *Handbook of Interview Research*, SAGE Publications, Thousand Oaks, CA, pp. 515-535.

Ahola, T., Vuori, M. and Viitamo, E. (2017), "Sharing the burden of integration: an activity-based view to integrated solutions provisioning", *International Journal of Project Management*, Vol. 35 No. 6, pp. 1006-1021.

Akerlof, G.A. (1970), "The market for 'lemons': quality uncertainty and the market mechanism", *The Quarterly Journal of Economics*, Vol. 84 No. 3, pp. 488-500.

Alchian, A.A. and Demsetz, H. (1972), "production, information costs, and economic organization", *The American Economic Review*, Vol. 62 No. 5, pp. 777-795.

Aliakbarlou, S., Wilkinson, S. and Costello, S.B. (2018), "Rethinking client value within construction contracting services", *International Journal of Managing Projects in Business*, Vol. 11 No. 4, pp. 1007-1025.

Alvesson, M. and Sköldberg, K. (2009), *Reflexive Methodology: New Vistas for Qualitative Research*, Sage, London.

Andersen, B., Samset, K. and Welde, M. (2016), "Low estimates – high stakes: underestimation of costs at the front-end of projects", *International Journal of Managing Projects in Business*, Vol. 9 No. 1, pp. 171-193.

Antinori, C. and Sathaye, J. (2007), *Assessing Transaction Costs of Project-Based Greenhouse Gas Emissions Trading*, Lawrence Berkeley National Laboratory, Berkeley, CA.

Arditi, D. and Chotibhongs, R. (2009), "Detection and prevention of unbalanced bids", *Construction Management and Economics*, Vol. 27 No. 8, pp. 721-732.

Arrow, K.J. (1969), "The organization of economic activity: issues pertinent to the choice of market versus nonmarket allocation", The Analysis and Evaluation of Public Expenditures: The PPB System, Joint Economic Committee, 91st Congress, 1st Session, Government Printing Office, Washington, DC, pp. 500-518.

Azanha, A., Argoud, A.R.T.T., Camargo, J.B.D. Jr and Antoniolli, P.D. (2017), "Agile project management with scrum: a case study of a Brazilian pharmaceutical company IT project", *International Journal of Managing Projects in Business*, Vol. 10 No. 1, pp. 121-142.

Bayliss, R., Cheung, S.-O., Suen, H.C.H. and Wong, S.-P. (2004), "Effective partnering tools in construction: a case study on MTRC TKE contract 604 in Hong Kong", *International Journal of Project Management*, Vol. 22 No. 3, pp. 253-263.

Benítez-Ávila, C., Hartmann, A., Dewulf, G. and Henseler, J. (2018), "Interplay of relational and contractual governance in public-private partnerships: the mediating role of relational norms, trust and partners' contribution", *International Journal of Project Management*, Vol. 36 No. 3, pp. 429-443.

Biong, H., Nes, E.B. and Sande, J.B. (2016), *Markedsføring på Bedriftsmarkedet*, Universitetsforlaget, Oslo.

Bititci, U., Turner, T., Mackay, D., Kearney, D., Parung, J. and Walters, D. (2007), "Managing synergy in collaborative enterprises", *Production Planning & Control*, Vol. 18 No. 6, pp. 454-465.

Bond-Barnard, T.J., Fletcher, L. and Steyn, H. (2018), "Linking trust and collaboration in project teams to project management success", *International Journal of Managing Projects in Business*, Vol. 11 No. 2, pp. 432-457.

Bond-Barnard, T.J., Steyn, H. and Fabris-Rotelli, I. (2013), "The impact of a call centre on communication in a programme and its projects", *International Journal of Project Management*, Vol. 31 No. 7, pp. 1006-1016.

Boukendour, S. and Hughes, W. (2014), "Collaborative incentive contracts: stimulating competitive behaviour without competition", *Construction Management and Economics*, Vol. 32 No. 3, pp. 279-289.

Bresnen, M. (2007), "Deconstructing partnering in project-based organisation: seven pillars, seven paradoxes and seven deadly sins", *International Journal of Project Management*, Vol. 25 No. 4, pp. 365-374.

Bryman, A. (2016), *Social Research Methods*, Oxford University Press, Oxford.

Buchanan, D.A. and Bryman, A. (2009), "The organizational research context: properties and implications", in Buchanan, D.A. and Bryman, A. (Eds), *The SAGE Handbook of Organizational Research Methods*, SAGE Publications, London, pp. 1-18.

Bygballe, L.E., Jahre, M. and Swärd, A. (2010), "Partnering relationships in construction: a literature review", *Journal of Purchasing and Supply Management*, Vol. 16 No. 4, pp. 239-253.

Cassell, C. (2009), "Interviews in organizational research", in Buchanan, D.A. and Bryman, A. (Eds), *The SAGE Handbook of Organizational Research Methods*, SAGE Publications, London, pp. 500-515.

Chakkol, M., Selviaridis, K. and Finne, M. (2018), "The governance of collaboration in complex projects", *International Journal of Operations & Production Management*, Vol. 38 No. 4, pp. 997-1019.

Cho, S. and Ballard, G. (2011), "Last planner and integrated project delivery", *Lean Construction Journal*, Vol. 7 No. 1, pp. 67-78.

Christensen, R.M. (2008), "Development practically speaking, learning processes in the Danish construction industry", PhD thesis, Aalborg University, Aalborg.

CII (1995), *Dispute Prevention and Resolution Techniques in the Construction Industry*, Construction Industry Institute, Universtiy of Texas, Austin.

Coase, R.H. (1937), "The nature of the firm", *Economica*, Vol. 4 No. 16, pp. 386-405.

Costa e Silva, S., Bradley, F. and Sousa, C.M.P. (2012), "Empirical test of the trust – performance link in an international alliances context", *International Business Review*, Vol. 21 No. 2, pp. 293-306.

Crouch, M. and McKenzie, H. (2006), "The logic of small samples in interview-based qualitative research", *Social Science Information*, Vol. 45 No. 4, pp. 483-499.

Crowley, L.G. and Hancher, D.E. (1995), "Risk assessment of competitive procurement", *Journal of Construction Engineering and Management*, Vol. 121 No. 2, pp. 230-237.

David, R.J. and Han, S.-K. (2004), "A Systematic assessment of the empirical support for transaction cost economics", *Strategic Management Journal*, Vol. 25 No. 1, pp. 39-58.

Davies, A., Gann, D. and Douglas, T. (2009), "Innovation in megaprojects: systems integration at London Heathrow Terminal 5", *California Management Review*, Vol. 51 No. 2, pp. 101-125.

De Schepper, S., Haezendonck, E. and Dooms, M. (2015), "Transaction cost analysis of public infrastructure delivery", *International Journal of Managing Projects in Business*, Vol. 8 No. 3, pp. 441-456.

Dietrich, P., Eskerod, P., Dalcher, D. and Sandhawalia, B. (2010), "The dynamics of collaboration in multipartner projects", *Project Management Journal*, Vol. 41 No. 4, pp. 59-78.

Duarte, M. and Davies, G. (2003), "Testing the conflict–performance assumption in business-to-business relationships", *Industrial Marketing Management*, Vol. 32 No. 2, pp. 91-99.

Dudkin, G. and Välilä, T. (2006), "Transaction costs in public-private partnerships: a first look at the evidence", *Competition and Regulation in Network Industries*, Vol. 1 No. 2, pp. 307-330.

Eisenhardt, K.M. (1985), "Control: organizational and economic approaches", *Management Science*, Vol. 31 No. 2, pp. 134-149.

Ely, M., Vinz, R., Downing, M. and Anzul, M. (1997), *On Writing Qualitative Research – Living by Words*, The Falmer Press, London.

Eriksson, E., Brian, A. and Torbjörn, N. (2009), "Overcoming barriers to partnering through cooperative procurement procedures", *Engineering, Construction and Architectural Management*, Vol. 16 No. 6, pp. 598-611.

Eriksson, P.E. (2010), "Partnering: what is it, when should it be used, and how should it be implemented?", *Construction Management and Economics*, Vol. 28 No. 9, pp. 905-917.

Eriksson, P.E., Larsson, J. and Pesämaa, O. (2017), "Managing complex projects in the infrastructure sector – a structural equation model for flexibility-focused project management", *International Journal of Project Management*, Vol. 35 No. 8, pp. 1512-1523.

Farajian, M. (2010), "Transaction cost estimation model for US infrastructure public private partnerships", MSc thesis, University of Maryland, College Park.

Fellows, R. and Liu, A.M.M. (2012), "Managing organizational interfaces in engineering construction projects: addressing fragmentation and boundary issues across multiple interfaces", *Construction Management and Economics*, Vol. 30 No. 8, pp. 653-671.

Flyvbjerg, B. (2005), "Design by deception: the politics of megaproject approval", *Harvard Design Magazine*, No. 22, pp. 50-59.

Flyvbjerg, B. (2009), “Survival of the unfittest: why the worst infrastructure gets built – and what we can do about it”, *Oxford Review of Economic Policy*, Vol. 25 No. 3, pp. 344-367.

Flyvbjerg, B., Holm, M.S. and Buhl, S. (2002), “Underestimating costs in public works projects: error or lie?”, *Journal of the American Planning Association*, Vol. 68 No. 3, pp. 279-295.

Forsythe, P., Sankaran, S. and Biesenthal, C. (2015), “How far can BIM reduce information asymmetry in the Australian construction context?”, *Project Management Journal*, Vol. 46 No. 3, pp. 75-87.

Fulford, R. and Standing, C. (2014), “Construction industry productivity and the potential for collaborative practice”, *International Journal of Project Management*, Vol. 32 No. 2, pp. 315-326.

Geyskens, I., Steenkamp, J.-B.E.M. and Kumar, N. (2006), “Make, buy, or ally: a transaction cost theory meta-analysis”, *The Academy of Management Journal*, Vol. 49 No. 3, pp. 519-543.

Glaser, B.G. and Strauss, A.L. (1967), *The Discovery of Grounded Theory*, Weidenfield and Nicolson, London.

Goldberg, V.P. (1976), “Regulation and administered contracts”, *The Bell Journal of Economics*, Vol. 7 No. 2, pp. 426-448.

Guest, G., Bunce, A. and Johnson, L. (2006), “How many interviews are enough? An experiment with data saturation and variability”, *Field Methods*, Vol. 18 No. 1, pp. 59-82.

Guo, L., Li, H., Li, P. and Zhang, C. (2016), “Transaction costs in construction projects under uncertainty”, *Kybernetes*, Vol. 45 No. 6, pp. 866-883.

Halvorsen, S.B. and Andersen, B. (2015), “Rapport – Frekvensstudie innen elektroinstallasjon”, SINTEF No. A-27259, SINTEF, Trondheim, available at: https://nelfo.no/Documents/Dokumenter,%20rapporter,%20publikasjoner/Frekvensstudie%20NELFO.pdf

Hanna, A.S. (2016), “Benchmark performance metrics for integrated project delivery”, *Journal of Construction Engineering and Management*, Vol. 142 No. 9, pp. 04016040-1-9.

Hauck, A.J., Walker, D.H.T., Hampson, K.D. and Peters, R.J. (2004), “Project alliancing at national museum of Australia – collaborative process”, *Journal of Construction Engineering and Management*, Vol. 130 No. 1, pp. 143-152.

Herzog, H. (2005), “On home turf: interview location and its social meaning”, *Qualitative Sociology*, Vol. 28 No. 1, pp. 25-47.

Hietajärvi, A.-M. and Aaltonen, K. (2018), “The formation of a collaborative project identity in an infrastructure alliance project”, *Construction Management and Economics*, Vol. 36 No. 1, pp. 1-21.

Hietajärvi, A.-M., Aaltonen, K. and Haapasalo, H. (2017), “What is project alliance capability?”, *International Journal of Managing Projects in Business*, Vol. 10 No. 2, pp. 404-422.

Ho, S.P. and Liu, L.Y. (2004), “Analytical model for analyzing construction claims and opportunistic bidding”, *Journal of Construction Engineering and Management*, Vol. 130 No. 1, pp. 94-104.

Ho, S.P. and Tsui, C.-W. (2009), “The transaction costs of public-private partnerships: implications on PPP governance design”, paper presented at Lead 2009 Specialty Conference: Global Governance in Project Organizations, South Lake Tahoe, CA, November 5-7, available at: www.epossociety.org/LEAD2009/Ho_Tsui.pdf (accessed April 13, 2018).

Ho, S.P., Levitt, R., Tsui, C.-W. and Hsu, Y. (2015), “Opportunism-focused transaction cost analysis of public-private partnerships”, *Journal of Management in Engineering*, Vol. 31 No. 6, pp. 04015007-1-10.

Hoegl, M. and Gemuenden, H.G. (2001), “Teamwork quality and the success of innovative projects: a theoretical concept and empirical evidence”, *Organization Science*, Vol. 12 No. 4, pp. 435-449.

Hosseini, A., Wondimu, P.A., Klakegg, O.J., Andersen, B. and Laedre, O. (2018), “Project partnering in the construction industry: theory vs practice”, *Engineering Project Organization Journal*, Vol. 8, January, pp. 13-35.

Ibrahim, C.K.I.C., Costello, S.B. and Wilkinson, S. (2015), “Key indicators influencing the management of team integration in construction projects”, *International Journal of Managing Projects in Business*, Vol. 8 No. 2, pp. 300-323.

Ibrahim, C.K.I.C., Costello, S.B., Wilkinson, S. and Walker, D. (2017), "Innovation in alliancing for improved delivery of road infrastructure projects", *International Journal of Managing Projects in Business*, Vol. 10 No. 4, pp. 700-720.

ICW (2017), "Insight into ISO 44001", Institute for Collaborative Working, London, available at: www.instituteforcollaborativeworking.com/Resources/Documents/insight_into_iso44001.pdf (accessed October 24, 2017).

Jackson, J. (2008), "Approved judgement – multiplex vs Cleveland Bridge", Case No. HT-04-314 & HT-04-238, Royal Court of Justice, available at: www.buildingdisputestribunal.co.nz/site/buildingdisputes/files/Court%20Decisions/Uk%20MULTIPLEX%20V%20CLEVELAND%20HT-04-314%20&%20HT-04-238%2029%20SEPTEMBER%202008.pdf (accessed May 5, 2018).

Jefferies, M., John Brewer, G. and Gajendran, T. (2014), "Using a case study approach to identify critical success factors for alliance contracting", *Engineering, Construction and Architectural Management*, Vol. 21 No. 5, pp. 465-480.

Jonasson, H.I. and Ingason, H.T. (2015), "Ethical considerations in project management research", in Pasian, B. (Ed.), *Designs, Methods and Practices for Research of Project Management*, Gower Publishing, Surrey, pp. 143-152.

Juran, J.M. (1954), "Universals in management planning and controlling", *Management Review*, Vol. 43 No. 11, pp. 748-761.

Kadefors, A. (2004), "Trust in project relationships-inside the black box", *International Journal of Project Management*, Vol. 22 No. 3, pp. 175-182.

Kadefors, A., Björlingson, E. and Karlsson, A. (2007), "Procuring service innovations: contractor selection for partnering projects", *International Journal of Project Management*, Vol. 25 No. 4, pp. 375-385.

Kerzner, H. (1995), *Project Management – A Systems Approach to Planning Scheduling and Controlling*, International Thomson Publishing, New York, NY.

Klein, B., Crawford, R.G. and Alchian, A.A. (1978), "Vertical integration, appropriable rents, and the competitive contracting process", *The Journal of Law and Economics*, Vol. 21 No. 2, pp. 297-326.

Koch, R. (1997), *The 80/20 Principle*, Egmont Hjemmets Bokforlag A/S, Oslo.

Kunglege-Vetenskaps-Akademien (2009), "Scientific bacground on the Sveriges Riksbank Prize in economic sciences in memory of Alfred Nobel 2009", available at: www.nobelprize.org/uploads/2018/06/press-7.pdf (accessed March 1, 2018).

Kvålshaugen, R. and Sward, A.R. (2018), "Sluttrapport 'Samhandling og prosessledelse'", Forskningsrapport No. 1/2018, Handelshøyskolen BI, Oslo, available at: https://brage.bibsys.no/xmlui/bitstream/handle/11250/2491006/2018_1_Sward.pdf?sequence=3&isAllowed=y (accessed April 5, 2018).

Lædre, O. (2009), *Er Det Noen Sak?*, Fagbokforlaget, Bergen.

Lædre, O. (2014), *Kontraktstrategi for Bygg- og Anleggsprosjekter*, Fagbokforlaget, Bergen.

Lafontaine, F. and Slade, M. (2007), "Vertical integration and firm boundaries: the evidence", *Journal of Economic Literature*, Vol. 45 No. 3, pp. 629-685.

Lahdenperä, P. (2012), "Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery", *Construction Management and Economics*, Vol. 30 No. 1, pp. 57-79.

Lappi, T. and Aaltonen, K. (2017), "Project governance in public sector agile software projects", *International Journal of Managing Projects in Business*, Vol. 10 No. 2, pp. 263-294.

Levy, D.T. (1985), "The Transactions cost approach to vertical integration: an empirical examination", *The Review of Economics and Statistics*, Vol. 67 No. 3, pp. 438-445.

Li, H., Arditi, D. and Wang, Z. (2013), "Factors that affect transaction costs in construction projects", *Journal of Construction Engineering and Management*, Vol. 139 No. 1, pp. 60-68.

Li, H., Arditi, D. and Wang, Z. (2014), "Transaction costs incurred by construction owners", *Engineering, Construction and Architectural Management*, Vol. 21 No. 4, pp. 444-458.

Li, H., Arditi, D. and Wang, Z. (2015), "Determinants of transaction costs in construction projects", *Journal of Civil Engineering and Management*, Vol. 21 No. 5, pp. 548-558.

Lo, W., Lin, C.L. and Yan, M.R. (2007), "Contractor's opportunistic bidding behavior and equilibrium price level in the construction market", *Journal of Construction Engineering and Management*, Vol. 133 No. 6, pp. 409-416.

Love, P.E.D., Davis, P.R., Chevis, R. and Edwards, D.J. (2011), "Risk/reward compensation model for civil engineering infrastructure alliance projects", *Journal of Construction Engineering and Management*, Vol. 137 No. 2, pp. 127-136.

Lu, W., Zhang, L. and Pan, J. (2015), "Identification and analyses of hidden transaction costs in project dispute resolutions", *International Journal of Project Management*, Vol. 33 No. 3, pp. 711-718.

Lumineau, F. and Quélin, B.V. (2012), "An empirical investigation of interorganizational opportunism and contracting mechanisms", *Strategic Organization*, Vol. 10 No. 1, pp. 55-84.

Macher, J.T. and Richman, B.D. (2008), "Transaction cost economics: an assessment of empirical research in the social sciences", *Business and Politics*, Vol. 10 No. 1, pp. 1-63.

Mandell, S. and Nyström, J. (2013), "Too much balance in unbalanced bidding", *Studies in Microeconomics*, Vol. 1 No. 1, pp. 23-35.

Manu, E., Ankrah, N., Chinyio, E. and Proverbs, D. (2015), "Trust influencing factors in main contractor and subcontractor relationships during projects", *International Journal of Project Management*, Vol. 33 No. 7, pp. 1495-1508.

Mason, M. (2010), "Sample size and saturation in PhD studies using qualitative interviews", *Forum: Qualitative Social Research*, Vol. 11 No. 3, Article No. 8.

Mohamed, K.A., Khoury, S.S. and Hafez, S.M. (2011), "Contractor's decision for bid profit reduction within opportunistic bidding behavior of claims recovery", *International Journal of Project Management*, Vol. 29 No. 1, pp. 93-107.

Müller, R. and Turner, J.R. (2005), "The impact of principal–agent relationship and contract type on communication between project owner and manager", *International Journal of Project Management*, Vol. 23 No. 5, pp. 398-403.

Nevstad, K., Børve, S., Karlsen, A.T. and Aarseth, W. (2018), "Understanding how to succeed with project partnering", *International Journal of Managing Projects in Business*, Vol. 11 No. 4, pp. 1044-1065.

Ngai, S.C., Drew, D.S., Lo, H.P. and Skitmore, M. (2002), "A theoretical framework for determining the minimum number of bidders in construction bidding competitions", *Construction Management and Economics*, Vol. 20 No. 6, pp. 473-482.

Ning, Y. (2018), "Impact of quality performance ambiguity on contractor's opportunistic behaviors in person-to-organization projects: the mediating roles of contract design and application", *International Journal of Project Management*, Vol. 36 No. 4, pp. 640-649.

Ning, Y. and Ling, F.Y.Y. (2015), "The effects of project characteristics on adopting relational transaction strategies", *International Journal of Project Management*, Vol. 33 No. 5, pp. 998-1007.

Nisonger, T.E. (2008), "The '80/20 rule' and core journals", *The Serials Librarian*, Vol. 55 Nos 1-2, pp. 62-84.

Nyström, J. (2015), "The balance of unbalanced bidding", *Procedia Economics and Finance*, Vol. 21, Special Issue, pp. 97-103.

Patel, H., Pettitt, M. and Wilson, J.R. (2012), "Factors of collaborative working: a framework for a collaboration model", *Applied Ergonomics*, Vol. 43 No. 1, pp. 1-26.

Pinto, J.K. (2010), *Project Management: Achieving Competitive Advantage*, Pearson Prentice Hall, Boston, MA.

Pinto, J.K. (2013), "Lies, damned lies, and project plans: recurring human errors that can ruin the project planning process", *Business Horizons*, Vol. 56 No. 5, pp. 643-653.

Pinto, J.K., Slevin, D.P. and English, B. (2009), "Trust in projects: an empirical assessment of owner/contractor relationships", *International Journal of Project Management*, Vol. 27 No. 6, pp. 638-648.

PMI (2017), *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Project Management Institute, Newton Square, PA.

Rajeh, M., Tookey, J.E., Olabode, J. and Rotimi, B. (2015), "Estimating transaction costs in the New Zealand construction procurement a structural equation modelling methodology", *Engineering, Construction and Architectural Management*, Vol. 22 No. 2, pp. 242-267.

Rindfleisch, A. and Heide, J.B. (1997), "Transaction cost analysis: past, present, and future applications", *Journal of Marketing*, Vol. 61 No. 4, pp. 30-54.

Rooke, J., Seymour, D. and Fellows, R. (2004), "Planning for claims: an ethnography of industry culture", *Construction Management and Economics*, Vol. 22 No. 6, pp. 655-662.

Sarhan, S., Pasquire, C., Manu, E. and King, A. (2017), "Contractual governance as a source of institutionalised waste in construction: a review, implications, and road map for future research directions", *International Journal of Managing Projects in Business*, Vol. 10 No. 3, pp. 550-577.

Saunders, M., Lewis, P. and Adrian, T. (2009), *Research Methods for Business Students*, Pearson Education.

Shelanski, H.A. and Klein, P.G. (1995), "Empirical research in transaction cost economics: a review and assessment", *Journal of Law, Economics, & Organization*, Vol. 11 No. 2, pp. 335-361.

Shepherd, M. (2015), "Interview methods for project management research", in Pasian, B. (Ed.), *Designs, Methods and Practices for Research of Project Management*, Gower Publishing, Surrey, pp. 185-202.

Shuy, R. (2002), "In-person versus telephone interviewing", in Gubrium, J.F. and Holstein, J.A. (Eds), *Handbook of Interview Research*, SAGE Publications, Thousand Oaks, CA, pp. 536-555.

Simon, H.A. (1957), *Administrative Behavior*, The Macmillian Company, New York, NY.

Simon, H.A. (1991), "Organizations and markets", *The Journal of Economic Perspectives*, Vol. 5 No. 2, pp. 25-44.

Song, H., Zhu, F., Klakegg, O.J. and Wang, P. (2018), "Relationship between contractual flexibility and contractor's cooperative behavior: the mediating effect of justice perception", *International Journal of Managing Projects in Business*, Vol. 11 No. 2, pp. 382-405.

Suprapto, M., Bakker, H.L.M., Mooi, H.G. and Moree, W. (2015), "Sorting out the essence of owner-contractor collaboration in capital project delivery", *International Journal of Project Management*, Vol. 33 No. 3, pp. 664-683.

Tan, Y.-T., Shen, L.-Y., Khalid, A.G. and Song, S.-C. (2008), "An examination of the factors affecting contractors' competition strategy: a Hong Kong study", *International Journal of Project Organisation and Management*, Vol. 1 No. 1, pp. 4-23.

Tjosvold, D., Hui, C., Ding, D.Z. and Hu, J. (2003), "Conflict values and team relationships: conflict's contribution to team effectiveness and citizenship in China", *Journal of Organizational Behavior*, Vol. 24 No. 1, pp. 69-88.

Turner, J.R. and Müller, R. (2004), "Communication and co-operation on projects between the project owner as principal and the project manager as agent", *European Management Journal*, Vol. 22 No. 3, pp. 327-336.

Um, K.H. and Kim, S.M. (2018), "Collaboration and opportunism as mediators of the relationship between NPD project uncertainty and NPD project performance", *International Journal of Project Management*, Vol. 36 No. 4, pp. 659-672.

Vaaland, T.I. and Håkansson, H. (2003), "Exploring interorganizational conflict in complex projects", *Industrial Marketing Management*, Vol. 32 No. 2, pp. 127-138.

von Danwitz, S. (2018), "Managing inter-firm projects: a systematic review and directions for future research", *International Journal of Project Management*, Vol. 36 No. 3, pp. 525-541.

Walker, D. and Lloyd-Walker, B.M. (2015), *Collaborative Project Procurement Arrangements*, Project Management Institute, Newton Square, PA.

Warren, C.A. (2002), "Qualitative interviewing", in Gubrium, J.F. and Holstein, J.A. (Eds), *Handbook of Interview Research; Context & Method*, SAGE Publications, Thousand Oaks, CA, pp. 83-101.

Williamson, O.E. (1971), "The vertical integration of production: market failure considerations", *The American Economic Review*, Vol. 61 No. 2, pp. 112-123.

Williamson, O.E. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*, Free Press, New York, NY.

Williamson, O.E. (1981), "The economics of organization: the transaction cost approach", *American Journal of Sociology*, Vol. 87 No. 3, pp. 548-577.

Williamson, O.E. (1985), *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, Free Press, New York, NY.

Williamson, O.E. (1996), *The Mechanisms of Governance*, Oxford University Press, New York, NY.

Winter, M., Smith, C., Morris, P. and Cicmil, S. (2006), "Directions for future research in project management: the main findings of a UK government-funded research network", *International Journal of Project Management*, Vol. 24 No. 8, pp. 638-649.

Wu, G., Liu, C., Zhao, X. and Zuo, J. (2017), "Investigating the relationship between communication-conflict interaction and project success among construction project teams", *International Journal of Project Management*, Vol. 35 No. 8, pp. 1466-1482.

Yap, J.B.H., Abdul-Rahman, H. and Chen, W. (2017), "Collaborative model: managing design changes with reusable project experiences through project learning and effective communication", *International Journal of Project Management*, Vol. 35 No. 7, pp. 1253-1271.

Yeung, J.F.Y., Chan, A.P.C. and Chan, D.W.M. (2007), "The definition of alliancing in construction as a Wittgenstein family-resemblance concept", *International Journal of Project Management*, Vol. 25 No. 3, pp. 219-231.

You, J., Chen, Y., Wang, W. and Shi, C. (2018), "Uncertainty, opportunistic behavior, and governance in construction projects: the efficacy of contracts", *International Journal of Project Management*, Vol. 36 No. 5, pp. 795-807.

Young, M. (2015), "Project management research: social dimensions and organisational context", in Pasian, B. (Ed.), *Designs, Methods and Practices for Research of Project Management*, Gower Publishing, Surrey, pp. 19-31.

Zack, J.G. (1993), "Claimsmanship: current perspective", *Journal of Construction Engineering and Management*, Vol. 119 No. 3, pp. 480-497.

Zhang, S., Fu, Y. and Kang, F. (2018), "How to foster contractors' cooperative behavior in the Chinese construction industry: direct and interaction effects of power and contract", *International Journal of Project Management*, Vol. 36 No. 7, pp. 940-953.

Zhang, X., Azhar, S., Nadeem, A. and Khalfan, M. (2018), "Using building information modelling to achieve lean principles by improving efficiency of work teams", *International Journal of Construction Management*, Vol. 18 No. 4, pp. 293-300.

**Corresponding author**
Haavard Haaskjold can be contacted at: haavard.haaskjold@ntnu.no

For instructions on how to order reprints of this article, please visit our website:
**www.emeraldgrouppublishing.com/licensing/reprints.htm**
Or contact us for further details: **permissions@emeraldinsight.com**

# Paper 2

**JMPM** Issue #22 | Vol.07 Num.04

# In search of Empirical Evidence for the Relationship Between Collaboration and Project Performance

Haavard Haaskjold; Bjørn Andersen; Jan Alexander Langlo
**Norwegian University of Technology and Science, Norway**

**Abstract:** Existing research suggests a positive relationship between the level of collaboration in projects and project performance in terms of cost, time and quality. However, empirical data to support this are scant and this paper responds to the calls for more empirical research on this specific relationship. In this paper, we conducted bivariate analysis on a dataset from 142 Norwegian projects which reported their cost, schedule and quality performance through the 10-10 benchmarking tool developed by the Construction Industry Institute (CII). We found a strong positive relationship between collaboration and project quality performance. Projects with good collaboration experienced fewer errors and deviations and more often delivered according to requirements and client expectations than projects with poor collaboration. We also propose an indicator that practitioners can apply to measure the collaboration quality in their projects.

**Keywords:** Collaboration, performance, cost, schedule, quality, construction

## 1 Introduction

The McKinsey Global Institute (Barbosa et al., 2017) claims that USD1.6 trillion is wasted each year globally due to poor productivity in the construction industry and that in most countries construction is lagging behind other industries when it comes to productivity. The specific figures are open to debate, but in general, this productivity gap is widely recognized among researchers (Zhang et al., 2018, Fulford and Standing, 2014).

Among several areas to improve, it estimated that improved collaboration alone could improve construction productivity by 8-9% (Barbosa et al., 2017). The term *collaboration* has been defined by the Institute for Collaborative Working (ICW, 2017, p. 29): *"Collaboration is a commitment between two or more parties to create value by striving to achieve shared competitive goals and operational benefit through a spirit of mutual trust and openness*".

There is a general agreement that improved collaboration has a positive effect on performance in construction projects (Caniëls et al., 2019, Sarhan et al., 2017, Walker et al., 2017, Eriksson and Westerberg, 2011). The majority of existing studies are based on surveys with limited empirical support and more empirical research on the relationship between collaboration and project performance is needed (Bond-Barnard et al., 2018, Silva and Harper, 2018, Meng and Gallagher, 2012). The purpose with this paper is to respond to this call for more empirical research as we used Dietrich et al. (2010)'s definition of collaboration quality and explored the relationship between collaboration quality and project performance in terms of cost, schedule and quality of the deliverables on a substantial dataset. We used these empirical data to test the proposition suggested by others, such as Eriksson and Westerberg (2011), that there is a positive relationship between collaboration and project performance.

Through bivariate analysis of a dataset of 142 Norwegian construction and infrastructure projects that utilize the 10-10 benchmarking system developed by the Construction Industry Institute (CII), we address the following research questions:

RQ: What is the relationship between collaboration quality in projects and project performance in terms of cost, schedule and quality?

The research objective of this paper is to establish an indicator to measure the collaboration quality in projects and use this indicator to investigate the relationship between collaboration quality and project performance. We contribute to the body of knowledge in a field where more empirical studies are needed (Bond-Barnard et al., 2018, Silva and Harper, 2018, Meng and Gallagher, 2012).

The structure of this paper is as follows. First, we present the theoretical background of the topic and present the research method. Next, we present the results and discuss their implications for theory and practice. This is followed by a conclusion where we summarize the paper and make recommendations for further research.

## 2 Theoretical background

The following section provides an overview of the state-of-the-art research on the relationship between collaboration and project performance. We identify a research gap calling for further empirical research on this topic. Finally, we discuss the theoretical foundation for building the collaboration quality construct that is used in this paper to analyze empirical data.

## 2.1 Relationship between collaboration and project performance

Collaboration generally has a positive effect on project performance (Bond-Barnard et al., 2018, Um and Kim, 2018, Cicmil and Marshall, 2005, Turner and Müller, 2003). It should lead to win-win situations for all parties (Bititci et al., 2007, Yeung et al., 2007) and the value of the relationship between customers and suppliers in supply chains is enhanced if there is a high degree of collaboration (Vaaland and Håkansson, 2003).

In **Table** ***2-1*** we present a summary of existing research that investigates the relationship between collaboration and project performance with regard to cost, time and quality, in other words, the performance measures within the traditional "iron triangle" of project efficiency constraints (Rezvani and Khosravi, 2018). In this table, a (+) symbol indicates where authors have found a correlation between collaboration and each of the three dimensions of the iron triangle, as opposed to a (-) symbol indicating that the authors studied this relation but found no correlation. A blank cell indicates that the authors did not study the relationship between collaboration and the specific dimension.

**Table 2-1: Existing research on the relationship between collaboration and project performance in terms of cost, time and quality**

| Author | Unit of analysis | Data collection method | Performance dimension | | |
|---|---|---|---|---|---|
| | | | Cost | Schedule | Quality |
| (Eriksson and Westerberg, 2011) | Factors affecting project performance | Conceptual framework based on literature | (+) | (+) | (+) |
| (Iyer and Jha, 2005) | Cost performance success factors | Survey, 112 practitioners in India | (+) | | |
| (Chan et al., 2003) | Partnering benefits | Survey 78 respondents in Hong Kong | (+) | (+) | (+) |
| (Silva and Harper, 2018) | Correlation between team integration and performance (cost/time) | Survey 26 projects in the US | (+) | (-) | |
| (Ibrahim et al., 2018) | Difference in performance between IPD projects and non-IPD | Survey, 109 projects | (+) | (+) | (+) |
| (Franz et al., 2017) | Difference in performance between contract types | Survey, 204 projects in the US | (+) | (+) | (+) |
| (Suprapto et al., 2016) | Difference in performance between contract types | Survey, 119 practitioners from | (+) | (+) | (+) |

| | | | | | |
|---|---|---|---|---|---|
| | | various in industries in the Netherlands | | | |
| (Dietrich et al., 2010) | Collaboration antecedents and outcomes | Conceptual framework based on literature | (+) | (+) | (+) |
| (Cho and Ballard, 2011) | Difference in performance between IPD projects and nonIPD | 49 construction projects | (+) | (+) | |
| (Asmar et al., 2013) | Difference in performance between IPD projects and nonIPD | Survey, 35 US construction projects | (-) | (+) | (+) |
| (Hanna, 2016) | Difference in performance between | Survey, 12 projects, 42 practitioners | (-) | (+) | (-) |
| | IPD projects and nonIPD | | | | |
| (Bond-Barnard et al., 2018) | Link between collaboration and project success | Online survey, 151 respondents from various industries | (+) | (+) | (+) |
| **Note:** | | | | | |
| (+) authors suggest that there is a relationship with collaboration | | | | | |
| (-) authors suggest that there is no relationship with collaboration | | | | | |
| Blank cell: the author did not discuss the relationship with collaboration | | | | | |

Eriksson and Westerberg (2011) proposed a conceptual framework with a positive relationship between collaboration level and project performance in terms of cost, time, and quality. In addition, they proposed a positive relationship between collaboration and success in terms of environmental impact, work environment and innovation. Similar findings were also reported by Dietrich et al. (2010), who through an extensive literature review of existing research found a relationship between collaboration quality and project success. Iyer and Jha (2005) conducted a survey of Indian construction projects where they identified coordination as the most significant factor that influenced project cost performance. Chan et al. (2003) conducted a survey of 78 practitioners working with partnering projects in Hong Kong and found that collaboration was positively related to all three sides of the iron triangle.

Based on a survey of US public transportation projects, Silva and Harper (2018) investigated correlations between how well-integrated teams were in projects and how well these projects performed with regard to cost and schedule. They found that project organizations that experience high levels of collaboration, in general, perform better with regard to cost performance, while there was no clear correlation with schedule performance. However, in their survey, only 26 projects had registered cost and schedule performance and the authors have encouraged other researchers to collect more project data and perform similar studies. Recently Bond-Barnard et al. (2018) published results from a survey where they found empirical evidence of a positive relationship between collaboration and project management success in terms of cost, time and quality.

Several studies compare how projects using different contract types perform with regard to cost, time and quality. Sullivan et al. (2017) provide a summary of 30 existing studies performed by researchers on projects using either design-build (DB), construction manager at risk (CMR) or design-bid-build (DBB) delivery methods. However, none of these 30 studies included projects that utilize high-order collaborative arrangements. Recently, some empirical studies have been published with a focus on the performance of higher-order collaborative delivery methods. For example, Ibrahim et al. (2018) analyzed 109 projects and found that projects that utilized Integrated Project Delivery (IPD) arrangements, in general, outperformed the remaining projects that used less collaborative procurement arrangements. Similar findings are reported by Asmar et al. (2013), who compared 12 IPD projects with 23 non-IPD projects in the US and found that there were no significant differences in cost performance between these projects but that there was a small difference in schedule growth. However, they found that IPD projects were superior in quality performance compared with the non-IPD projects. Regarding quality performance, Hanna (2016) came to a different conclusion and found no difference in quality performance between IPD and non-IPD projects. However, Hanna (2016) did find similar results to those of Asmar et al. (2013) regarding cost and schedule growth.

Furthermore, Franz et al. (2017) collected data from 204 projects and found generally positive correlations between collaboration and project performance in terms of cost, time and quality. They found some differences between various delivery methods but highlighted that choosing a collaborative contract arrangement did not automatically lead to improved performance. Similar conclusions were reached by Suprapto et al. (2016), who studied project performance based on survey responses from 119 practitioners in the Netherlands and compared how projects (mainly oil and gas) used various contract types performed. Their main finding was that relational attitude and level of teamwork are more important than which type of contract is used.

## 2.2 Research gap

According to von Danwitz (2018), there is a general need for project management research for more quantitative studies based on large datasets. The majority of empirical research on the relationship between collaboration and performance in construction projects is focused on comparing projects that use different procurement arrangements and contract types as shown in **Table** ***2-1***. The prevailing view on performance measurement is that more research is needed on collaborative organizations (Bititci et al., 2012). Eriksson and Westerberg (2011) encourage researchers to collect data from a large number of projects to test their proposition that there is a positive relationship between collaboration and project performance.

*"The value of having this framework tested is potentially great as the project management literature has many indications that increased cooperation may be a good strategy for achieving project success, but empirical evidence delineating this in a more holistic way is lacking"* (Eriksson and Westerberg, 2011, p. 206).

There is a need for more empirical research to investigate the relationship between collaboration and project performance (Bond-Barnard et al., 2018, Silva and Harper, 2018, Meng and Gallagher, 2012).

## 2.3 Collaboration quality

Based on a review of existing literature, we have proposed constructs that describe the quality of the collaboration in projects. We will use these constructs to study the correlation between collaboration quality and project performance, as presented in the method section in this paper. These constructs are Trust, communication, teamwork, and coordination. Supporting literature that provides a theoretical foundation for each construct is presented in **Table** ***2-2***. In section 3 of this paper, we connect these four constructs to our dataset containing questionnaires collected from projects.

**Table 2-2: Summary of elements describing collaboration quality**

| Collaboration element | Supporting literature |
|---|---|
| C1 - Trust | (Walker and Lloyd-Walker, 2016)<br>(Chan et al., 2004)<br>(von Danwitz, 2018)<br>(Bond-Barnard et al., 2018)<br>(Pinto et al., 2009)<br>(Kadefors, 2004)<br>(Haaskjold et al., 2019)<br>(Nevstad et al., 2018)<br>(Suprapto et al., 2015)<br>(Ling et al., 2013)<br>(Yeung et al., 2007)<br>(Dietrich et al., 2010) |
| C2 - Communication | (Walker and Lloyd-Walker, 2016)<br>(Dietrich et al., 2010)<br>(Chan et al., 2004)<br>(Badi and Pryke, 2015)<br>(Aliakbarlou et al., 2018)<br>(Simatupang and Sridharan, 2005)<br>(Nevstad et al., 2018)<br>(Suprapto et al., 2015)<br>(Yap et al., 2017)<br>(Hoegl and Gemuenden, 2001)<br>(Yeung et al., 2007) |
| C3 – Teamwork | (Aliakbarlou et al., 2018)<br>(Caniëls et al., 2019)<br>(Suprapto et al., 2016)<br>(Walker and Lloyd-Walker, 2016)<br>(Hoegl and Gemuenden, 2001)<br>(von Danwitz, 2018)<br>(Ling et al., 2013) |
| C4 – Coordination | (Walker and Lloyd-Walker, 2016)<br>(Dietrich et al., 2010)<br>(Chan et al., 2004)<br>(von Danwitz, 2018)<br>(Hoegl and Gemuenden, 2001)<br>(Ling et al., 2013)<br>(Dietrich et al., 2010) |

Several authors such as (Bond-Barnard et al., 2018, Pinto et al., 2009, Kadefors, 2004) have found a positive relationship between trust and collaboration in projects. Trust is defined by (Rousseau et al., 1998, p. 395) as follows: "Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another". Furthermore, trust can have different forms. Calculative trust follows rational choices (Rousseau et al., 1998) and can be tangible in terms of for example certificates (Kadefors, 2004). Relational trust is less tangible and develops over time based on previous behavior (Rousseau et al., 1998) while institutional trust describes how necessary circumstances for trust are created through for example legal systems (Rousseau et al., 1998).

An openness that encourages the sharing of both bad and good news is positively associated with trust (Suprapto et al., 2015, McAllister, 1995). Having effective mechanisms to resolve issues is one of several factors that contributes to trust (Manu et al., 2015). Other elements of trust include role clarity (Henderson et al., 2016, Buvik and Rolfsen, 2015) and empowering team members and contractors with sufficient authority (Schoorman et al., 2007).

Effective communication plays an important role in the collaborative relationship between clients and contractors (Aliakbarlou et al., 2018). It is important that all parties communicate and understand the project's objectives and goals (Yeung et al., 2007). Poor communication can lead to misunderstandings and conflicts (Lædre, 2009, Young, 2006). The quality of communication is often best when there is a balance between formal and informal communication (Turner and Müller, 2004). Geographical co-location often leads to better communication and higher collaboration levels among the parties (Walker and Lloyd-Walker, 2015). Another example is how the use of shared workspaces facilitates better communication between different professions on construction sites (Christensen, 2008).

Teamwork quality influences how well teams collaborate (Hoegl and Gemuenden, 2001). Parties that achieve a high order of collaboration often demonstrate strong elements of a no-blame culture, consensus when making decisions and a culture where the team members act for the best of the project instead of pursuing personal gains (Walker and Lloyd-Walker, 2015). Having team members with the right experience (Park and Lee, 2014, Patel et al., 2012) who are motivated by good leadership (Caniëls et al., 2019) contributes to a high-performing collaborative climate.

Coordination describes to what extent the parties have a common understanding of the goals and what activities need to be taken to achieve these (Dietrich et al., 2010). In order to collaborate, the parties must manage the interfaces between stakeholders effectively and ensure that resources are allocated where they are needed most (Chan et al., 2004). Having effective work processes to manage and coordinate activities and changes also contributes to improved collaboration (Simatupang and Sridharan, 2005).

Through a literature review, we have identified the need for more empirical research on the relationship between collaboration and project performance. Furthermore, we have presented the theoretical foundation for construct elements that describe collaboration quality. In the following section, we present the research method used as we analyzed a set of data from construction and infrastructure projects in Norway.

## 3 Data and methodology

Through deduction, we build constructs based on existing theory, analyze empirical data, and compare findings with previous research. The dataset contains quantitative empirical data collected from 142 Norwegian construction and infrastructure projects that utilize the 10-10 benchmarking tool. We conducted a bivariate analysis to explore relationships between collaboration quality and project performance. Typically we use bivariate analysis when we search for evidence that variation in one variable correlates with the variation in another variable (Bryman, 2016).

### 3.1 10-10 Benchmarking program of Norwegian construction projects

As a response to the negative trend in productivity in the Norwegian construction industry (Todsen, 2018) the Norwegian Building Authority (DiBK) initiated a study to identify measurement tools that industry actors could use to measure and benchmark their performance. The outcome of this study was a recommendation to implement the CII 10-10 benchmarking program in Norway (Langlo et al., 2017). The 10-10 Program was originally developed by the US-based Construction Industry Institute (CII) and is designed to evaluate project performance in the construction industry (Yun et al., 2016). Data from each project are recorded and companies receive benchmarking scores on their performance compared with other projects in the database. The categories for rating are based on CII's 30 years of research on best industry practice for 10 input factors and 10 outcomes, hence the name 10-10.

In Norway, several major construction owners and contractors have implemented the 10-10 Program in their project organizations and today data from 142 projects from 26 different companies have been registered in a common database for Norwegian projects. Companies participating in the 10-10 Program receive feedback on how they perform compared to a selection of comparable projects and use this as a tool for continuous improvement. Based on these measures, project organizations can evaluate how they are performing in order to adjust and improve their performance (Choong, 2014). In addition to providing a benchmarking tool for companies, one intention in establishing the 10-10 Program in Norway was to establish a database with a large volume of reliable project data that can be used for academic project management research (Langlo et al., 2017).

## 3.2 Suitability of 10-10 dataset to investigate research questions

The projects in the database can be grouped into three main characteristics which are: Road construction projects, power grid development projects, and building projects. The building projects typically include hospitals, schools, apartment buildings and other large buildings. With regards to the procurement method used for the 142 projects recorded in the database, the distribution was as follows: 50 of the projects used the design-bid-build method, 76 projects used design-build, 14 used parallel primes while 2 used Integrated Project Delivery models.

The authors have access to all data in the 10-10 database for Norwegian projects. Since 142 projects are registered in the database today and the fact that each of these contains in average 79 data points registered by project participants (in total 1,629 people), we consider this a substantial dataset. All these data are extracted from the CII 10-10 system and have subsequently been entered into the IBM SPSS software by the authors.

The dataset for each project consists of two main sections. The first section contains descriptive information which includes specific scope, cost, and schedule data for the project. Both planned and actual values are registered. The second section contains data collected through a questionnaire developed by CII based on their research on industry best practices (Yun et al., 2016). The full set of questionnaires can be downloaded from the 10-10 Program website (http://www.10-10program.org). Certified 10-10 benchmarking coordinators facilitate the data collection process in the companies to ensure the reliability of the data. These coordinators also provide guidance to respondents who have questions related to the interpretation of the questions. Numbers and values such as cost data, schedule data, etc., are entered into the database by the coordinator based on input from the project manager and/or project control personnel.

Furthermore, when a company's 10-10 coordinator submits the data to the database, the data is validated by CII in the United States as a final check of the dataset.

Respondents are chosen by the project manager and the company's certified 10-10 coordinator to ensure that relevant fields of expertise are covered. On average, each project in the dataset has 11.5 respondents filling in the questionnaire (total 1,629 respondents).

A schematic presentation of our research design is shown in **Figure** ***3-1***. The left side of the figure illustrates how we built a common construct for collaboration quality and this is further described in chapter 3.3 of this paper. The right side of **Figure** ***3-1*** shows how we measure project performance in terms of cost growth, schedule growth and quality of deliverables, something that is further described in section 3.4.

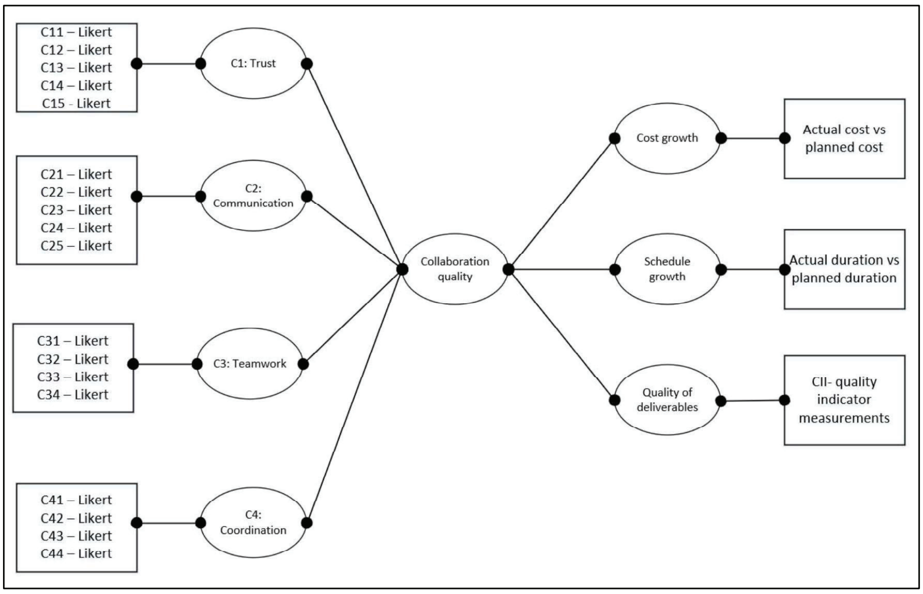



**Figure 3-1: Research design schematic**

## 3.3 Collaboration quality construct

Construct concepts must be soundly founded on theory and we must apply statistical tools to test that they are reliable and measure the same concept (Bryman, 2016). In this section, we provide the theoretical foundation for our constructs before we calculate the Cronbach's alpha to check the internal reliability of the constructs. In **Table** ***2-2***, we presented a summary of elements that describe collaboration quality in projects. This summary was based on a literature review of existing research. Next, we searched the questions in the 10-10 dataset for questions that describe any of these elements and sorted these into the constructs. A complete list of which questions are associated with each question from the questionnaire is presented in **Table** ***3-1*** together with supporting literature providing the theoretical foundation for allocating the questions to the construct to ensure validity. All the questions in this table utilize the same Likert scale with five increments ranging from *strongly disagree* (1) to *strongly agree* (5).

**Table 3-1: Building constructs for collaboration quality based on questions in the 10-10 questionnaire**

| Question from 10-10 questionnaire | Supporting literature |
|---|---|
| **C1: Trust** | |
| C11-Project leaders were open to hearing "bad news", and they wanted input from project team members | (Suprapto et al., 2015)<br>(McAllister, 1995)<br>(Chan et al., 2004)<br>(Hoegl and Gemuenden, 2001) |
| C12 - When issues arose, there were effective mechanisms to ensure they were resolved | (Manu et al., 2015)<br>(Dietrich et al., 2010)<br>(Chan et al., 2004)<br>(Ling et al., 2013)<br>(Kvålshaugen and Sward, 2018) |
| C13-Project management team members were clear about their roles and how to work with others on the project | (Kalkman and de Waard, 2017)<br>(Buvik and Rolfsen, 2015)<br>(Dietrich et al., 2010)<br>(Chan et al., 2004) |
| C14 - A high degree of trust, respect and transparency existed among companies working on this project | (Pinto et al., 2009)<br>(Kadefors, 2004)<br>(Walker and Lloyd-Walker, 2016)<br>(Bond-Barnard et al., 2018)<br>(Chan et al., 2004) |
| C15 - Project team members had the authority necessary to do their jobs | (Schoorman et al., 2007)<br>(Park and Lee, 2014)<br>(Kvålshaugen and Sward, 2018) |
| **C2: Communication** | |
| C21 - The project's objectives were appropriately communicated to the relevant project team members | (Yeung et al., 2007)<br>(Walker and Lloyd-Walker, 2016)<br>(Walker et al., 2017)<br>(Badi and Pryke, 2015)<br>(Hoegl and Gemuenden, 2001) |
| C22 – The project management team maintained open and effective communication | (Dietrich et al., 2010)<br>(Walker et al., 2017)<br>(Chan et al., 2004) |
| | (Hoegl and Gemuenden, 2001) |
| C23 - The owner level of involvement was appropriate | (Andersson, 2016)<br>(Badi and Pryke, 2015)<br>(Kvålshaugen and Sward, 2018) |
| C24 - Leaders effectively communicated business objectives, priorities and project goals | (Yeung et al., 2007)<br>(Dietrich et al., 2010)<br>(Ling et al., 2013) |
| C25 - Plan and progress including changes were communicated clearly and frequently among project stakeholders | (Simatupang and Sridharan, 2005)<br>(Walker et al., 2017)<br>(Ling et al., 2013) |

| **C3: Teamwork** | |
|---|---|
| C31 - People on this project worked effectively as a team | (Caniëls et al., 2019)<br>(Suprapto et al., 2016)<br>(Ling et al., 2013) |
| C32 - All of the necessary, relevant project team members were involved in the risk assessment process | (Walker and Lloyd-Walker, 2016)<br>(Walker et al., 2017)<br>(Tsiga et al., 2016) |
| C33 - The project team including project manager(s) had skills and experiences with similar projects / processes | (Patel et al., 2012) (Park and Lee, 2014) |
| C34 - Project leaders recognised and rewarded outstanding personnel and results | (Caniëls et al., 2019)<br>(Maurer, 2010)<br>(Kvålshaugen and Sward, 2018) |
| **C4: Coordination** | |
| C41 - The interfaces between project stakeholders were well managed | (Rahi et al., 2019)<br>(Pinto, 2010)<br>(PMI, 2017)<br>(Jaafar and Yusof, 2019) |
| C42 - The project control system was effective in monitoring project progress in terms of cost, schedule and scope | (Yousefi et al., 2019)<br>(PMI, 2017)<br>(De Koning and Vanhoucke, 2016) |
| C43- A dedicated process was used to proactively manage change on this project | (Simatupang and Sridharan, 2005)<br>(PMI, 2017)<br>(Pinto, 2010) |
| C44- Resources were allocated according to project priorities | (Chan et al., 2004)<br>(Patel et al., 2012)<br>(PMI, 2017) |

Furthermore, we consolidated the constructs C1-C4 into one combined construct called "Collaboration quality" as shown in **Table *3-2*** and **Figure *3-1***. This collective construct describes the overall collaboration quality in each project.

The more questions that measure the same attribute, the greater the reliability of the data. However, when we use multiple indicator measures, such as several questions from a questionnaire, we need to make sure that these questions measure the same thing (Bryman, 2016). To validate that the various questions in a constructed measure the same attribute we must, in addition to building these on theory, check the internal reliability of the construct. A commonly used test is to calculate what is known as the "Cronbach's coefficient alpha" (Bryman, 2016). This is a coefficient developed by Cronbach (1951) to measure the internal consistency of a scale containing multiple items. The higher the value of the coefficient, the more reliable our constructs are. An often-cited source is Murphy and Davidshofer (2005), who suggested that values below 0.6 are unacceptable, 0.7 is low level, 0.8-0.9 is moderate to a high level, and above 0.9 is high level. Kaplan and Saccuzzo (2009) state that coefficients in the range between 0.7 and 0.8 are generally considered "good enough" for most research and that the more items included in a construct the more reliable it becomes. Bryman (2016) recommends 0.8 as a rule of thumb for an acceptable level. Although more than two decades old, it is interesting to read the work by Peterson (1994), who investigated alpha coefficients from 832 published studies and found that the mean value was 0.77. Furthermore, Peterson explored the alpha value for studies using various construct scales. For constructs based on more than three items and with Likert scales containing more than 4 scale items, the mean value was 0.78 (Peterson, 1994). Purely presenting Cronbach's alpha is not enough alone to verify that constructs measure the same attribute (Schmitt, 1996) and we must build the constructs on a solid theoretical foundation to ensure validity (Bryman, 2016) as shown in **Table *3-1***.

Using the IBM SPSS software, we calculated the Cronbach's alpha coefficient for our constructs and report these in **Table *3-2***. The Cronbach's alpha for the four constructs C1-C4 is in the range between 0.79 and 0.89. We also see from **Table *3-2*** that the Cronbach's alpha for the overall "collaboration quality" construct combining C1, C2, C3, and C4 is 0.93. We, therefore, argue that the questions from the questionnaire that have been associated with each construct have acceptable internal consistency, i.e., the various questions combined into a constructed measure the same attribute or concept.

In addition to the Cronbach's alpha being acceptable, we should investigate the factor loading to determines the minimum sample size needed to ensure statistical significance. A loading factor of 0.70 or higher means that a sample size of 60 is sufficient. For a sample size of 100, the factor loading should be above 0.55 (Hair et al., 2014). We see from **Table *3-2*** that our lowest factor loading is 0.73, i.e. acceptable for our sample size.

Furthermore, we should have composite reliability (CR) values of a minimum 0.70 (Bagozzi and Yi, 1988) and the values for the average variance extracted (AVE) should not be lower than 0.50 (Bagozzi and Yi, 1988, Fornell and Larcker, 1981). Our lowest CR value is 0.87 and the lowest AVE value is 0.60, i.e., acceptable.

**Table 3-2: Reliability of constructs**

| **Latent variable** | **Observed variable (ref *Table 3-1* )** | **Factor loading □** | **Average variance extracted (AVE)** | **Composite reliability (CR)** | **Cronbach's □** |
|---|---|---|---|---|---|
| **C1** | | | **0.70** | **0.92** | **0.89** |
| | C11 | 0.79 | | | |
| | C12 | 0.85 | | | |
| | C13 | 0.85 | | | |
| | C14 | 0.85 | | | |
| | C15 | 0.84 | | | |
| **C2** | | | **0.60** | **0.88** | **0.83** |
| | C21 | 0.77 | | | |
| | C22 | 0.82 | | | |
| | C23 | 0.73 | | | |
| | C24 | 0.76 | | | |
| | C25 | 0.81 | | | |
| **C3** | | | **0.63** | **0.87** | **0.80** |
| | C31 | 0.84 | | | |
| | C32 | 0.80 | | | |
| | C33 | 0.76 | | | |
| | C34 | 0.77 | | | |
| **C4** | | | **0.62** | **0.87** | **0.79** |
| | C41 | 0.79 | | | |
| | C42 | 0.76 | | | |
| | C43 | 0.73 | | | |
| | C44 | 0.86 | | | |
| | | | | | |
| **Collaboration** | | | **0.82** | **0.95** | **0.93** |
| | C1 | 0.93 | | | |
| | C2 | 0.90 | | | |
| | C3 | 0.93 | | | |
| | C4 | 0.87 | | | |

## 3.4 Performance in terms of cost, schedule and quality of deliverables

In this paper, we investigate how collaboration quality is related to project performance in terms of cost, time and quality. Above, we have described how we used the questionnaire from the 10-10 dataset to build reliable constructs measuring the collaboration quality in the projects. The following section describes how performance in terms of cost, time and quality is represented in the 10-10 dataset. Performance in terms of these dimensions is commonly known as the "iron triangle" (Rezvani and Khosravi, 2018). Most researchers today agree that iron triangle is too limited as a definition of project success (Müller and Jugdev, 2012). We agree, and broader definitions have for example been proposed by Pinto and Slevin (1988) as a supplement to the iron triangle to describe success. However, the dataset we investigate mainly contains performance metrics within the iron triangle of cost, time and quality. For this reason, we have chosen to narrow our study to these metrics.

In the dataset, both the planned cost and the actual cost were recorded for each project in monetary value. Based on this, a factor called cost growth is calculated. The cost growth factor is simply the actual cost compared with the planned cost. From the 142 projects included in the dataset, the cost growth factor was calculated for 104 of these. For the remaining cases, either planned cost or actual cost had not been registered sufficiently. Similarly, we can also calculate the scheduled growth for each project. The schedule growth factor is calculated by comparing the actual duration with the planned duration. From the 142 projects included in the dataset, the schedule growth factor was calculated for 125 of these. For the remaining cases, either planned duration or actual duration had not been registered sufficiently.

Quality is defined by PMI (2017) p. 718 as "the degree to which a set of inherent characteristics fulfills requirements", while Juran and Godfrey (1999) and Oakland (2012) remind us that quality is also associated with meeting customers' needs beyond purely conforming to specifications and requirements. The project should create value for the owner (Haddadi and Johansen, 2019). Based on the research of industry best practice, CII has developed a quality performance indicator that is measured with the 10-10 benchmarking tool. Based on the various data registered for each project, the quality performance indicator is calculated as a number ranging from 0 to100. This indicator cover several aspects related to quality best practices such as Amount of changes, errors, omissions and cost of quality (PMI, 2017), meeting functional and regulatory requirements (Arditi and Gunaydin, 1997), level of non-conformances and deviations (Yeung et al., 2013), conformity to expectations (Molenaar et al., 1999) and client satisfaction (Oakland, 2012, Juran and Godfrey, 1999).

## 3.5 Criticism of the method

We have not designed the questions used in the dataset ourselves specifically to address the research questions of this paper, but instead reviewed an existing dataset and searched for relevant questions related to our research questions. With this pragmatic approach, we must be careful to avoid bias and ensure that the data we use from the 10-10 dataset is relevant for our specific research questions and soundly founded on existing theoretical frameworks. To compensate for this, we have performed an extensive literature review, presented in **Table *3-1***, to ensure that we have a solid theoretical foundation when we allocate questions to each construct. Furthermore, we have validated the internal reliability of these constructs by calculating Cronbach's alpha.

Companies that participate in the 10-10 program are proactive and seek continuous improvement in their projects. Since the dataset only contains data from such projects, one can argue that projects with less focus on continuous improvement and benchmarking will not be captured in the dataset, as they may not have been using the 10-10 benchmarking tool. Furthermore, we know that being measured does affect behavior (Spitzer, 2007) and one can, therefore, argue that there is a risk that participants may focus more on specific elements that they know will be measured through the 10-10 program than other elements not specifically measured. There is also a risk of respondent bias as many of the respondents to some extent are responsible or accountable for the project outcome. One can, therefore, argue that this may have influenced how respondents answer certain questions.

The data are collected in projects that are executed in Norway and one can, therefore, argue that some caution should be taken in generalizing findings outside this context. However, the questions in the questionnaire were developed by CII based on their comprehensive research on best practices (Yun et al., 2016) and we argue that this is an element that improves the generalisability of the findings.

# 4 Results and analysis

In this section, we report the results of our analysis. First, we provide a summary of the mean value and distribution for the various variables. Following this, we show detailed results from the bivariate analysis and report the Pearson's r correlations.

## 4.1 Descriptive summary

The main descriptive data from the analysis is shown in **Table *4-1*** and the frequency distribution of the data is presented in **Figure *4-1***. The projects experienced mean cost growth of 14% compared with the planned cost. Out of a total of 104 valid cases, 63 of these reported a cost-performance within +- 5% or better compared with the planned cost. The remaining 41 projects exceed the planned cost with more than 5%, and 16 of these exceeded the planned cost with more than 25%. The mean schedule growth factor was 13%. From 125 valid cases, 85 projects reported a schedule performance within +-5% of the planned duration or better. The other 40 projects exceed the planned duration with more than 5% where 23 of these exceeded the planned duration with more than 25%. These values for cost growth and schedule growth are similar to results published in a recent study of 418 projects where Chen et al. (2016) found that that 77% of the projects were completed on cost or below and that 68% finished on time, or ahead of time.

**Table 4-1: Descriptive statistics**

| Variable | Scale | Mean value | Std. deviation | Valid cases |
|---|---|---|---|---|
| Cost growth | (Actual cost / planned cost) - 1 | 0.14 | 0.53 | 104 |
| Schedule growth | (Actual duration / planned duration) - 1 | 0.13 | 0.51 | 125 |
| Quality of deliverables | Indicator ranging from 0-100 | 70.4 | 9.9 | 142 |
| Collaboration quality | Likert (1-5) | 3.76 | 0.52 | 142 |

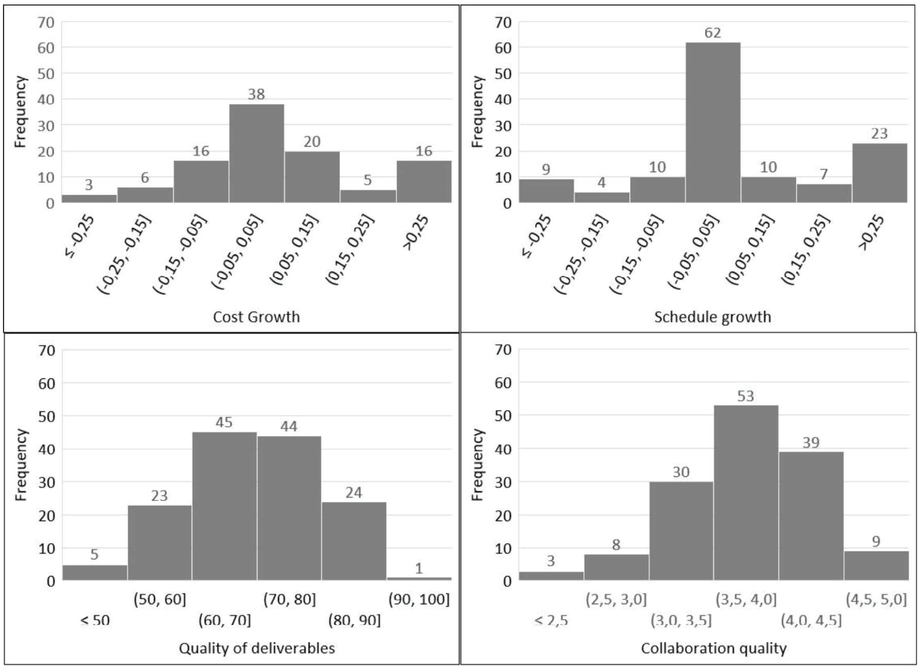



**Figure 4-1: Frequency distribution of results. Cost growth (top left), schedule growth (top right), quality of deliverables (bottom left) and collaboration quality (bottom right).**

From the top left and top right diagrams in **Figure** ***4-1*** we see the distribution for cost growth and schedule growth. We see that from those projects that finish above cost or behind schedule, many of them exceed the planned value with 25% or more. The fact that so many of the projects are found to the right in these two diagrams, away from the mean value, explains why the standard deviation is high compared with the mean value for cost growth and schedule growth in **Table** ***4-1***.

Moving on to the quality of deliverables, we see that on a scale from 0-100, the projects received a mean score of 70.4 for the measured indicator. From the bottom left diagram in **Figure** ***4-1*** we see that the distribution for this indicator follows a bell curve where few of the projects are to the far left or far right in the diagram. A similar distribution, although slightly skewed, is also found for the quality of collaboration indicator (bottom right diagram). On a Likert scale from 1 to 5, the mean score was 3.76 for this variable.

## 4.2 Bivariate analysis – Pearson's r correlation

A summary of Pearson's r correlations is shown in **Table** ***4-2***. The number between 0 and 1 indicates the strength of the relationship between the variables. A value close to 0 indicates a weak relationship, as opposed to values closer to 1, which indicates a strong relationship (Bryman, 2016). Various labeling systems exist to categorize the value of the correlation, i.e., the strength of the relationship. For example, Taylor (1990) argues that <0.35 indicates weak correlations while values between 0.36 and 0.67 have moderate strength. Higher values indicate strong correlations. A rule of thumb for medical research suggests the following: negligible (<0.30), low strength (0.30-0.50), moderate strength (0.50-0.70), high strength (0.70-0.90) and very high strength (>0.90) (Mukaka, 2012).

In addition to the strength of the relationship, we need to check if the relationships we found are statistically significant. I.e., to what extent can we expect that our findings apply to projects outside our sample size of 142 projects. According to Bryman (2016), statistical significance at <0.05 or lower is in general considered acceptable in social research. We can then argue that there is a five percent (or less) chance that we have identified a relationship in our dataset that is not representative of a larger population.

**Table 4-2: Pearson's r correlations between performance and collaboration quality**

| Variable / Variable | | Cost growth | Schedule growth | Quality of deliverables | Collaboration quality |
|---|---|---|---|---|---|
| **Cost growth** | Pearson Correlation | 1 | | | |
| | Sig. (2-tailed) | | | | |
| | N | 104 | | | |
| **Schedule growth** | Pearson Correlation | -.002 | 1 | | |
| | Sig. (2-tailed) | .984 | | | |
| | N | 102 | 125 | | |
| **Quality of deliverables** | Pearson Correlation | -.147 | -.086 | 1 | |
| | Sig. (2-tailed) | .138 | .341 | | |
| | N | 104 | 125 | 142 | |
| **Collaboration quality** | Pearson Correlation | -.088 | -.081 | .744** | 1 |
| | Sig. (2-tailed) | .372 | .367 | .000 | |
| | N | 104 | 125 | 142 | 142 |

Furthermore, we illustrate the findings in **Figure** *4-2* with scatter plots in the three first quadrants of the figure. Each dot in these scatter plots represents one project from the dataset. The horizontal axis shows the collaboration quality value for the project while the vertical axis indicates performance in terms of cost growth factor, schedule growth factor and quality of deliverables. Scatter plots are useful to examine bivariate relationships and variables grouped along a straight line indicate that there is a strong linear relationship or correlation (Hair et al., 2014). The fourth quadrant shows a schematic summary of the correlation between collaboration quality and each of the three sides of the iron triangle.

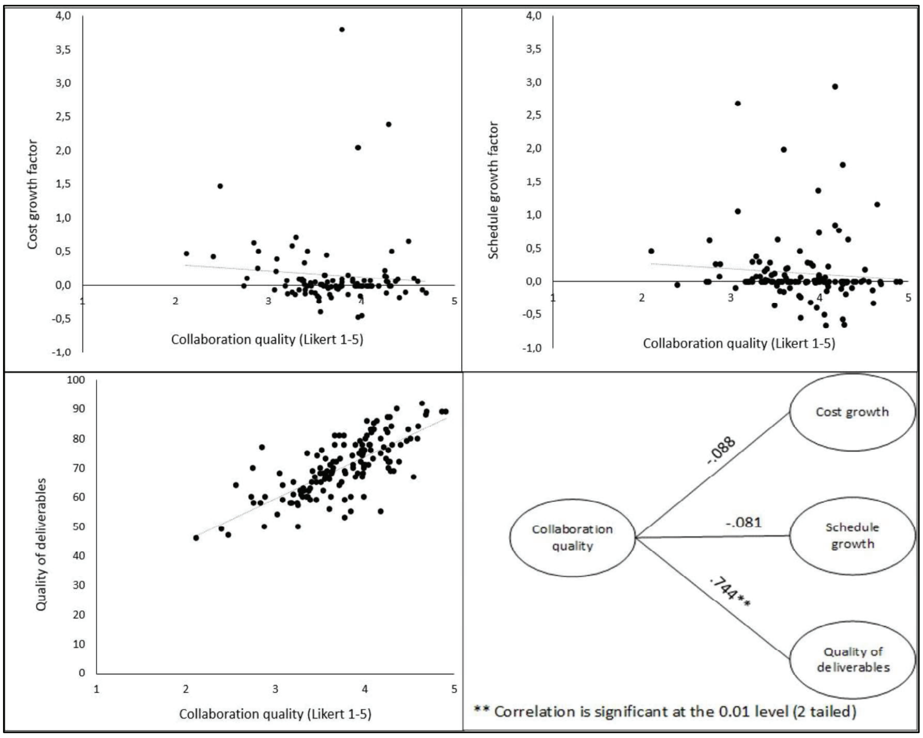



**Figure 4-2: Correlation between collaboration quality and project performance**

A common misuse of correlations is to interpret them as an explanation for cause and effect (Bryman, 2016). For example, our findings in **Table *4-2*** show a strong correlation between collaboration quality and the quality of the project deliverables. Although it is tempting to conclude that our findings show that improving collaboration will lead to improved quality of the deliverables, we cannot establish this cause and effect based on our findings. Our statistical analysis has purely identified that those projects that scored high on collaboration quality also, in general, scored high on the quality of their deliverables. We have to rely on existing research that investigates the specific cause and effect before making conclusions (Bryman, 2016).

### 4.2.1 Correlation between collaboration quality and cost growth

From ***Table 4-2*** we see that the value of the relationship found (-.088) is low and not statistically significant. Hence, we did not find evidence that suggests that projects that scored high on collaboration quality experience less cost growth than those that scored lower on collaboration quality. From the top left scatter plot in **Figure *4-2*** we see a few cases with very high-cost growth that may be considered outliers. To investigate the effect such potential outliers have on the results, we did a test where we removed these potential outliers from the dataset, but we found that this had very little impact on the results.

#### 4.2.2 Correlation between collaboration quality and schedule growth

Moving on, we see from ***Table 4-2*** that we did not identify a relationship between collaboration quality and schedule growth either. The Pearson's r factor is -0.081 and it is not statistically significant. Our study, therefore, finds no evidence that there is a relationship between collaboration quality in a project and the scheduled growth in the project. We also have potential outliers related to schedule growth in the data set because a few of the cases have rather a high schedule growth values, as one can see in the top right scatter plot in **Figure *4-2***. To investigate the effect such potential outliers have on the results, we did a test where we removed these potential outliers from the dataset, but we found that this had very little impact on the results.

#### 4.2.3 Correlation between collaboration quality and quality of deliverables

From ***Table 4-2*** we see that the relationship between collaboration quality and the quality of the deliverables is strong, with a value of 0.744. This relationship is also statistically significant at the 0.01 level. Projects that have received a high score for the collaboration quality construct have also received a high score for the quality level indicator of the project deliverables. From the bottom left scatter plot in **Figure *4-2***, we see that the variables follow a straight line. We, therefore, claim that we have found evidence suggesting a relationship between the quality of the collaboration in a project and the project performance in terms of quality.

## 5 Discussions and implications

In this section, we discuss the consequences of our findings and how they correspond with previous research in the field. Furthermore, we highlight contributions to the body of knowledge and practical implications from our research that practitioners may benefit from.

Most of the cited research in ***Table 2-1*** suggests that there is a relationship between collaboration quality in a project and the quality of the deliverables. Projects with a high level of collaboration are expected to experience fewer errors and deviations, more often meet requirements and more often have satisfied clients than projects with poor collaboration. Our research shows similar results as we find a clear correlation between collaboration quality in projects and how well these projects deliver in terms of the quality of the deliverables.

Consequently, our findings contribute to further validate existing research, as we have provided more empirical support in a field where several authors have highlighted the need for more empirical studies (Bond-Barnard et al., 2018, Silva and Harper, 2018, Meng and Gallagher, 2012). Our findings are similar to those of Eriksson and Westerberg (2011) and Bond-Barnard et al. (2018) who found a correlation between collaboration and quality performance. Participants in construction projects where there is a high level of trust are more likely to actively search for improvements and innovative solutions than in projects with less trust (Kadefors, 2004). Similarly, good communication and teamwork is important to ensure that all parties understand the goals for the projects and avoid misunderstandings (Li et al., 2015). If specifications and expectations are not clearly communicated, an opportunistic contractor may choose to reduce quality to increase profit or recoup costs for under-pricing (Liu et al., 2016). The best results are in general achieved when there is a balance between formal and informal communication (Turner and Müller, 2003). Trust, communication, teamwork and coordination are all important elements for collaboration (Haaskjold et al., 2019, Dietrich et al., 2010) and we found that projects that do well in these areas, in general, perform better in terms of quality of the project deliverables.

Our findings also raise a question related to how strong the relationship is between collaboration quality and project performance in terms of the remaining two sides of the iron triangle. Overrun on cost or time can often cause critical problems for project managers (Yousefi et al., 2019). With the exception of (Silva and Harper, 2018, Asmar et al., 2016, Asmar et al., 2013) the literature in ***Table 2-1*** suggests that projects with good collaboration in general also perform better in terms of both cost and schedule. Improved collaboration is one of several cures recommended by Zidane and Andersen (2018) as a remedy to reduce project delays. We found only weak correlations between collaboration and project performance in terms of cost and schedule. None of these were statistically significant. We do not argue that collaboration is bad for cost and schedule performance, but rather point out that for the projects we studied we found no clear correlations either way. There may be several reasons for this. The first obvious reason that needs to be discussed is the quality of our data itself. From the distribution in ***Figure 4-1*** we see that many of the projects reported a cost or schedule performance within +-5% of the planned value. We, therefore, excluded these from the dataset to explore how this affected the correlations. We found still no significant correlation with the cost growth of schedule growth even if we removed all projects that performed on cost and time from the dataset. Asmar et al.

(2013) found similar results to us in their study. They found a correlation between collaboration and quality, but not with cost or schedule.

Another possible reason for the lack of correlation between collaboration quality and performance in terms of cost and schedule is that there may be several independent factors that affect cost and schedule performance that does not necessarily correlate with collaboration. There are many different factors affecting project success (Fortune and White, 2006). One example of a factor that may affect project cost and time performance is how well the scope of work was defined (Iyer and Jha, 2005). Projects may experience growth in scope as a result of new requirements from the client. This will lead to cost growth and schedule growth as the project will cost more and take longer to complete. However, the quality of the deliverables will not suffer if the scope work increases and the duration and budget are increased to accommodate the increased work scope.

The main contribution to theory is that we have provided empirical analyses based on a high-quality data set within a research field where there is a need for more empirical research. Hence, we have responded to calls for more empirical research on the relationship between collaboration and project performance as raised by (Bond-Barnard et al., 2018, Silva and Harper, 2018, Meng and Gallagher, 2012). We have tested a part of the theoretical framework suggested by Eriksson and Westerberg (2011) and found evidence supporting their proposed relationship between collaboration quality and project success in terms of quality. The recorded data has been validated by CII, which has created the questionnaire based on three decades of research. We also claim that our study contributes to validating parts of the research by others such as Bond-Barnard et al. (2018) Silva and Harper (2018), Asmar et al. (2013) and Eriksson and Westerberg (2011). Our research makes a contribution to the body of knowledge dedicated to collaboration as proposed by (Busi and Bititci, 2006), as we share collaboration performance details from 142 projects.

When it comes to practical implications, we propose that project managers can use the collaboration quality construct that we established in this paper to measure the collaboration quality in their project. The 18 questions from the 10-10 questionnaire that constitute the construct are listed in **Table *3-1*** and can be applied by practitioners to measure collaboration quality. Our findings suggest that collaboration is strongly related to the quality side of the iron triangle.

More than a decade ago, Josephson and Saukkoriipi (2005) published a report of waste in Swedish construction projects and found that 10% of the total construction cost for projects at the time was related to control and repair poor quality. Hwang et al. (2009) claimed that direct costs related to rework are on average 5% of the construction cost. Large productivity benefits can be achieved if the quality of the project deliverables are improved through collaboration (Barbosa et al., 2017, Fulford and Standing, 2014). In this paper, we have established an indicator for measuring collaboration quality that project managers can use to measure the collaboration quality in their project. Since we also found a strong correlation between collaboration and the quality of the project deliverables, we propose that project managers can use the collaboration quality indicator as an early warning sign for the level of quality of the project deliverables from their project. If projects score low on the collaboration quality indicator in an early phase of the project, this may be a warning sign that the project may be heading in a direction where the deliverables may not be in accordance with specifications and client expectations. Hence, the project manager can take necessary actions at this stage to ensure that the desired quality level is achieved upon the delivery of the project.

## 6 Conclusion, limitations and recommendations for further research

The purpose of this paper was to investigate the relationship between collaboration and project performance in terms of cost, time and quality. We have analyzed a set of data from 142 Norwegian construction and infrastructure projects that utilize the 10-10 benchmarking tool developed by the Construction Industry Institute (CII). This is a high-quality dataset where certified coordinators in the participating companies collect data.

We have investigated the following research questions:

RQ: What is the relationship between collaboration quality in projects and project performance in terms of cost, schedule and quality?

We did not find evidence for a relationship between collaboration quality in projects and cost performance. Projects with high collaboration quality did not experience less cost growth than projects with lower collaboration quality. When it came to scheduling performance, we found similar results. Projects with high collaboration quality did not experience less schedule growth than those with lower collaboration quality.

However, we found a strong, and statistically significant, the relationship between collaboration quality and project quality performance. Projects with good collaboration experienced few errors and deviations and more often delivered according to requirements and client expectations than projects with poor collaboration.

Our main theoretical contribution is that we have provided empirical analyses of the relationship between collaboration and project performance based on what we consider to be a high- quality dataset. Hence, we contribute to increasing the number of empirical studies on a topic where several authors have highlighted the need for more empirical studies (BondBarnard et al., 2018, Silva and Harper, 2018, Meng and Gallagher, 2012). Furthermore, we have proposed an indicator to measure collaboration quality that can be used by project practitioners.

Although we consider the dataset to be of high quality, it has certain limitations. The data have been collected from only Norwegian projects. However, the 10-10 tool that was used to collect data has been developed by CII based on their research on project best practices (Yun et al., 2016). Another limitation is that one can argue that projects that use the 10-10 benchmarking have taken an action toward continuous improvement purely by participating in this benchmarking program. There is a risk that low-performing projects are less likely to take part and register their data with the 10-10 benchmarking tool and that such projects may, therefore, be less represented in the dataset than high-performing projects. We see that the performance data for the projects in our dataset follow a similar distribution as data published in studies from other countries. We, therefore, argue that our findings can be generalized, at least to a certain extent, outside the Norwegian context and the 10-10 benchmarking program,

Another potential weakness is that companies that use the benchmarking tool used repeatedly for new projects. Participants are therefore aware of the measured metrics in the benchmarking tool and they may know what will be measured. This can lead to what Meyer (2002) calls "perverse learning", a phenomenon where people adjust their behavior to ensure that they perform well on tasks that they know will be measured while other areas not measured will suffer.

As the size of the dataset increases with more registered projects, it would be interesting to perform longitudinal research on the same dataset to explore developments of trends. For example, how has the relationship between collaboration quality and project performance developed over time? Since we found no correlations with cost and schedule performance in our dataset, it would be welcome if other researchers with access to similar datasets conducted similar bivariate analyses and compared those with our findings.

As most of the studied cases in our research utilized design-build or design-bid-build as a delivery method it would be useful if future studies on the relationship between collaboration and performance included more cases that utilized more collaborative delivery methods such as IPD to see if the results will be different.

## References

**Aliakbarlou, S., Wilkinson, S. & Costello, S. B. 2018.** Rethinking client value within construction contracting services. *International Journal of Managing Projects in Business,* Vol. 11(4), pp. 1007-1025. doi:10.1108/IJMPB-07-2017-0076

**Andersson, A. 2016.** Communication barriers in an interorganizational ERP-project. *International Journal of Managing Projects in Business,* Vol. 9(1), pp. 214-233. doi:10.1108/IJMPB-06-2015-0047

**Arditi, D. & Gunaydin, H. M. 1997.** Total quality management in the construction process. *International Journal of Project Management,* Vol. 15(4), pp. 235-243.

**Asmar, M. E., Hanna, A. S. & Loh, W.-Y. 2013**. Quantifying Performance for the Integrated Project Delivery System as Compared to Established Delivery Systems. *Journal of Construction Engineering and Management,* Vol. 139(11), pp. 04013012. doi:10.1061/(ASCE)CO.1943-7862.0000744

**Asmar, M. E., Hanna, A. S. & Loh, W.-Y. 2016.** Evaluating Integrated Project Delivery Using the Project Quarterback Rating. *Journal of Construction Engineering and Management,* Vol. 142(1), pp. 04015046. doi:10.1061/(ASCE)CO.1943-7862.0001015

**Badi, S. M. & Pryke, S. D. 2015.** Assessing the quality of collaboration towards the achievement of Sustainable Energy Innovation in PFI school projects. *International Journal of Managing Projects in Business,* Vol. 8(3), pp. 408-440. doi:10.1108/IJMPB09-2014-0060

**Bagozzi, R. P. & Yi, Y. 1988**. On the evaluation of structural equation models. *Journal of the academy of marketing science,* Vol. 16(1), pp. 74-94.

**Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M., Bertram, N. & Brown, S. 2017**. Reinventing construction through a productivity revolution. *McKinsey Global Institute.*

**Bititci, U., Garengo, P., Dörfler, V. & Nudurupati, S. 2012.** Performance Measurement: Challenges for Tomorrow*. *International Journal of Management Reviews,* Vol. 14(3), pp. 305-327. doi:10.1111/j.1468-2370.2011.00318.x

**Bititci, U., Turner, T., Mackay, D., Kearney, D., Parung, J. & Walters, D. 2007.** Managing synergy in collaborative enterprises. *Production Planning & Control,* Vol. 18(6), pp. 454-465. doi: 10.1080/09537280701494990

**Bond-Barnard, T. J., Fletcher, L. & Steyn, H. 2018**. Linking trust and collaboration in project teams to project management success. *International Journal of Managing Projects in Business,* Vol. 11(2), pp. 432-457. 10.1108/IJMPB-06-2017-0068

**Bryman, A. 2016.** *Social Research Methods,* Oxford, Oxford University Press.

**Busi, M. & Bititci, U. S. 2006**. Collaborative performance management: present gaps and future research. *International Journal of Productivity and Performance Management,* Vol. 55(1), pp. 7-25. doi:10.1108/17410400610635471

**Buvik, M. P. & Rolfsen, M. 2015.** Prior ties and trust development in project teams – A case study from the construction industry. *International Journal of Project Management,* Vol. 33(7), pp. 1484-1494. https://doi.org/10.1016/j.ijproman.2015.06.002

**Caniëls, M. C. J., Chiocchio, F. & Van Loon, N. P. a. A. 2019.** Collaboration in project teams: The role of mastery and performance climates. *International Journal of Project Management,* Vol. 37(1), pp. 1-13. https://doi.org/10.1016/j.ijproman.2018.09.006

**Chan, A. P. C., Chan, D. W. M., Chiang, Y. H., Tang, B. S., Chan, E. H. W. & Ho, K. S. K. 2004.** Exploring Critical Success Factors for Partnering in Construction Projects. *Journal of Construction Engineering and Management,* Vol. 130(2), pp. 188-198. doi:10.1061/(ASCE)0733-9364(2004)130:2(188)

**Chan, A. P. C., Chan, D. W. M. & Ho, K. S. K. 2003.** An empirical study of the benefits of construction partnering in Hong Kong. *Construction Management and Economics,* Vol. 21(5), pp. 523-533. 10.1080/0144619032000056162

**Chen, Q., Jin, Z., Xia, B., Wu, P. & Skitmore, M. 2016.** Time and Cost Performance of DesignBuild Projects. *Journal of Construction Engineering and Management,* Vol. 142(2), pp. 04015074. doi:10.1061/(ASCE)CO.1943-7862.0001056

**Cho, S. & Ballard, G. 2011.** Last planner and integrated project delivery. *Lean Construction Journal,* Vol. 7(1), pp. 67-78.

**Choong, K. K. 2014.** Has this large number of performance measurement publications contributed to its better understanding? A systematic review for research and applications. *International Journal of Production Research,* Vol. 52(14), pp. 41744197. 10.1080/00207543.2013.866285

**Christensen, R. M. 2008.** *Development Practically Speaking, Learning processes in the Danish Construction Industry.* PhD thesis, Aalborg University.

**Cicmil, S. & Marshall, D. 2005.** Insights into collaboration at the project level: complexity, social interaction and procurement mechanisms. *Building Research & Information,* Vol. 33(6), pp. 523-535. 10.1080/09613210500288886

**Cronbach, L. J. 1951.** Coefficient alpha and the internal structure of tests. *psychometrika,* Vol. 16(3), pp. 297-334.

**De Koning, P. & Vanhoucke, M. 2016.** Stability of earned value management: Do project characteristics influence the stability moment of the cost and schedule performance index. *The Journal of Modern Project Management,* Vol. 4(1), pp. 8-25.

**Dietrich, P., Eskerod, P., Dalcher, D. & Sandhawalia, B. 2010.** The dynamics of collaboration in multipartner projects. *Project Management Journal,* Vol. 41(4), pp. 59-78. 10.1002/pmj.20194

**Eriksson, P. E. & Westerberg, M. 2011.** Effects of cooperative procurement procedures on construction project performance: A conceptual framework. *International Journal of Project Management,* Vol. 29(2), pp. 197-208. https://doi.org/10.1016/j.ijproman.2010.01.003

**Fornell, C. & Larcker, D. F. 1981.** Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research,* Vol. 18(1), pp. 3950.

**Fortune, J. & White, D. 2006.** Framing of project critical success factors by a systems model. *International Journal of Project Management,* Vol. 24(1), pp. 53-65. https://doi.org/10.1016/j.ijproman.2005.07.004

**Franz, B., Leicht, R., Molenaar, K. & Messner, J. 2017**. Impact of Team Integration and Group Cohesion on Project Delivery Performance. *Journal of Construction Engineering and Management,* Vol. 143(1)**,** pp**.** 04016088. doi:10.1061/(ASCE)CO.1943-7862.0001219

**Fulford, R. & Standing, C. 2014.** Construction industry productivity and the potential for collaborative practice. *International Journal of Project Management,* Vol. 32(2)**,** pp**.** 315-326. https://doi.org/10.1016/j.ijproman.2013.05.007

**Haaskjold, H., Andersen, B., Lædre, O. & Aarseth, W. 2019**. Factors affecting transaction costs and collaboration in projects. *International Journal of Managing Projects in Business,* Vol.**,** pp**.**

**Haddadi, A. & Johansen, A. 2019.** Value Proposition in Different Types of Buildings-Characteristics and Means. *The Journal of Modern Project Management,* Vol. 6(3)**,** pp**.**

**Hair, J., Black, W., Babin, B. & Anderson, R. 2014.** *Multivariate Data Analysis (new int. ed.),* Essex, Harlow: Pearson Education.

**Hanna, A. S. 2016.** Benchmark performance metrics for integrated project delivery. *Journal of Construction Engineering and Management,* Vol. 142(9)**,** pp**.** 04016040-1-9. doi:10.1061/(ASCE)CO.1943-7862.0001151

**Henderson, L. S., Stackman, R. W. & Lindekilde, R. 2016.** The centrality of communication norm alignment, role clarity, and trust in global project teams. *International Journal of Project Management,* Vol. 34(8)**,** pp**.** 1717-1730. https://doi.org/10.1016/j.ijproman.2016.09.012

**Hoegl, M. & Gemuenden, H. G. 2001.** Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence. *Organization Science,* Vol. 12(4)**,** pp**.** 435-449. 10.1287/orsc.12.4.435.10635

**Hwang, B.-G., Thomas, S. R., Haas, C. T. & Caldas, C. H. 2009.** Measuring the Impact of Rework on Construction Cost Performance. *Journal of Construction Engineering and Management,* Vol. 135(3)**,** pp**.** 187-198. doi:10.1061/(ASCE)0733-9364(2009)135:3(187)

**Ibrahim, M., Hanna, A. & Kievet, D. 2018.** Comparative Analysis between Project Delivery Systems through Quantitative Assessment of Project Performance. *Construction Research Congress 2018.*

**Icw 2017.** Insight into ISO 44001. London: Institute for Collaborative Working.

**Iyer, K. C. & Jha, K. N. 2005.** Factors affecting cost performance: evidence from Indian construction projects. *International Journal of Project Management,* Vol. 23(4)**,** pp**.** 283-295. https://doi.org/10.1016/j.ijproman.2004.10.003

**Jaafar, K. & Yusof, S. 2019.** Evaluating Stakeholder's Level of Involvement in Project Execution Phase. *The Journal of Modern Project Management,* Vol. 7(1)**,** pp**.**

**Josephson, P.-E. & Saukkoriipi, L. 2005.** Slöseri i byggprojekt: behov av förändrat synsätt. External organization.

**Juran, J. & Godfrey, A. B. 1999**. *Quality handbook,* New York, McGraw-Hill.

**Kadefors, A. 2004.** Trust in project relationships-inside the black box. *International Journal of Project Management,* Vol. 22(3)**,** pp**.** 175-182. 10.1016/S0263-7863(03)00031-0

**Kalkman, J. P. & De Waard, E. J. 2017.** Inter-organizational disaster management projects: Finding the middle way between trust and control. *International Journal of Project Management,* Vol. 35(5)**,** pp**.** 889-899. https://doi.org/10.1016/j.ijproman.2016.09.013

**Kaplan, R. M. & Saccuzzo, D. P. 2009.** *Psychological testing: Principles, applications, and issues,* Belmont, CA, Wadsworth, Cengage Learning.

**Kvålshaugen, R. & Sward, A. R. 2018.** Sluttrapport "Samhandling og prosessledelse". Oslo: Handelshøyskolen BI.

**Langlo, J. A., Bakken, S., Karud, O. J., Landet, R., Smidt Olsen, A., Andersen, B. & Hajikazemi, S. 2017.** Sluttrapport - Prestasjonsmåling i norsk BAE-næring.

**Li, H., Arditi, D. & Wang, Z. 2015.** Determinants of transaction costs in construction projects. *Journal of Civil Engineering and Management,* Vol. 21(5), pp. 548-558. 10.3846/13923730.2014.897973

**Ling, F. Y. Y., Ning, Y., Ke, Y. & Kumaraswamy, M. M. 2013.** Modeling relational transaction and relationship quality among team members in public projects in Hong Kong. *Automation in Construction,* Vol. 36(pp. 16-24. https://doi.org/10.1016/j.autcon.2013.08.006

**Liu, L., Bannerman, P. L., Ding, X., Elliott, E.-J., Ewart, G. & Kong, X. 2016.** The Motives for and Consequences of Underpricing for Construction Contractors—Evidence from Australia. *The Journal of Modern Project Management,* Vol. 3(3), pp. 36-45.

**Lædre, O. 2009**. *Er Det Noen Sak?,* Bergen, Norway, Fagbokforlaget.

**Manu, E., Ankrah, N., Chinyio, E. & Proverbs, D. 2015.** Trust influencing factors in main contractor and subcontractor relationships during projects. *International Journal of Project Management,* Vol. 33(7), pp. 1495-1508. http://dx.doi.org/10.1016/j.ijproman.2015.06.006

**Maurer, I. 2010.** How to build trust in inter-organizational projects: The impact of project staffing and project rewards on the formation of trust, knowledge acquisition and product innovation. *International Journal of Project Management,* Vol. 28(7), pp. 629637. 10.1016/j.ijproman.2009.11.006

**Mcallister, D. J. 1995.** Affect-and cognition-based trust as foundations for interpersonal cooperation in organizations. *Academy of management journal,* Vol. 38(1), pp. 24-59.

**Meng, X. & Gallagher, B. 2012.** The impact of incentive mechanisms on project performance. *International Journal of Project Management,* Vol. 30(3), pp. 352-362. https://doi.org/10.1016/j.ijproman.2011.08.006

**Meyer, M. W. 2002.** *Rethinking Performance Measurement* Cambridge, University Press.

**Molenaar, K. R., Songer, A. D. & Barash, M. 1999.** Public-Sector Design/Build Evolution and Performance. *Journal of Management in Engineering,* Vol. 15(2), pp. 54-62. doi:10.1061/(ASCE)0742-597X(1999)15:2(54)

**Mukaka, M. M. 2012.** A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal,* Vol. 24(3), pp. 69-71.

**Murphy, K. R. & Davidshofer, C. O. 2005.** *Psychological testing : principles and applications,* Upper Saddle River, N.J, Pearson/Prentice Hall.

**Müller, R. & Jugdev, K. 2012.** Critical success factors in projects: Pinto, Slevin, and Prescott– the elucidation of project success. *International Journal of Managing Projects in Business,* Vol. 5(4), pp. 757-775.

**Nevstad, K., Børve, S., Karlsen, A. T. & Aarseth, W. 2018.** Understanding how to succeed with project partnering. *International Journal of Managing Projects in Business,* Vol. 11(4), pp. 1044-1065. 10.1108/IJMPB-07-2017-0085

**Oakland, J. S. 2012.** *Oakland on quality management,* New York, Routledge.

**Park, J.-G. & Lee, J. 2014.** Knowledge sharing in information systems development projects: Explicating the role of dependence and trust. *International Journal of Project Management,* Vol. 32(1), pp. 153-165. https://doi.org/10.1016/j.ijproman.2013.02.004

**Patel, H., Pettitt, M. & Wilson, J. R. 2012.** Factors of collaborative working: A framework for a collaboration model. *Applied Ergonomics,* Vol. 43(1)**,** pp**.** 1-26. https://doi.org/10.1016/j.apergo.2011.04.009

**Peterson, R. A. 1994.** A meta-analysis of Cronbach's coefficient alpha. *Journal of consumer research,* Vol. 21(2)**,** pp**.** 381-391.

**Pinto, J. K. 2010.** *Project Management : Achieving Competitive Advantage,* Boston, Pearson Prentice Hall.

**Pinto, J. K. & Slevin, D. P. 1988.** Project success. *Project management journal,* Vol. 4(pp**.** 6772.

**Pinto, J. K., Slevin, D. P. & English, B. 2009.** Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management,* Vol. 27(6)**,** pp**.** 638-648. http://dx.doi.org/10.1016/j.ijproman.2008.09.010

**Pmi 2017.** *A Guide to the Project Management Body of Knowledge (PMBOK® Guide),* Newtown Square, Pennsylvania, Project Management Institute.

**Rahi, K., Bourgault, M. & Robert, B. 2019.** Benchmarking Project Resilience. *The Journal of Modern Project Management,* Vol. 7(1)**,** pp**.** 6-21.

**Rezvani, A. & Khosravi, P. 2018.** A comprehensive assessment of project success within various large projects. *The Journal of Modern Project Management,* Vol. 6(1)**,** pp**.** 115123.

**Rousseau, D. M., Sitkin, S. B., Burt, R. S. & Camerer, C. 1998.** Not So Different After All: A Cross-Discipline View Of Trust. *Academy of Management Review,* Vol. 23(3)**,** pp**.** 393404. 10.5465/amr.1998.926617

**Sarhan, S., Pasquire, C., Manu, E. & King, A. 2017.** Contractual governance as a source of institutionalised waste in construction: A review, implications, and road map for future research directions. *International Journal of Managing Projects in Business,* Vol. 10(3)**,** pp**.** 550-577. doi:10.1108/IJMPB-07-2016-0058

**Schmitt, N. 1996.** Uses and abuses of coefficient alpha. *Psychological Assessment,* Vol. 8(4)**,** pp**.** 350-353. 10.1037/1040-3590.8.4.350

**Schoorman, F. D., Mayer, R. C. & Davis, J. H. 2007.** An integrative model of organizational trust: Past, present, and future. Academy of Management Briarcliff Manor, NY 10510.

**Silva, A. & Harper, C. 2018.** Using Project Team Integration to Predict Cost and Schedule Performance in Public Transportation Projects. *Construction Research Congress 2018.*

**Simatupang, T. M. & Sridharan, R. 2005.** The collaboration index: a measure for supply chain collaboration. *International Journal of Physical Distribution & Logistics Management,* Vol. 35(1)**,** pp**.** 44-62. doi:10.1108/09600030510577421

**Spitzer, D. R. 2007**. *Transforming Performance Measurement,* New York, AMACOM books.

**Sullivan, J., Asmar, M. E., Chalhoub, J. & Obeid, H. 2017.** Two decades of performance comparisons for design-build, construction manager at risk, and design-bid-build: quantitative analysis of the state of knowledge on project cost, schedule, and quality. *Journal of Construction Engineering and Management,* Vol. 143(6)**,** pp**.** 04017009.

**Suprapto, M., Bakker, H. L. M., Mooi, H. G. & Hertogh, M. J. C. M. 2016.** How do contract types and incentives matter to project performance? *International Journal of Project Management,* Vol. 34(6)**,** pp**.** 1071-1087. 10.1016/j.ijproman.2015.08.003

**Suprapto, M., Bakker, H. L. M., Mooi, H. G. & Moree, W. 2015.** Sorting out the essence of owner–contractor collaboration in capital project delivery. *International Journal of Project Management,* Vol. 33(3)**,** pp**.** 664-683. https://doi.org/10.1016/j.ijproman.2014.05.001

**Taylor, R. 1990.** Interpretation of the Correlation Coefficient: A Basic Review. *Journal of*

*Diagnostic Medical Sonography,* Vol. 6(1), pp. 35-39. 10.1177/875647939000600106 **Todsen, S. 2018.** *Produktivitetsfall i bygg og anlegg* [Online]. Statistics Norway. Available: https://www.ssb.no/bygg-bolig-og-eiendom/artikler-og-publikasjoner/produktivitsfalli-bygg-og-anlegg [Accessed 20.08.2018 2018].

**Tsiga, Z. D., Emes, M. & Smith, A. 2016.** Attitudes to risk management in space projects. *The Journal of Modern Project Management,* Vol. 4(1), pp. 41-51.

**Turner, J. R. & Müller, R. 2003.** On the nature of the project as a temporary organization. *International Journal of Project Management,* Vol. 21(1), pp. 1-8. http://dx.doi.org/10.1016/S0263-7863(02)00020-0

**Turner, J. R. & Müller, R. 2004.** Communication and co-operation on projects between the project owner as principal and the project manager as agent. *European Management Journal,* Vol. 22(3), pp. 327-336. https://doi.org/10.1016/j.emj.2004.04.010

**Um, K. H. & Kim, S. M. 2018.** Collaboration and opportunism as mediators of the relationship between NPD project uncertainty and NPD project performance. *International Journal of Project Management,* Vol. 36(4), pp. 659-672. 10.1016/j.ijproman.2018.01.006

**Vaaland, T. I. & Håkansson, H. 2003.** Exploring interorganizational conflict in complex projects. *Industrial Marketing Management,* Vol. 32(2), pp. 127-138. https://doi.org/10.1016/S0019-8501(02)00227-4

**Von Danwitz, S. 2018**. Managing inter-firm projects: A systematic review and directions for future research. *International Journal of Project Management,* Vol. 36(3), pp. 525-541.

**Walker, D. & Lloyd-Walker, B. M. 2015.** *Collaborative Project Procurement Arrangements,* Newton Square, Pennsylvania, USA, Project Management Institute.

**Walker, D. H. T., Davis, P. R. & Stevenson, A. 2017.** Coping with uncertainty and ambiguity through team collaboration in infrastructure projects. *International Journal of Project Management,* Vol. 35(2), pp. 180-190. https://doi.org/10.1016/j.ijproman.2016.11.001

**Walker, D. H. T. & Lloyd-Walker, B. M. 2016.** Understanding the motivation and context for alliancing in the Australian construction industry. *International Journal of Managing Projects in Business,* Vol. 9(1), pp. 74-93. doi:10.1108/IJMPB-07-2015-0065

**Yap, J. B. H., Abdul-Rahman, H. & Chen, W. 2017.** Collaborative model: Managing design changes with reusable project experiences through project learning and effective communication. *International Journal of Project Management,* Vol. 35(7), pp. 12531271. 10.1016/j.ijproman.2017.04.010

**Yeung, J. F. Y., Chan, A. P. C. & Chan, D. W. M. 2007.** The definition of alliancing in construction as a Wittgenstein family-resemblance concept. *International Journal of Project Management,* Vol. 25(3), pp. 219-231. https://doi.org/10.1016/j.ijproman.2006.10.003

**Yeung, J. F. Y., Chan, A. P. C., Chan, D. W. M., Chiang, Y. H. & Yang, H. 2013.** Developing a Benchmarking Model for Construction Projects in Hong Kong. *Journal of Construction Engineering and Management,* Vol. 139(6), pp. 705-716. doi:10.1061/(ASCE)CO.1943-7862.0000622

**Young, R. R. 2006.** *Project Requirements, A Guide to Best Practices,* Virginia, USA, Management Concepts.

**Yousefi, N., Sobhani, A., Naeni, L. M. & Currie, K. R. 2019.** Using statistical control charts to monitor duration-based performance of project. *The Journal of Modern Project Management,* Vol. 6(3), pp. 88-103.

**Yun, S., Choi, J., De Oliveira, D. P. & Mulva, S. P. 2016.** Development of performance metrics for phase-based capital project benchmarking. *International Journal of Project Management,* Vol. 34(3), pp. 389-402. https://doi.org/10.1016/j.ijproman.2015.12.004

**Zhang, X., Azhar, S., Nadeem, A. & Khalfan, M. 2018.** Using building information modelling to achieve Lean principles by improving efficiency of work teams. *International Journal of Construction Management,* Vol. 18(4), pp. 293-300. 10.1080/15623599.2017.1382083

**Zidane, Y. & Andersen, B. 2018.** Causes of delay and their cures in major Norwegian projects. *The Journal of Modern Project Management,* Vol. 5(3), pp. 80-91.

## About Authors

**Haavard Haaskjold** is a PhD Candidate of project management at the Norwegian University of Technology and Science (NTNU). The research topic for his thesis is reduction of project transaction costs through improved collaboration. Haaskjold is currently a lecturer at the continuous education Master of Science programme at NTNU where he teaches classes in project management. He is also a reviewer for several international journals. Haaskjold is a certified Project Management Professional (PMP) from the Project Management Institute and has 15 years of experience as a practitioner of project management in the international oil and gas industry.

**Bjørn Andersen** is a professor of quality and project management at the Norwegian University of Technology and Science. He has authored/co-authored around 25 books and numerous papers for international journals and conferences, in total more than 300 publications. Professor Andersen serves as Director of Project Norway and has since its inception been a member of the steering group of the Concept research program, which conducts trailing research of large public investments projects that go through the Norwegian quality assurance scheme. He has managed and been involved in several national and international research and implementation projects, in areas such as stakeholder management, lean construction, project performance, etc., as well as a number of project evaluations. Andersen is an Academic in the International Academy of Quality, is co-editor of the journal Production Planning & Control and reviewer for several other journals and conferences.

**Jan Alexander Langlo** is an associate professor of quality and project management at the Norwegian University of Science and Technology. He has more than 20 years' experience as senior researcher and research manager at SINTEF. He is coordinator for NTNUs continued education programme in project management and teaches several courses. Langlo har also worked in numerous research projects as both project manager and team member. In addition, Langlo has been a central resource for establishing and running the research program Project Norway for more than 20 years. Recently, he has also been appointed as manager of the member association Nordic 10-10, which is providing the 10-10 performance measurement tool and the Nordic 10-10 performance improvement processes to the Norwegian construction industry.

# Paper 3

# Follow the collaboration compass

Haavard Haaskjold*, Bjørn Andersen and Jan Alexander Langlo

Department of Mechanical and Industrial Engineering,
Norwegian University of Science and Technology,
NO-7491 Trondheim, Norway
Email: haavard.haaskjold@ntnu.no
Email: bjorn.andersen@ntnu.no
Email: jan.a.langlo@ntnu.no
*Corresponding author

Wenche Aarseth

Business School,
Nord University,
NO-8049 Bodø, Norway
Email: wenche.aarseth@nord.no

**Abstract:** Many different mechanisms are available to project managers who wish to improve collaboration in the relationship between client and contractor in a project. However, it is not necessarily clear which mechanisms that are most suited to use for a specific project. The purpose of this paper is to investigate how experienced project managers from three different industries (oil and gas, construction, ICT) apply such collaboration mechanisms successfully in their projects. Based on the findings from 39 interviews with experienced projects managers, we apply Shenhar's framework for project classification and introduce a collaboration compass that project managers can follow to identify which collaboration mechanisms that may be most suited for their specific project depending on the project's level of novelty, complexity, technology and pace.

**Keywords:** collaboration mechanisms; project management; practice; project classification.

**Reference** to this paper should be made as follows: Haaskjold, H., Andersen, B., Langlo, J.A. and Aarseth, W. (xxxx) 'Follow the collaboration compass', *Int. J. Project Organisation and Management*, Vol. X, No. Y, pp.000–000.

**Biographical notes:** Haavard Haaskjold is a PhD Candidate of Project Management at the Norwegian University of Science and Technology (NTNU). His research interest is the relationship between project transaction costs and collaboration. He is currently a lecturer at the continuing education program at NTNU where he teaches courses in project management. He is a certified Project Management Professional (PMP) from the Project Management Institute and has 15 years of experience from large offshore construction projects in the international oil and gas industry.

Copyright © 200x Inderscience Enterprises Ltd.

Bjørn Andersen is a Professor of Quality and Project Management at the Norwegian University of Technology and Science. He has authored/co-authored around 25 books and numerous papers for international journals and conferences, in total more than 300 publications. He serves as the Director of Project Norway and has since its inception been a member of the steering group of the concept research program, which conducts trailing research of large public investments projects that go through the Norwegian quality assurance scheme. He has managed and been involved in several national and international research and implementation projects, in areas such as stakeholder management, lean construction, project performance, etc., as well as a number of project evaluations. He is an Academic in the International Academy of Quality, is Co-Editor of the journal *Production Planning & Control* and reviewer for several other journals and conferences.

Jan Alexander Langlo is an Associate Professor of Quality and Project Management at the Norwegian University of Science and Technology. He has more than 20 years of experience as a Senior Researcher and Research Manager at SINTEF, as well as ten years experience as an Associate Professor at NTNU. He is the Coordinator for NTNUs continued education programme in project management and teaches several courses. He has also worked in numerous research projects as both project manager and team member. In addition, he has been a central resource for establishing and running the research program Project Norway for more than 20 years. Currently, he manages the member association 'Nordic 10-10', which is providing the 10-10 performance measurement tool and the Nordic 10-10 performance improvement processes to the Norwegian construction industry.

Wenche Aarseth is a Professor in Project Leadership at Nord University Business School in Norway and a Professor II in Management at the Norwegian University of Science and Technology. She holds a PhD in project leadership from NTNU. At Nord University she is head of the MBA in Strategy and Leadership continuing education programme for leaders. She has 20 years of experience collaborating with different organisations such as the large oil company Equinor, the national construction company Statsbygg, the national road authorities Statens vegvesen and financial banks. She has collaborated for ten years with professors at University of Berkeley California and Stanford University in USA.

## 1 Introduction

For centuries, the compass has helped seafarers to find their destination across vast oceans. Even if the sky was cloudy or the fog was heavy, the needle would point the mariner in the right direction. The invention of the compass led to increased trade and exploration. Travelling to new corners of the world made it possible to meet new people and exchange knowledge and information. Travelling is an example of a well-established mechanism to enhance collaboration in the relationship between people. Similar mechanisms are used to enhance collaboration in the relationship between clients and contractors in projects. Project participants travel to construction sites and meetings to exchange information and discuss project matters. In addition to travelling, many other mechanisms can be used to ensure successful collaboration. Each of these mechanisms has its benefits and its limitations. In their daily work, project managers must determine which collaboration mechanisms offer the most benefits for their specific projects. By collecting experiences from 39 experienced project managers, from three different industries, we can provide a compass that other project managers can follow in the future to identify which collaboration mechanisms that have been successfully used on similar projects in the past.

Good collaboration between the client and its contractors should lead to win-win situations for all parties (Bititci et al., 2007) and contributes to project success (Bond-Barnard et al., 2018; Kwofie et al., 2018). However, collaboration relies on the presence of both formal and behavioural issues and many projects are subject to problems related to the social dimensions of collaboration (Hietajärvi and Aaltonen, 2018; Nevstad et al., 2018). Examples of formal issues and processes include contract arrangements with pain/gain share incentive mechanisms, while examples of behavioural issues include trust (Bond-Barnard et al., 2018; Pinto et al., 2009; Kadefors, 2004) and having a no-blame culture (Walker and Lloyd-Walker, 2015). Using a collaborative procurement arrangement, such as partnering or alliancing, does not necessarily contribute to better project performance unless the parties manage to develop a real collaborative relationship (Suprapto et al., 2016; Bresnen and Marshall, 2002).

Factors affecting collaboration have been widely studied and have been included in the newly developed ISO 44001 Standard for *Collaborative Business Relationships* (ISO, 2017). The positive effects that can be harvested from collaboration and contribute to project success are also well known (Bond-Barnard et al., 2018; Um and Kim, 2018). Actual day-to-day mechanisms and practical tools applied by project managers to achieve collaborative behaviour have been studied less than factors and contracting methods (Suprapto et al., 2015; Aarseth, 2014; Bresnen and Marshall, 2002).

The purpose of this paper is to study how project managers use different mechanisms in their day-to-day practice to achieve successful collaboration in the relationship between client and contractors in projects. As a taxonomy, we use the four-dimensional framework developed by Shenhar and Dvir (2004) as we map projects with different degrees of novelty, complexity, technology and pace and introduce a collaboration compass. We have established the following research question:

RQ How do project managers use different mechanisms in their day-to-day practice to achieve successful collaboration in the relationship between client and contractors in projects?

We follow the definition of collaboration as given by the Institute for Collaborative Working. "Collaboration is a commitment between two or more parties to create value by striving to achieve shared competitive goals and operational benefit through a spirit of mutual trust and openness" [ICW, (2017), p.29]. Furthermore, we limit our study to investigate collaboration within the context of the relationship between clients and contractors, where the contractor acts as an agent on behalf of the client (Pratt and Zeckhauser, 1991; Ross, 1973). We use the term collaboration quality as defined by Dietrich et al. (2010), where high collaboration quality is characterised by: Efficient and open communication, mutual understanding of goals, willingness to help each other, alignment and the presence of a collaborative spirit.

This paper is structured as follows: First, we provide a description of the theoretical background and state-of-the-art research on collaboration mechanisms as well as the taxonomy used to classify projects with different characteristics. Secondly, we describe our research methods and how we used semi-structured interviews to learn about experiences from practice in 69 different projects. Finally, we present the results from the analysis of the interviews and discuss implications. We introduce the 'collaboration compass' as a means to help project managers to identify appropriate mechanisms for their specific projects.

## 2 Theoretical background

In this section, we describe the state-of-the-art research on collaboration mechanisms followed by a description of Shenhar and Dvir (2004)'s four-dimensional framework that we used as taxonomy for classification of the studied projects. Finally, we present a research gap and argue why there is a need for more practical studies on collaboration mechanisms.

### *2.1 Collaboration mechanisms*

It is important to not mix success factors and success conditions (Ika and Donnelly, 2017). Success conditions are typically activities done by a project manager to trigger the factor (Ika and Donnelly, 2017). For example, trust is a success factor for collaboration in the relationship between a client and its contractors (Bond-Barnard et al., 2018; Müller et al., 2014; Pinto et al., 2009; Kadefors, 2004). One way to build trust can be to 'open up the books' and give each other access to, for example, pricing mechanisms and risk registers (Lloyd-Walker et al., 2014). It is important to make a clear distinction between factors and the actions, or mechanisms, used to enable a factor. Dietrich et al. (2010) use the term 'mechanisms' to describe such actions while others use the term 'enablers' (O'Connor et al., 2014; Yeh et al., 2006). In this paper we chose to use the term 'mechanisms'. Hence, we distinguish between collaboration factors (i.e., trust) and collaboration mechanisms (i.e., open books). Collaboration factors are not studied in this paper, which is limited to investigating collaboration mechanisms applied by project managers.

Dietrich et al. (2010) performed a literature study where they identified previous research on various mechanisms that enhance collaboration. Co-locating the teams from the client and contractor increases informal communication (Eriksson et al., 2009; Christensen, 2008). Through regular contact and meetings, the contractor can better understand the client's true problem, and establishing common rules helps to build trust (Turner et al., 2019). In a Danish case study, Christensen (2008) found that establishing a common building and work shed for all the people on a construction site improved the learning and social relations between the workers from different contractors. In addition to the co-location itself, adjusting the physical workspace in the building where teams work together improves informal communication and fosters collaboration (Kokkonen and Vaagaasar, 2018; Bosch-Sijtsema and Tjell, 2017). Adjusting the physical workspace in the project and creating open spaces that allow for increased face-to-face communication is another example of methods that contribute to collaborative behaviour (Bosch-Sijtsema and Tjell, 2017).

In their case study, Eriksson et al. (2009) described how a Swedish construction project used several different mechanisms to overcome collaborative barriers. The collaborative mechanisms that they identified included sharing IT systems, arranging social teambuilding events and collaboration workshops, and co-locating the project office to the construction site. In another case study, Ahola et al. (2017) describe several mechanisms that were used to improve the collaboration between the contractors and the client in a complex oil and gas delivery project. These mechanisms included frequent coordination meetings, early involvement of contractors, relation-specific investments and the frequent use of co-location. Similar mechanisms are also identified in a recently published study of infrastructure partnering projects (Hosseini et al., 2016).

In an often cited article, Bresnen and Marshall (2000) present several tools to build collaboration. These include both hard and soft tools. Examples of hard tools are contract incentives and contractor selection processes. Softer tools are related to building and managing relationships and include co-location of teams, teambuilding and opening the books to share information. Similar mechanisms are presented by Turner et al. (2019) who also describe the importance of having regular workshops as a means to improve the communication in the relationship. It is better to arrange frequent simple teambuilding events that include all staff rather than to hold fewer, and more expensive, events limited to key personnel (Eriksson et al., 2009; Bresnen and Marshall, 2000).

Establishing a clear set of routines and rules and establishing a joint code of conduct that describes the accepted behaviour between the parties is commonly used as a mechanism to build collaborative behaviour with a no-blame culture (Hans and Mnkandla, 2019; Lloyd-Walker et al., 2014). Having a kick-off or workshop session early in the project to establish ground rules for collaboration is important in order to achieve a no-blame culture (Lloyd-Walker et al., 2014). In fact, kick-off meetings were found to be the tool most frequently used by project managers in a study that investigated how frequently 20 different project management tools were used by project managers (Tereso et al., 2019). In the book titled collaborative procurement arrangements, Walker and Lloyd-Walker (2015) categorise various procurement methods from first-order collaboration to fourth-order collaboration as a function of increased level of early contractor involvement and use of pain/gain share incentives. In order to reach the fourth order of collaboration, several different mechanisms can be used such as combining IT solutions, co-location and frequent site visits (Walker and Lloyd-Walker, 2015). A common denominator for collaborative procurement methods is that they have elements of pain/gain share incentives that allow for a win-win situation so that all participants may harvest economic advantages by participating (Bititci et al., 2007).

Involving contractors early in the project has shown a positive effect on collaborative behaviour (Rahmani et al., 2018; Hosseini et al., 2016). Early involvement of contractors where they can contribute with their detailed competence at the concept stage enhances the collaboration level in the project (Ahola et al., 2017; Wondimu et al., 2016). Similarly, early involvement of users and other important stakeholders improves collaboration (Badi and Pryke, 2015). Tendering in public projects must comply with public procurement regulations, which sometimes makes it difficult for clients to involve contractors as early as they ideally would have liked to (Bygballe and Swärd, 2019).

In a case study of a Hong Kong partnering project, workshops, social activities, newsletters and use of incentives were identified as important mechanisms to improve collaboration (Bayliss et al., 2004). It has also been suggested that establishing a common project call centre is a practical way to establish the right balance between informal and formal communication in a project and reduce mistrust (Bond-Barnard et al., 2013).

**Table 1** Collaboration mechanisms

| *Supporting literature ID* | *Dietrich et al. (2010)* | *Christensen (2008)* | *Eriksson et al. (2009)* | *Kokkonen and Vaagaasar (2018)* | *Bosch-Sijtsema and Tjell (2017)* | *Ahola et al. (2017)* | *Hosseini et al. (2016)* | *Bresnen and Marshall (2000)* | *Bygballe and Swärd (2019)* | *Turner et al. (2019)* | *Lloyd-Walker et al. (2014)* | *Walker and Lloyd-Walker (2015)* | *Bayliss et al. (2004)* | *Aarseth et al. (2016)* | *Wilkinson (2005)* | *Harley (2011)* | *Matthews et al. (2018)* | *Erdogan et al. (2008)* | *Smits and van Marrewijk (2012)* | *Karis et al. (2016)* | *Cho and Ballard (2011)* | *Bond-Barnard et al. (2013)* | *Singh et al. (2011)* | *Sebastian (2011)* | *Porwal and Hewage (2013)* | *Merschbrock and Munkvold (2015)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | ✓ | | | | | | |
| B | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | |
| C | ✓ | | ✓ | | | | | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| D | | | ✓ | | | | | ✓ | | | | | ✓ | ✓ | | | | | | | | | | | | |
| E | ✓ | | | | | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| F | | | | | | | ✓ | | ✓ | ✓ | | | ✓ | | | | | | | | ✓ | | ✓ | | | |
| G | ✓ | | | | | ✓ | | | | | | | | | | | | | ✓ | | | | | | | |
| H | | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | ✓ | | | | | |
| I | ✓ | | | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | | | | | ✓ | | | | | |
| J | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | | |
| K | | | ✓ | | | | | | | | | ✓ | | | | | | | | ✓ | | | | | | |
| L | | | | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | | |

Notes: A: Co-locate teams, adjust the physical workspace.
B: Hold kick-off meeting to clarify expectations and establish ground rules for collaboration.
C: Share IT solutions.
D: Frequent use of social activities and teambuilding.
E: Spend time with key decision makers and stakeholders.
F: Hold regular multidisciplinary work sessions.
G: Use external collaboration facilitators – chaperoning.
H: Involve contractors and users early in planning.
I: Use collaborative procurement methods.
J: Open up books and share both bad and good news.
K: Encourage frequent travelling to work sites and meetings. Increase travel budget.
L: Use advanced communication tools and video conferencing systems.

By sharing IT systems, people in the various companies that participate in the project can more easily exchange information with each other (Engström and Stehn, 2016; Harley, 2011). The use of internet has changed our capacity to communicate and online collaboration tools make it easy for project participants to access and share data (Harley, 2011; Wilkinson, 2005) as well as BIM models (Matthews et al., 2018). The use of online meetings can reduce the need for travelling (Erdogan et al., 2008). However, even with modern video portals with live video streams between locations, travelling is still often needed to achieve good collaboration quality. After one face-to-face meeting, the quality of remote collaboration is multiplied by 10 as a result of trust achieved from a first face-to-face meeting (Karis et al., 2016). In a recent study, Aljuwaiber (2019) found that although face-to-face meetings are superior in terms of communication richness, video meetings can often be a pragmatic solution in projects were high workload and tight schedules limits the possibilities to travel and meet face-to-face. However, it is crucial with top management support when establishing the video conference system and allocate resources to quickly resolve any technical issues, in particular in the implementation phase. In a recent study, Blenke et al. (2017) found that less than 4% of the respondents preferred virtual communication over face-to-face meetings.

In order to maintain more efficient information sharing between the contractors working in a project, a dedicated role may be established as interface coordinator. This person is responsible for coordinating interfaces between the actors (Ahola et al., 2017). In the Panama Canal expansion project, specialised consultants were used in the project to teach the actors and monitor their collaborative behaviour, a mechanism known as 'chaperoning' (Smits and van Marrewijk, 2012).

## *2.2 Project classification*

Several frameworks and models can be used as a taxonomy in project management research. The governance framework for project management (Muller, 2009) classifies the following three main forces that impact project management: "What can be done?/What should be done?/What is done?". The Cynefin framework (Snowden and Boone, 2007) can be used by leaders to better understand the context of the project's complexity in order to take the most appropriate actions or decisions.

In addition to complexity, the NCTP framework (Shenhar and Dvir, 2004) includes three other dimensions. In this framework, projects are categorised according to their level of novelty (N), complexity (C), technology (T) and pace (P). The novelty dimension describes how new a product delivered by a project is on a scale from 1–3. The lowest score (derivative) indicates that the product is well known in the market as opposed to the highest (breakthrough), which describes products that are new to the world. The complexity dimension ranges from 1–3, where low complexity (assembly) describes a scope of work isolated to a single function as opposed to the highest complexity (array), which would include projects with a high level of interfaces such as a city's highway system or the development of an offshore oil field. The technology dimension is used to describe the uncertainty related to the technology applied in the project and ranges from 1 (low tech) to 4 (super high-tech). The fourth, and final, dimension is pace, which describes the urgency of which the project needs to be executed, ranging from 1 (regular) to 3 (blitz critical) (Shenhar and Dvir, 2004).

In this paper, we use the NTCP framework (Shenhar and Dvir, 2004) as the taxonomy for our research. The reason for this choice is that it allows us to differentiate projects based on their characteristics in four different directions. Also, the framework is widely recognised in the field with a strong burstiness score and a high citation frequency (De Rezende et al., 2018).

### *2.3 Research gap*

Existing research on collaboration has a strong focus on formal mechanisms such as contracts (Suprapto et al., 2015). As presented in the theoretical background section of this paper, we have also found a fair amount of existing research that presents various mechanisms and practices used by project managers. Much of this research is based on case studies and addresses specific mechanisms used in the specific case. We have found some literature that provide summaries of various mechanisms, such as Dietrich et al. (2010) and Eriksson et al. (2009) but existing research that maps how different mechanisms are used for projects with different characteristics is scarce. There is a need for more practice-oriented studies of collaboration in the client-contractor relationship that are useful for project managers (Baiden et al., 2018; Svejvig and Andersen, 2015). There is also a need for more studies on collaboration in projects from different industries, as the majority of the existing studies are based on construction projects (Braun and Sydow, 2019). In that respect, we argue that there is a need for studies that investigate collaboration mechanisms used for projects with different characteristics based on a sample of projects from different industries. Hence, the aim is to help project managers to identify the most appropriate mechanisms to use for their specific project and make a contribution to bridging the gap between theory and practice in project management research (Shenhar, 1998).

## 3 Research method

Through deduction we depart from existing theory in the field and collect empirical data through 39 interviews with experienced project managers in the field of project management. To explore the research questions, we used semi-structured interviews. The reason for using interviews is that they allow us to explore the research questions in depth and ask follow-up questions (Cassell, 2009) during the interview. This allows us to get a better understanding of the mechanisms the respondents use in their projects. If we had used a more quantitative approach, such as a survey, this would have limited the information we received from respondents to predefined categories defined by the researcher. Qualitative interviewing is a good method to use to investigate topics where the experience and opinions of project management are central aspects of the research question (Shepherd, 2015). Both qualitative and quantitative methods are commonly used in project management research and Von Danwitz (2018) found that 49% of recent published articles on project management use qualitative methods and 31% used quantitative methods, while the remaining 20 percent used conceptual or mixed methods.

**Table 2** Respondent information

| *ID* | *Industry* | *Current role* | *Current position* | *Project experience in years* |
|---|---|---|---|---|
| R1 | ICT | Contractor | Project manager | 14 |
| R2 | ICT | Contractor | Senior project manager | 20 |
| R3 | ICT | Contractor | Project manager | 14 |
| R4 | ICT | Contractor | Senior project manager | 30 |
| R5 | ICT | Contractor | Senior project manager | 25 |
| R6 | ICT | Contractor | Project manager | 7 |
| R7 | ICT | Contractor | Senior project manager | 29 |
| R8 | ICT | Contractor | Manager for PM group | 31 |
| R9 | ICT | Contractor | Project manager | 5 |
| R10 | Oil and gas | Client | Senior project manager | 26 |
| R11 | Oil and gas | Client | Project manager | 14 |
| R12 | Oil and gas | Contractor | Project engineering manager | 9 |
| R13 | Oil and gas | Contractor | Project manager | 15 |
| R14 | Oil and gas | Contractor | Project manager | 10 |
| R15 | Oil and gas | Contractor | Bid manager / project manager | 16 |
| R16 | ICT | Client | Senior project manager | 14 |
| R17 | ICT | Client | Senior project manager | 24 |
| R18 | Construction | Client | Project director | 30 |
| R19 | Construction | Client | Project manager | 20 |
| R20 | Construction | Contractor | Senior project advisor | 24 |
| R21 | Construction | Client | Managing director | 11 |
| R22 | ICT | Contractor | Consulting director | 20 |
| R23 | ICT | Contractor | Project manager | 35 |
| R24 | ICT | Contractor | Senior project manager | 25 |
| R25 | ICT | Contractor | Senior project advisor | 24 |
| R26 | Construction | Contractor | Project compliance manager | 9 |
| R27 | Construction | Contractor | Project manager | 20 |
| R28 | Construction | Contractor | Project manager | 26 |
| R29 | Construction | Contractor | Project manager | 31 |
| R30 | Construction | Contractor | Project manager | 35 |
| R31 | Construction | Contractor | Project manager | 20 |
| R32 | Construction | Contractor | Project manager | 20 |
| R33 | Oil and gas | Contractor | Project director | 16 |
| R34 | Oil and gas | Contractor | Project engineering manager | 10 |
| R35 | Oil and gas | Contractor | Project manager | 19 |
| R36 | Oil and gas | Client | Project director | 25 |
| R37 | Oil and gas | Client | Project manager | 32 |
| R38 | Oil and gas | Client | Project and alliance manager | 17 |
| R39 | Oil and gas | Contractor | Project manager | 10 |

### *3.1 Respondents*

We conducted interviews with a total of 39 project managers in Norway. Details about each respondent are presented in Table 2. On average these respondents had 20 years of professional project experience as project managers. Of 39 respondents, 15 worked in the information and communication technologies (ICT) industry while 11 respondents worked in the construction industry. The remaining 13 respondents worked with projects in the oil and gas industry. The group of respondents worked for 16 different companies, and 29 respondents worked for companies that can be categorised as contractors. Ten respondents worked for companies that can be categorised as clients. All respondents were located in Norway, but several of them worked with international projects or had previous project experience from abroad. Respondents were recruited by purposive sampling (Bryman, 2016) as we searched for experienced project managers in delivery projects with different backgrounds. There was also an element of snowball sampling (Bryman, 2016) as, during the interviews, some respondents suggested names of other potential respondents who they believed could contribute with valuable information.

### *3.2 Interview method and ethical awareness*

During the interviews, we asked open questions where we simply asked the respondents to describe projects where they had achieved successful collaboration and what they had done to achieve this. Based on their long work experience, they told us about various projects that they had been involved in and which mechanisms had been used to achieve successful collaboration. Many of the respondents discussed projects that they had worked with for companies other than the one where they currently worked.

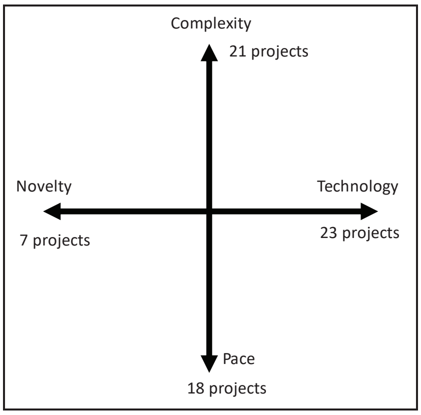
The interviews were conducted in 2017 and 2018. Each interview lasted between 60 and 90 minutes, and all interviews were conducted as face-to-face meetings, as this in general leads to a better quality interview than for example telephone interviews (Bryman, 2016). The interviews were conducted in the office building where the respondents worked because people are more likely to share information when interviewed at their own location (Adler and Adler, 2001) as the location influences the balance between the interviewer and the interviewee (Herzog, 2005). Immediately after each interview, a summary of the interview was written by the interviewer and sent to the respondent for review and approval. Any confidential information and naming of clients or names of persons given by the respondents in the interviews were anonymised by the author when writing the summary from each interview.

We decided not to audio record the interviews mainly because using recording devices may lead respondents to be less open and more reluctant to share information (Saunders et al., 2019; Warren, 2002). Instead, the interviewer took handwritten notes during the interview and wrote a summary of the interview immediately after the interview was finished. This summary was sent for review and approval to the respondent within 24 hours after the interview. The interview method was reviewed and approved by the Norwegian Data Protection Official for Research, which is an agency that verifies that research is performed in accordance with Norwegian laws related to the individual's right to privacy. All respondents received a document that described the purpose of the interview and the method, with details about how their anonymity would be secured. Respondents gave their written consent to participate in the interview on these terms.

## *3.3 Analysis and coding of interviews*

We imported all the summaries from the interviews into the NVivo 12 software. Based on the description that respondents gave of various projects during the interviews, we listed these in a spreadsheet. This spreadsheet can be seen in Appendix. The spreadsheet includes a short description of the project content and links each specific project to each respondent. Certain projects were discussed by more than one respondent. In such cases (see for example P34) both respondents are linked to the same projects in the table. Next, we categorised each project according to the NCTP framework (Shenhar and Dvir, 2004) and identified the governing dimension for each project as summarised in Figure 1. The first group consists of seven projects where novelty is the governing dimension. The next group consists of 21 projects where high complexity characterises the projects. The third group describes those 23 projects where technology was the governing dimension. The fourth and final group describes those projects where pace was the governing dimension.

**Figure 1** Grouping of projects based on their governing dimension




Using NVivo, we highlighted sections in the interviews where respondents described how they used various mechanisms to achieve collaboration in their projects. We then looked for patterns where respondents described similar mechanisms and created group codes (Alvesson and Sköldberg, 2009; Ely et al., 1997). Each code was given a letter from A to L, as shown in Table 1, and described a type of mechanism used by respondents in the interviews. We also searched literature and identified supporting literature for each of these 12 mechanisms as shown in Table 1. A complete list of the mechanisms used by each of the 69 projects is provided in Appendix. For each project we ticked off which of the mechanisms, labelled A–L, that had been described by the respondent. A tick means that the specific mechanism was described by a respondent as a means that was successfully used to achieve collaboration in the specific project. At the bottom of the table we counted how many projects that used each of the mechanisms and calculated this as a percentage of the total number of projects. For example, co-location and adjusting physical workspace (label A) was described by respondents in 13 of the 69 projects, i.e., 19%. Furthermore, we have separated the results for the four various project dimensions and applied the same analysis method to each group. For example, the mechanism labelled A was not found in any of the seven projects categorised by novelty, while it was found in 33% of projects in the complexity direction, 13% of the projects in the technology dimension and 17% of the projects in the pace dimension.

### *3.4 Criticism to research method*

When it comes to validity and reliability, it is fair to say the method used has some weaknesses. Since no audio recording devices were used in the interviews, there is a risk of bias and lack of accuracy as the interviewer may have misunderstood the respondent. To reduce the risk of poor accuracy, the interviewer sent a summary of the interview to the respondent within 24 hours after the interview was conducted. The respondents were asked to review this summary and correct any mistakes before approving it and return it to the interviewer. To illustrate findings from the interviews, we have used several quotations from respondents in this paper. As the interviews were not audio-recorded and conducted in the Norwegian language, there is a risk that some precision is lost when writing down the quotes during the interviews and later when translating these to English.

A weakness that affects the external validity of the findings is the fact that all respondents currently work in companies located in Norway. However, most of these companies operate in an international market and through their working experience (on average 20 years) many of the respondents had worked in projects in several different countries. We therefore argue that one can still generalise our findings outside the Norwegian context to a certain extent.

During the interviews, the respondents gave a short description of each project that they discussed. Based on this description, we later coded the interviews and rated each project with regard to novelty, complexity, technology and pace based on the comprehensive description and examples outlined by Shenhar and Dvir (2004). There is clearly a risk that some mistakes may have occurred when we categorised the projects, as the project description given by the respondents is short and brief. However, the number of projects is large and the purpose of the NCTP framework is to distinguish the differences between projects at a high level. One may argue that it would have been beneficial to ask the respondents to rate their projects themselves according to the NCTP framework, but this would also introduce potential weakness from increased respondent bias as respondents would potentially analyse their project within their specific context instead as context free as recommended by Shenhar and Dvir (2004). Our dataset contains only seven projects where novelty is the governing dimension. Hence, our study has some limitations when it comes to findings related to the novelty dimension.

## 4 Findings

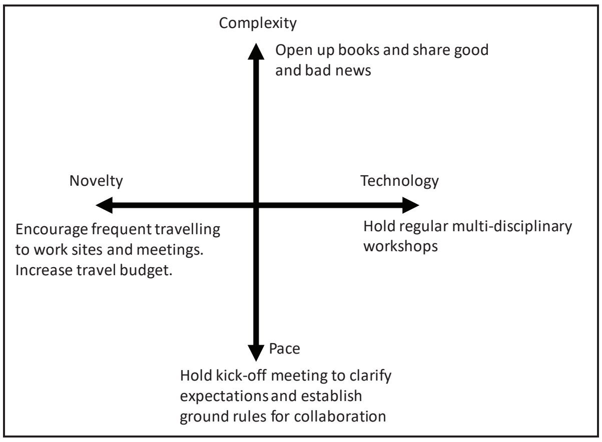
In this section we present the main findings from the coding of the interviews. First, we rank how frequently the various mechanisms to achieve collaboration were used in all the projects. Secondly, we identify the most used mechanism for projects depending on their classification in terms of level of novelty, complexity, technology and pace.

Table 3 ranks the various collaboration mechanisms based on the number of projects in which these were used. We can see that *hold kick-off meeting* was the mechanism most frequently found that was used to achieve successful collaboration. At the bottom of the table we find *use external collaboration facilitators – chaperoning*, a mechanism that was only used in a few of the studied projects.

**Table 3** Ranking of collaboration mechanisms used successfully in studied projects

| *Rank* | *Mechanism used to achieve collaboration* |
|---|---|
| 1 | Hold kick-off meeting to clarify expectations and establish ground rules for collab. |
| 2 | Hold regular multidisciplinary work sessions |
| 3 | Spend time with key decision makers and stakeholders |
| 4 | Involve contractors and users early in planning |
| 5 | Open up books and share both bad and good news |
| 6 | Share IT solutions |
| 7 | Encourage frequent travelling to work sites and meetings. increase travel budget |
| 8 | Co-locate teams, adjust physical work space |
| 9 | Frequent use of social activities and teambuilding |
| 10 | Use collaborative procurement methods |
| 11 | Use advanced communication tools and video conferencing system |
| 12 | Use external collaboration facilitators – chaperoning |

**Figure 2** The collaboration compass – most used collaboration mechanisms for projects with different characteristics




In Figure 2 we introduce 'the collaboration compass'. Each direction of the compass shows the mechanism most frequently used to achieve successful collaboration depending on whether a project is characterised by its novelty, complexity, technology or pace. A complete list of the rating for each mechanism in each direction is provided in Appendix.

We see that *encourage frequent travelling to work sites and meetings. Increase travel budget* was the most frequently used mechanism for projects with particularly high novelty. Moving on, we see that for those projects governed by the complexity dimension the most frequently used mechanism was *open up books and share good and bad news*. For projects governed by the technology dimension we found that that *holding regular multidisciplinary workshops* was the most frequently used mechanism. Finally, we see that for projects characterised by the pace dimension the most used mechanism was *hold kick-off meeting to clarify expectations and establish ground rules for collaboration*.

In Appendix we provide detailed findings for each of the 69 projects. A short description about each project is included together with the detailed coding of each project's level of novelty, complexity, technology and pace. The rightmost columns in the table show which mechanisms were used in each of these 69 projects. The labels A–L refer to the various collaboration mechanisms that were presented in Table 1.

## 5 Analysis and discussions

In this section we discuss the main findings. First, we discuss the most used mechanism for each compass direction based on the findings shown in Figure 2. We also discuss some of the less frequently used mechanisms.

### *5.1 Novelty direction – encourage frequent travelling*

Respondents that worked with projects with particularly high novelty reported that they frequently travelled to sites to conduct face-to-face meetings or to be present on the site where work was conducted. Project managers encouraged their team members to travel frequently and not only depend on video conferences, e-mails, etc. Managers of projects with high novelty allocated a significant travel budget and encouraged team members to travel between sites frequently to achieve good collaboration. This was to ensure that they take part in the decisions that are *taken around the coffee machine*.

> "Important decisions are often taken during coffee breaks or prior to or after the video conference meeting itself and the only way to take part in these important discussions is to be present face to face." Project manager

Although encouraging frequent travelling was the most used mechanism for projects in the novelty direction it was not much used in the other directions. In fact, if we look at Table 3 we see that this mechanism only ranks 7th when we look at all projects. One reason for this may be that projects with high novelty have a higher degree of trial and error and later design freeze than other projects (Shenhar and Dvir, 2004) and may require particularly rich communication between the actors. It is therefore not surprising that project managers of this type of projects highlight the importance of meeting face to face to cope with the low maturity such projects may have. Specifications and plans may be unclear and industrial standards are often not available in these types of projects.

The need to travel raises two paradoxes. The first is related to project transaction costs. High quality collaboration in the client-contractor relationship reduces transaction costs in projects (Dietrich et al., 2010; Ahola, 2009). As trust increases with collaboration (Kadefors, 2004) there is less need for the parties to safeguard their own interests against opportunisms. Hence, project transaction costs are reduced (Williamson, 1996). It is therefore a paradox that one of the mechanisms to achieve collaboration, and reduce transaction costs, is to increase the travel budget, which is also a project transaction cost itself (Li et al., 2015). In other words, frequent travelling may lead to lower transaction costs through increased collaboration and trust, but this travelling itself has a cost that must be weighed up against the benefits.

The second paradox with increased travelling is related to project sustainability. There is an increased focus on sustainable project management in terms of both what the project delivers and sustainable processes in the project (Sabini et al., 2019; Schipper and Silvius, 2018). To achieve sustainable projects, the environmental effects caused by the project should be minimised (Aarseth et al., 2017). Extensive use of air travel has a negative impact on the environment through increased emissions to the atmosphere. It is therefore challenging for a project manager who aims to deliver the project with a minimum of negative environmental impact to encourage frequent travelling, in particular air travel.

### *5.2 Complexity direction – open up books and share information*

Respondents who worked with projects with high complexity highlighted the importance of opening up the books and sharing all good and bad news. Projects with high complexity have many interfaces and communication channels (Shenhar and Dvir, 2004) and an intricate risk picture (Velayudhan and Thomas, 2018; Williams, 2017). Several of our respondents described the importance of being honest and sharing information with all parties to achieve efficient interface management and to reduce project uncertainty and risk.

> "The client allowed us to talk freely with the other contractors in the project and we shared all the latest information with each other. We could call directly to our third parties and exchange information. This greatly improved the quality and efficiency of managing interfaces between us." Project manager

Opening up books and sharing information requires trust and a willingness to share (Hietajärvi et al., 2017). If there is mistrust – let us say for example that the client is afraid that a contractor may use information to speculate and claim extra payment through opportunistic change orders, and vice versa – the willingness to share information may be disrupted.

> "In the beginning, people are often sceptical to sharing sensitive information with clients and third parties. It took a significant effort to build such culture for openness." Project manager

Collaborative procurement methods, such as integrated project delivery (IPD) or alliancing, often have incentives that encourage information sharing (Walker and Lloyd-Walker, 2015) to ensure win-win situations for all parties (Bititci et al., 2007). One could therefore expect that managers in complex projects, where information sharing and open books is particularly important, would also highlight the importance of collaborative procurement methods. However, only a few of the managers of projects with high complexity described the use of such methods because the majority used traditional contracting mechanisms. It is worth mentioning that high-order collaborative procurement arrangements are less common in the Nordic construction industry compared to other regions such as the UK and South-East Asia (Bygballe et al., 2010). It would therefore be interesting to conduct a similar study in regions where high-order collaborative procurement arrangements are more frequently used.

The impact of social relations in projects is significant and incentive systems alone are not sufficient to ensure collaborative behaviour; there is a need to invest time in people and building relationships (Bresnen and Marshall, 2000). It is therefore not surprising that the mechanism 'spend time with key decision makers and stakeholders' was frequently used across all project types, and in particular for projects with high complexity. One of the respondents in a complex project described how he adjusted his work hours to spend more time with a key decision maker:

> "An important decision maker in the project owner organization was always very busy during the day, however I noticed that he always worked late in the evenings. I therefore adjusted my working hours so that I spent more time in the building in the evenings as well, when he was less busy. We then had many long talks in his office or at the coffee machine in the evenings. We established common references and a relationship that was very valuable for the project." Project manager

## *5.3 Technology direction – multidisciplinary workshops*

Managers of high-tech projects described how they often used multidisciplinary workshops in their projects to achieve collaboration. Several of the respondents arranged regular workshops where participants from different disciplines and companies worked together. A wide variety of concepts and methods for such sessions is available, including integrated concurrent engineering (ICE) (Chachere et al., 2004) and last planner (Cho and Ballard, 2011). For IT projects, several respondents described the use of scrum techniques (Takeuchi and Nonaka, 1986). Although the difference between these concepts is distinct, a common denominator for such mechanisms is that they enhance multidisciplinary collaboration through organised work sessions at frequent intervals. The use of regular multidisciplinary workshops was common in the projects studied and many of the respondents described how such workshops were conducted. Several respondents described how they had prepared meeting rooms as a dedicated space where different disciplines could work together, so-called big rooms (Majava et al., 2019).

> "Every Tuesday we conduct ICE meetings. We have a big room where all can sit together. Next to the big room are several smaller rooms where groups can work together. There is a specific agenda for the ICE meeting where dedicated persons are chairing various points on the agenda. During the meeting we always plan ahead for the next three weeks." Project manager

Co-location in terms of moving the project team to one location or building was not frequently found in the projects we studied. However, there are clearly some elements of this mechanism being used in the example above as the project manager describes how they use a big room to conduct ICE meetings.

The main difference is that co-location as a mechanism means locating the project staff at the same physical location to enhance informal communication on a day-to-day basis (Kokkonen and Vaagaasar, 2018), while multidisciplinary workshops, such as ICE meetings, may only require that the staff from the various actors sit together in one room during these workshops. The rest of the time, they may be working at different locations.

## *5.4 Pace direction – kick-off meetings to establish ground rules for collaboration*

The use of kick-off meetings was frequently used across all types of projects but was particularly popular with projects governed by the pace dimension. For such projects, having a short time-to market is a competitive advantage. Short project duration in these projects has a significant impact on project success (Shenhar and Dvir, 2004). Many of the construction projects were governed by this dimension, because the owner wanted to make the building available for rent or sale as early as possible to start earning money. In order to reduce project duration, roles and responsibilities should be clear (PMI, 2017). To ensure an efficient start-up where all participants as early as possible have a common understanding of the project, many conducted kick-off meetings. During these meetings, roles and routines were established and ground rules were established between clients and contractors. We found several examples of how these kick-off meetings included development of team contracts. Clarifying expectations is an important aspect at this phase (Lloyd-Walker et al., 2014). Collaboration meetings were often conducted in the beginning of the projects as a kick-off, but there were many respondents who described how such meetings were conducted at regular intervals throughout the project. One of the respondents gave an example of how they invested heavily in a collaboration kick-off at the beginning of the project.

> "Prior to starting phase 1, we conducted a kick-off for the entire team which counted 25 people. The meeting lasted for two days and included representatives from the client, contractors and sub-contractors…. Through group sessions, team contracts were developed." Project manager

In terms of the stages of group development identified by Tuckman (1965) it may be particularly important for projects in the pace direction to reach the performing stage as quickly as possible. Kick-off meetings with a focus on ground rules for collaboration may reduce the risk for the project suffering a long period of storming. This could also explain why projects in the pace direction also often invited users and contractors to participate in the project as early as possible. We also learned that several respondents in projects governed by the pace dimension used various versions of the Last Planner system (Ballard, 2000) to ensure that the skilled workers were involved early in the detailed planning of project tasks.

## *5.5 Less frequently used collaboration mechanisms*

In the above sections, we have discussed the most frequently used collaboration mechanisms found for each of the four dimensions in the NCTP framework (Shenhar and Dvir, 2004). We also need to discuss some of those less frequently used mechanisms that have not already been discussed. All the different collaboration mechanisms listed in Table 3 were identified through a literature review of existing research on collaboration mechanisms. Even though some of these mechanisms were found less frequently in our study, it does not mean that we consider these to be less relevant. One third of the project managers we interviewed described how they shared IT solutions to achieve collaboration. This was surprising, as we had expected this number to be significantly higher. The use of common IT solutions through for example BIM models (Matthews et al., 2018), project portals and various online collaboration tools (Harley, 2011) is commonly described in collaborative project management research. Some respondents used project hotels to exchange interface information but only a few of the projects shared their IT solutions on a larger scale. Sharing of IT solutions was much more frequently used in ICT projects than in construction projects. Some of the ICT project managers described how they needed extensive access to the client's internal IT system in order to collaborate with the client's IT team, for example when implementing new solutions.

Only a few of the respondents described how they hired external consultants to help them to facilitate collaboration. A chaperone can be hired to facilitate collaborative behaviour (Smits and van Marrewijk, 2012). Some of the respondents described situations where they had hired consultants to take care of the interfaces between various contractors. The aim was to ensure that the information flow between the contractors was efficient and that interface-related questions were addressed to the appropriate people and solved at the right level. However, we found few examples of extensive chaperoning. There is often a cost-benefit aspect related to hiring such external consultants to facilitate collaboration. The cost of hiring the consultants is a tangible transaction cost that is easily identifiable on the balance sheet. However, the benefits achieved by using chaperoning may be less tangible and more difficult to identify in the balance sheet. Benefits achieved from collaboration are not always easy to measure in terms of money and it may be difficult to prove that the benefit is caused by the use of chaperoning.

Co-location can be an efficient way to improve collaboration and reduce friction (Bosch-Sijtsema and Tjell, 2017). Co-location of project teams was also not frequently used in the projects we studied and was ranked 8th in Table 3. Co-locating teams as a collaboration mechanism was more often used in complex projects than other types of projects. In such projects with many interfaces, the benefits of co-locating teams to improve information flow (Kokkonen and Vaagaasar, 2018) may be particularly useful.

The development of advanced new solutions for communication between sites is rapidly evolving. For example, today's technology makes it possible to participate in meetings remotely through video conference systems with advanced screen sharing possibilities and even virtual reality that enhances collaboration in meetings although participants are at different locations (Karis et al., 2016). However, it was interesting to find that, even though such methods were highlighted as important by a few respondents, most of them used less advanced systems as they often experienced technical problems with the more advanced systems. Only a few of the respondents described the use of more advanced video conference systems as a good way to achieve collaboration; other respondents simply considered it an acceptable tool to reduce the need for travelling. However, those respondents that described the benefits of such systems had been pro-active and invested both time and money to ensure that the full benefits could be harvested. Those project managers who had taken active initiatives to ensure that the systems worked properly and used the systems frequently themselves described more benefits of the system compared to the project managers who were more sceptical about such video conferencing systems.

## 6 Conclusions and implications

The purpose of this paper was to study how project managers use different mechanisms in their day-to-day practice to achieve successful collaboration in the relationship between client and contractors in projects. Through interviews with project managers who had 782 years of project experience in total between them, we have analysed 69 projects from three different industries and classified them according to Shenhar and Dvir (2004)'s framework of novelty, complexity, technology and pace. We identified the most frequent mechanisms used to achieve successful collaboration for projects depending on their governing dimension. Based on this we introduce the collaboration compass that project managers can follow to learn which collaboration mechanisms may be most relevant for their specific project.

If the project has a high degree of novelty, frequent travelling and face-to-face meetings are commonly used as a means to achieve collaboration. In projects with high complexity it may be particularly important to have open books and share both bad and good news with each other. Moving on to high-tech projects, we learned that frequent use of multidisciplinary work sessions such as ICE meetings and scrum methods is particularly common. In projects that are governed by the pace dimension, it is important to finish the project fast. In these projects we learned that having comprehensive kick-off meetings where ground rules for collaboration are established can be particularly important.

The academic contribution from this paper mainly consists of two parts. First, we contribute to the state-of-the-art research on collaboration mechanisms, simply by increasing the number of studies in this field. Based on a literature review of existing research we have investigated which mechanisms are most frequently used successfully in 69 different projects. We have responded to the call for more practice-oriented studies that are useful for project managers (Svejvig and Andersen, 2015) and contribute to bridge the gap between theory and practice in project management research (Shenhar, 1998). Our second academic contribution is that we have identified a new area where the NCTP framework developed by Shenhar and Dvir (2004) can be used. By applying the NCTP framework as a taxonomy for research on collaboration mechanisms we achieve a finer mesh as we study how the use of the mechanisms varies between projects with different novelty, complexity, technology and pace.

Our main practical contribution is that we provide a compass that project managers can follow in their daily practice. First, by using Shenhar and Dvir (2004) to map the main dimension (novelty, complexity, technology or pace) and then applying the compass to this map. For example, if the project is governed by high complexity, it is particularly important to open up books and share information. Following the compass, project managers can prioritise which collaborative mechanisms are optimal to implement in their project. If the project is governed by two dimensions, the project manager can plot a course combining collaboration mechanisms from these two directions.

For society, reduced travelling in projects has positive effects as it cuts transaction costs and reduces negative environmental impact. The development of advanced new solutions for communication between sites is rapidly evolving. For example, today's technology makes it possible to participate in meetings remotely through video conference systems with advanced screen sharing possibilities and even virtual reality that enhances collaboration in meetings event though participants are at different locations (Karis et al., 2016). It is therefore a paradox that increased travelling and face-to-face meetings are still identified as key mechanism to achieve collaboration in projects with high novelty.

A limitation to our study is that it only includes respondents based in Norway. However, we still argue that one can generalise the findings outside the Norwegian context as many of the respondents worked in international companies or global projects. Some of the respondents had been working abroad and many of the projects included international partners. Another limitation to our study is that we have only studied delivery projects. Other projects such as R&D projects have not been covered by our work.

We propose that the collaboration compass is tested and applied in projects by other researches. All compasses need to be calibrated, and it would be particularly interesting to apply the compass in projects in different parts of the world to calibrate it for different contexts and cultures. We also encourage other researchers to apply the collaboration compass on types of projects other than delivery projects. Hence, we can calibrate the compass further and make it more accurate for project managers to follow.

## References

Aarseth, W. (2014) *Project Management – A New Mindset for Success: Collaborative Business and Global Mindset*, Fagbokforlaget, Bergen, Norway.

Aarseth, W., Ahola, T., Aaltonen, K., Økland, A. and Andersen, B. (2017) 'Project sustainability strategies: A systematic literature review', *International Journal of Project Management*, Vol. 35, No. 6, pp.1071–1083, https://doi.org/10.1016/j.ijproman.2016.11.006.

Aarseth, W., Rolstadås, A. and Klev, R. (2016) *Project Leadership Challenges : Their Nature and How They are Managed*, Fagbokforlaget, Bergen.

Adler, P.A. and Adler, P. (2001) 'The reulctant respondent', in Gubrium, J.F. and Holstein, J.A. (Eds.): *Handbook of Interview Research*, pp.515–535, SAGE Publications, Thousand Oaks, California.

Ahola, T. (2009) *Efficiency in Project Networks: The Role of Inter-organizational Relationships in Project Implementation*, Doctoral PhD thesis, Helsinki University of Technology.

Ahola, T., Vuori, M. and Viitamo, E. (2017) 'Sharing the burden of integration: an activity-based view to integrated solutions provisioning', *International Journal of Project Management*, Vol. 35, No. 6, pp.1006–1021, https://doi.org/10.1016/j.ijproman.2017.05.002.

Aljuwaiber, A. (2019) 'Technology-based vs. face-to-face interaction for knowledge sharing in the project teams', *International Journal of Project Organisation and Management*, Vol. 11, No. 3, pp.227–242.

Alvesson, M. and Sköldberg, K. (2009) *Reflexive Methodology: New Vistas for Qualitative Research*, SAGE Publications, London.

Badi, S. M. and Pryke, S. D. (2015) 'Assessing the quality of collaboration towards the achievement of sustainable energy innovation in PFI school projects', *International Journal of Managing Projects in Business*, Vol. 8, No. 3, pp.408–440, doi:10.1108/IJMPB-09-2014-0060.

Baiden, B.K., Agyekum, K. and Atuahene, B.T. (2018) 'Client-contractor relations on construction projects in Ghana', *International Journal of Project Organisation and Management*, Vol. 10, No. 4, pp.333–351.

Ballard, H. G. (2000) *The Last Planner System of Production Control*, Doctoral PhD Thesis, University of Birmingham.

Bayliss, R., Cheung, S-O., Suen, H.C.H. and Wong, S-P. (2004) 'Effective partnering tools in construction: a case study on MTRC TKE contract 604 in Hong Kong', *International Journal of Project Management*, Vol. 22, No. 3, pp.253–263, https://doi.org/10.1016/S0263-7863(03)00069-3.

Bititci, U., Turner, T., Mackay, D., Kearney, D., Parung, J. and Walters, D. (2007) 'Managing synergy in collaborative enterprises', *Production Planning & Control*, Vol. 18, No. 6, pp.454–465 doi: 10.1080/09537280701494990.

Blenke, L.R., Gosavi, A. and Daughton, W. (2017) 'Attitudes towards face-to-face meetings in virtual engineering teams: perceptions from a survey of defence projects', *International Journal of Project Organisation and Management*, Vol. 9, No. 2, pp.95–112.

Bond-Barnard, T.J., Fletcher, L. and Steyn, H. (2018) 'Linking trust and collaboration in project teams to project management success', *International Journal of Managing Projects in Business,* Vol. 11, No. 2, pp.432-457, 10.1108/IJMPB-06-2017-0068.

Bond-Barnard, T.J., Steyn, H. and Fabris-Rotelli, I. (2013) 'The impact of a call centre on communication in a programme and its projects', *International Journal of Project Management,* Vol. 31, No. 7, pp.1006–1016, https://doi.org/10.1016/j.ijproman.2012.12.012.

Bosch-Sijtsema, P.M. and Tjell, J. (2017) 'The concept of project space: studying construction project teams from a spatial perspective', *International Journal of Project Management*, Vol. 35, No. 7, pp.1312–1321, https://doi.org/10.1016/j.ijproman.2017.05.009.

Braun, T. and Sydow, J. (2019) 'Selecting organizational partners for interorganizational projects: the dual but limited role of digital capabilities in the construction industry', *Project Management Journal*, Vol. 50, No. 4, pp.398–408, 10.1177/8756972819857477.

Bresnen, M. and Marshall, N. (2000) 'Building partnerships: case studies of client contractor collaboration in the UK construction industry', *Construction Management and Economics*, Vol. 18, No. 7, pp.819–832, 10.1080/014461900433104.

Bresnen, M. and Marshall, N. (2002) 'The engineering or evolution of co-operation? A tale of two partnering projects', *International Journal of Project Management*, Vol. 20, No. 7, pp.497–505, https://doi.org/10.1016/S0263-7863(01)00043-6.

Bryman, A. (2016) *Social Research Methods*, Oxford University Press, Oxford.

Bygballe, L.E. and Swärd, A. (2019) 'Collaborative project delivery models and the role of routines in institutionalizing partnering', *Project Management Journal*, Vol. 50, No. 2, pp.161–176, 10.1177/8756972818820213.

Bygballe, L.E., Jahre, M. and Swärd, A. (2010) 'Partnering relationships in construction: a literature review', *Journal of Purchasing and Supply Management*, Vol. 16, No. 4, pp.239–253, https://doi.org/10.1016/j.pursup.2010.08.002.

Cassell, C. (2009) 'Interviews in organizational research', in Buchanan, D.A. and Bryman, A. (Eds.): *The SAGE Handbook of Organizational Research Methods*, pp.500–515, SAGE Publications, London.

Chachere, J., Kunz, J. and Levitt, R. (2004) *Observation, Theory, and Simulation of Integrated Concurrent Engineering: Grounded Theoretical Factors that Enable Radical Project Acceleration*, CIFE Working Paper 87, Stanford University.

Cho, S. and Ballard, G. (2011) 'Last planner and integrated project delivery', *Lean Construction Journal*, Vol. 7, No. 1, pp.67–78.

Christensen, R.M. (2008) *Development Practically Speaking, Learning Processes in the Danish Construction Industry*, PhD thesis, Aalborg University.

De Rezende, L.B., Blackwell, P. and Pessanha Goncalves, M.D. (2018) 'Research focuses, trends, and major findings on project complexity: a bibliometric network analysis of 50 years of project complexity research', *Project Management Journal*, Vol. 49, No. 1, pp.42–56.

Dietrich, P., Eskerod, P., Dalcher, D. and Sandhawalia, B. (2010) 'The dynamics of collaboration in multipartner projects', *Project Management Journal*, Vol. 41, No. 4, pp.59–78, 10.1002/pmj.20194.

Ely, M., Vinz, R., Downing, M. and Anzul, M. (1997) *On Writing Qualitative Reseearch – Living by Words*, The Falmer Press, London.

Engström, S. and Stehn, L. (2016) 'Barriers to client-contractor communication: implementing process innovation in a building project in Sweden', *International Journal of Project Organisation and Management*, Vol. 8, No. 2, pp.151–171.

Erdogan, B., Anumba, C. J., Bouchlaghem, D. and Nielsen, Y. (2008) 'Collaboration environments for construction: implementation case studies', *Journal of Management in Engineering*, Vol. 24, No. 4, pp.234–244.

Eriksson, E., Brian, A. and Torbjörn, N. (2009) 'Overcoming barriers to partnering through cooperative procurement procedures', *Engineering, Construction and Architectural Management*, Vol. 16, No. 6, pp.598–611, doi:10.1108/09699980911002593.

Hans, R.T. and Mnkandla, E. (2019) 'A framework for improving the recognition of project teams as key stakeholders in information and communication technology projects', *International Journal of Project Organisation and Management*, Vol. 11, No. 3, pp.199–226.

Harley, J. (2011) 'Collaboration and the use of online collaborative toolsets in the project management environment', *International Journal of Managing Projects in Business*, Vol. 4, No. 2, pp.345–354, doi:10.1108/17538371111120289.

Herzog, H. (2005) 'On home turf: interview location and its social meaning', *Qualitative Sociology*, Vol. 28, No. 1, pp.25–47, 10.1007/s11133-005-2629-8.

Hietajärvi, A-M. and Aaltonen, K. (2018) 'The formation of a collaborative project identity in an infrastructure alliance project', *Construction Management and Economics*, Vol. 36, No. 1, pp.1–21, 10.1080/01446193.2017.1315149.

Hietajärvi, A-M., Aaltonen, K. and Haapasalo, H. (2017) 'What is project alliance capability?', *International Journal of Managing Projects in Business*, Vol. 10, No. 2, pp.404–422, doi:10.1108/IJMPB-07-2016-0056.

Hosseini, A., Wondimu, P.A., Bellini, A., Henriktune, Haugseth, N., Andersen, B. and Lædre, O. (2016) 'Project partnering in Norwegian construction industry', in *Sustainable Built Environment, SBE16*, 5–7 October 2016, Tallin and Helsinki, Energy Procedia, pp.241–252.

ICW (2017) *Insight into ISO 44001*, Institute for Collaborative Working [online] https://www.instituteforcollaborativeworking.com/Resources/Documents/insight_into_iso44001.pdf (accessed 24 October 2017).

Ika, L.A. and Donnelly, J. (2017) 'Success conditions for international development capacity building projects', *International Journal of Project Management,* Vol. 35, No. 1, pp.44–63, https://doi.org/10.1016/j.ijproman.2016.10.005.

ISO (2017) *ISO 44001 – Collaborative Business Relationship*, ISO – the International Organization for Standardization, Geneva, Switzerland.

Kadefors, A. (2004) 'Trust in project relationships-inside the black box', *International Journal of Project Management,* Vol. 22, No. 3, pp.175–182, 10.1016/S0263-7863(03)00031-0.

Karis, D., Wildman, D. and Mané, A. (2016) 'Improving remote collaboration with video conferencing and video portals', *Human-Computer Interaction,* Vol. 31, No. 1, pp.1–58, 10.1080/07370024.2014.921506.

Kokkonen, A. and Vaagaasar, A. L. (2018) 'Managing collaborative space in multi-partner projects', *Construction Management and Economics*, Vol. 36, No. 2, pp.83–95, 10.1080/01446193.2017.1347268.

Kwofie, T.E., Aigbavboa, C.O. and Matsane, Z.S-S. (2018) 'Dimensions of social barriers to effective collaborative working in construction supply chain', *International Journal of Project Organisation and Management*, Vol. 10, No. 1, pp.37–53.

Li, H., Arditi, D. and Wang, Z. (2015) 'Determinants of transaction costs in construction projects', *Journal of Civil Engineering and Management*, Vol. 21, No. 5, pp.548–558, 10.3846/13923730.2014.897973.

Lloyd-Walker, B.M., Mills, A.J. and Walker, D.H.T. (2014) 'Enabling construction innovation: the role of a no-blame culture as a collaboration behavioural driver in project alliances', *Construction Management and Economics*, Vol. 32, No. 3, pp.229–245, 10.1080/01446193.2014.892629.

Majava, J., Haapasalo, H. and Aaltonen, K. (2019) 'Elaborating factors affecting visual control in a big room', *Construction Innovation*, Vol. 19, No. 1, pp.34–47, doi:10.1108/CI-06-2018-0048.

Matthews, J., Love, P.E.D., Mewburn, J., Stobaus, C. and Ramanayaka, C. (2018) 'Building information modelling in construction: insights from collaboration and change management perspectives', *Production Planning & Control,* Vol. 29, No. 3, pp.202–216, 10.1080/09537287.2017.1407005.

Merschbrock, C. and Munkvold, B.E. (2015) 'Effective digital collaboration in the construction industry – a case study of BIM deployment in a hospital construction project', *Computers in Industry*, Vol. 73, No. 1, pp.1–7, https://doi.org/10.1016/j.compind.2015.07.003.

Muller, R. (2009) *Project Governance*, Gower Publishing, Surrey.

Müller, R., Turner, R., Andersen, E.S., Shao, J. and Kvalnes, O. (2014) 'Ethics, trust, and governance in temporary organizations', *Project Management Journal*, Vol. 45, No. 4, pp.39–54, 10.1002/pmj.21432.

Nevstad, K., Børve, S., Karlsen, A.T. and Aarseth, W. (2018) 'Understanding how to succeed with project partnering', *International Journal of Managing Projects in Business*, Vol. 11, No. 4, pp.1044–1065, 10.1108/IJMPB-07-2017-0085.

O'Connor, J.T., O'brien, W.J. and Choi, J.O. (2014) 'Critical success factors and enablers for optimum and maximum industrial modularization', *Journal of Construction Engineering and Management*, Vol. 140, No. 6, pp.04014012, doi:10.1061/(ASCE)CO.1943-7862.0000842.

Pinto, J.K., Slevin, D.P. and English, B. (2009) 'Trust in projects: an empirical assessment of owner/contractor relationships', *International Journal of Project Management,* Vol. 27, No. 6, pp.638–648, http://dx.doi.org/10.1016/j.ijproman.2008.09.010.

PMI (2017) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Project Management Institute, Newtown Square, Pennsylvania.

Porwal, A. and Hewage, K.N. (2013) 'Building information modeling (BIM) partnering framework for public construction projects', *Automation in Construction*, May, Vol. 31, pp.204–214, https://doi.org/10.1016/j.autcon.2012.12.004.

Pratt, J.W. and Zeckhauser, R. (1991) 'Principals and agents: an overview', in Pratt, J.W. and Zeckhauser, R. (Eds.): *Principals and Agents: The Structure of Business*, pp.241, Harvard Business School Press, USA.

Rahmani, F., Khalfan, M.M. and Maqsood, T. (2018) 'A comparative study of early contractor involvement and project alliancing', *International Journal of Project Organisation and Management*, Vol. 10, No. 2, pp.93–108.

Ross, S.A. (1973) 'The economic theory of agency: the principal's problem', *The American Economic Review*, Vol. 63, No. 2, pp.134–139.

Sabini, L., Muzio, D. and Alderman, N. (2019) '25 years of 'sustainable projects. What we know and what the literature says', *International Journal of Project Management*, Vol. 37, No. 6, pp.820–838, https://doi.org/10.1016/j.ijproman.2019.05.002.

Saunders, M., Lewis, P. and Adrian, T. (2019) *Research Methods for Business Students*, Pearson Education Harlow, UK.

Schipper, R.R. and Silvius, A.G. (2018) 'Towards a conceptual framework for sustainable project portfolio management', *International Journal of Project Organisation and Management*, Vol. 10, No. 3, pp.191–221.

Sebastian, R. (2011) 'Changing roles of the clients, architects and contractors through BIM', *Engineering, Construction and Architectural Management*, Vol. 18, No. 2, pp.176–187, doi:10.1108/09699981111111148.

Shenhar, A.J. (1998) 'From theory to practice: toward a typology of project-management styles', *IEEE Transactions on Engineering Management*, Vol. 45, No. 1, pp.33–48.

Shenhar, A.J. and Dvir, D. (2004) 'How projects differ and what to do about it', in Morris, P.W.G. and Pinto, J.K.(Eds.): *The Wiley Guide to Managing Projects*, pp.1265–1286, John Wiley and Sons, Hoboken, New Jersey.

Shepherd, M. (2015) 'Interview methods for project management research', in Pasian, B. (Ed.): *Designs, Methods and Practices for Research of Project Management*, pp.185–202, Gower Publishing Ltd., Surrey.

Singh, V., Gu, N. and Wang, X. (2011) 'A theoretical framework of a BIM-based multi-disciplinary collaboration platform', *Automation in Construction*, Vol. 20, No. 2, pp.134–144, https://doi.org/10.1016/j.autcon.2010.09.011.

Smits, K. and Van Marrewijk, A. (2012) 'Chaperoning: practices of collaboration in the Panama Canal Expansion Program', *International Journal of Managing Projects in Business*, Vol. 5, No. 3, pp.440–456, doi:10.1108/17538371211235317.

Snowden, D.J. and Boone, M.E. (2007) 'A leader's framework for decision making', *Harvard business review,* Vol. 85, No. 11, p.68.

Suprapto, M., Bakker, H.L.M., Mooi, H.G. and Hertogh, M.J.C.M. (2016) 'How do contract types and incentives matter to project performance?', *International Journal of Project Management*, Vol. 34, No. 6, pp.1071–1087, https://doi.org/10.1016/j.ijproman.2015.08.003.

Suprapto, M., Bakker, H.L.M., Mooi, H.G. and Moree, W. (2015) 'Sorting out the essence of owner-contractor collaboration in capital project delivery', *International Journal of Project Management*, Vol. 33, No. 3, pp.664–683, 10.1016/j.ijproman.2014.05.001.

Svejvig, P. and Andersen, P. (2015) 'Rethinking project management: a structured literature review with a critical look at the brave new world', *International Journal of Project Management,* Vol. 33, No. 2, pp.278–290, https://doi.org/10.1016/j.ijproman.2014.06.004.

Takeuchi, H. and Nonaka, I. (1986) 'The new product development game', *Harvard Business Review*, Vol. 64, No. 1, pp.137–146.

Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I. and Ferreira, M. (2019) 'Project management practices in private organizations', *Project Management Journal*, Vol. 50, No. 1, pp.6–22, 10.1177/8756972818810966.

Tuckman, B.W. (1965) 'Developmental sequence in small groups', *Psychological Bulletin*, Vol. 63, No. 6, p.384.

Turner, J.R., Lecoeuvre, L., Sankaran, S. and Er, M. (2019) 'Marketing for the project: project marketing by the contractor', *International Journal of Managing Projects in Business*, Vol. 12, No. 1, pp.211–227, doi:10.1108/IJMPB-10-2017-0118.

Um, K.H. and Kim, S.M. (2018) 'Collaboration and opportunism as mediators of the relationship between NPD project uncertainty and NPD project performance', *International Journal of Project Management*, Vol. 36, No. 4, pp.659–672, 10.1016/j.ijproman.2018.01.006.

Velayudhan, D.P. and Thomas, S. (2018) 'Role of technological uncertainty, technical complexity, intuition and reflexivity in project planning – a study on software development projects', *International Journal of Project Organisation and Management*, Vol. 10, No. 1, pp.82–92.

Von Danwitz, S. (2018) 'Managing inter-firm projects: a systematic review and directions for future research', *International Journal of Project Management*, Vol. 36, No. 3, pp.525–541.

Walker, D. and Lloyd-Walker, B.M. (2015) *Collaborative Project Procurement Arrangements*, Project Management Institute, Newton Square, Pennsylvania, USA.

Warren, C.A. (2002) 'Qualitative interviewing', in Gubrium, J.F. and Holstein, J.A. (Eds.): *Handbook of Interview Research; Context & Method*, SAGE Publications, Thousand Oaks, pp.83–101.

Wilkinson, P. (2005) *Construction Collaboration Technologies: An Extranet Evolution*, Taylor & Francis, New York.

Williams, T. (2017) 'The nature of risk in complex projects', *Project Management Journal*, Vol. 48, No. 4, pp.55–66.

Williamson, O.E. (1996) *The Mechanisms of Governance*, Oxford University Press, New York.

Wondimu, P.A., Hosseini, A., Lohne, J., Hailemichael, E. and Lædre, O. (2016) 'Early contractor involvement in public infrastructure projects', in *Proc. 24th Ann. Conf. of the Int'l. Group for Lean Construction*, Boston, MA, USA, pp.13–22.

Yeh, Y.J., Lai, S.Q. and Ho, C.T. (2006) 'Knowledge management enablers: a case study', *Industrial Management & Data Systems*, Vol. 106, No. 6, pp.793–810, doi:10.1108/02635570610671489.

## Appendix

### *Detailed spreadsheet with findings from interviews*

| *Project and respondent information* | | | *Project classification* | | | | | *Collaboration mechanism* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Project no.* | *Project description* | *Respondent ID* | *N: novelty (1–3)* | *C: complexity (1–3)* | *T: technology (1–4)* | *P: pace (1–3)* | *Governing dimension* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* |
| P1 | New IT systems on all ships in a fleet | R1 | 2 | 2 | 4 | 2 | T | | | | | ✓ | ✓ | | | | | | |
| P2 | Transformation of IT system for a large construction group | R1 | 2 | 2 | 3 | 1 | T | | | | | ✓ | ✓ | | ✓ | | | ✓ | |
| P3 | Transformation of IT system for a company | R1 | 2 | 2 | 3 | 1 | T | | ✓ | | ✓ | ✓ | ✓ | | | | | | |
| P4 | Outfitting 80 university classrooms with ICT equipment | R2 | 2 | 2 | 3 | 1 | T | | | | | ✓ | ✓ | | | | | | |
| P5 | Outfitting of IT system in high school classrooms | R2 | 2 | 2 | 3 | 1 | T | | | | | ✓ | ✓ | | | | | | |
| P6 | Installation of a large screen on a football stadium | R2 | 2 | 1 | 3 | 2 | T | | | | | ✓ | ✓ | | | | | | |
| P7 | Installation of theatre stage | R2 | 2 | 1 | 3 | 2 | T | | | | | ✓ | ✓ | | | | | | |
| P8 | Outfitting of IT systems in 170 rooms in an office building | R2 | 2 | 1 | 3 | 1 | T | | | | | ✓ | ✓ | | | | | | |
| P9 | Transformation and upgrade of IT system for a municipal | R3 | 2 | 2 | 4 | 2 | T | | ✓ | | | ✓ | ✓ | | ✓ | | | ✓ | ✓ |
| P10 | Transformation and upgrade of IT system for a large municipal | R3 | 2 | 3 | 3 | 2 | C | | ✓ | | | | ✓ | | ✓ | | | ✓ | ✓ |
| P11 | Transformation and upgrade of IT system for a municipal | R3 | 2 | 2 | 4 | 2 | T | | ✓ | | | | ✓ | | ✓ | | | ✓ | ✓ |
| P12 | Transformation of IT system with 100 servers and 3000 users | R4 | 2 | 2 | 3 | 2 | T | | ✓ | | | | | | | | ✓ | | |
| P13 | Outfitting of 10 nursing homes with wealth fare technology | R5 | 3 | 2 | 3 | 1 | N | | | ✓ | ✓ | | | | | | | ✓ | |
| P14 | Outfitting of 3 nursing homes with sensors and wealth fare technology | R5 | 3 | 2 | 3 | 1 | N | | ✓ | ✓ | ✓ | | | | | | | ✓ | |
| P15 | Outfitting of nursing homes with sensors and wealth fare technology | R5 | 3 | 2 | 3 | 1 | N | | ✓ | ✓ | ✓ | | | | | | | ✓ | |
| P16 | Outfitting of nursing homes with sensors and wealth fare technology | R5 | 3 | 2 | 3 | 1 | N | | ✓ | ✓ | ✓ | | | | | | | ✓ | |
| P17 | Establish new intranet system for a company | R6 | 2 | 2 | 3 | 1 | T | | ✓ | ✓ | | | ✓ | | | | ✓ | | |
| P18 | Transformation of IT system for a company | R6 | 2 | 2 | 3 | 2 | T | | ✓ | | | | | | | | ✓ | | |
| P19 | Outfitting of nursing homes with sensors and wealth fare technology | R6 | 3 | 2 | 3 | 1 | N | | ✓ | | | | | | | | ✓ | | |
| P20 | Outfitting of nursing homes with sensors and wealth fare technology | R7 | 3 | 2 | 3 | 1 | N | | | | | ✓ | ✓ | | ✓ | | | | |
| P21 | Replace all IT systems for a municipal | R7 | 2 | 2 | 4 | 2 | T | ✓ | | | | | ✓ | | | | | | |
| P22 | Develop IT systems for a municipal | R7 | 2 | 2 | 4 | 2 | T | | ✓ | | | | ✓ | | | | | | |
| P23 | Develop new IT systems for a large oil company | R8 | 2 | 3 | 4 | 2 | T | | ✓ | | | | | | | | | | |

*Detailed spreadsheet with findings from interviews (continued)*

| *Project and respondent information* | | | *Project classification* | | | | | *Collaboration mechanism* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Project no.* | *Project description* | *Respondent ID* | *N: novelty (1–3)* | *C: complexity (1–3)* | *T: technology (1–4)* | *P: pace (1–3)* | *Governing dimension* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* |
| P24 | Transformation and upgrade of IT system for a municipal | R8 | 2 | 2 | 3 | 2 | T | | ✓ | | | ✓ | | | | | | | |
| P25 | Installation of theatre stage | R8 | 1 | 1 | 2 | 2 | P | | ✓ | | | | | | | | | | |
| P26 | Transformation of IT system for a large construction group | R8 | 2 | 2 | 3 | 2 | T | | ✓ | | | | | | | | | | |
| P27 | New IT system for a company with strict requirements for security | R9 | 2 | 3 | 4 | 2 | T | | ✓ | ✓ | | | ✓ | | | | | | |
| P28 | Implementation of new ERP system for a large retail group | R9 | 2 | 2 | 3 | 2 | T | | | | | | ✓ | | | | | ✓ | |
| P29 | Outfitting of nursing homes with sensors and wealth fare technology | R9 | 3 | 2 | 3 | 1 | N | | | | | | ✓ | | | | | ✓ | |
| P30 | Replace 350 routers in an office building | R9 | 1 | 1 | 2 | 2 | P | | | | | | ✓ | | | | | | |
| P31 | Development of a large subsea oil field in the North sea | R10 | 2 | 3 | 3 | 2 | C | | | | | | | | | | ✓ | | |
| P32 | Detail engineering for an offshore oil field development | R10 | 2 | 3 | 2 | 2 | C | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | | |
| P33 | Establish a new office for the company in a new region | R10 | 1 | 1 | 1 | 3 | P | | ✓ | | | | | | | | | | |
| P34 | Construction of underwater pipelines in the North sea | R10/11 | 2 | 3 | 3 | 2 | C | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | ✓ | | ✓ |
| P35 | Development of a subsea oil field in the North sea | R10 | 2 | 3 | 3 | 2 | C | | | | | ✓ | | | | | ✓ | | |
| P36 | Development of a large gas field in the North sea | R11 | 3 | 3 | 4 | 2 | T | ✓ | | | ✓ | | ✓ | | | | ✓ | | ✓ |
| P37 | Development of a fast track subsea oil field in the North sea | R11 | 2 | 2 | 3 | 3 | P | ✓ | | ✓ | | | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| P38 | Detail engineering project for an oil company | R12 | 2 | 3 | 3 | 2 | C | | | | | | ✓ | | | | ✓ | | |
| P39 | Detail engineering project for an oil company | R13 | 2 | 3 | 3 | 2 | C | | ✓ | | | ✓ | ✓ | | | | ✓ | | ✓ |
| P40 | Concept study engineering for an oil field development | R13 | 2 | 3 | 3 | 2 | C | | | | | ✓ | ✓ | | | | ✓ | | ✓ |
| P41 | Detail engineering for an oil company developing an offshore oil field | R14 | 2 | 3 | 3 | 2 | C | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| P42 | Detail engineering for an oil company developing an offshore oil field | R14 | 2 | 3 | 3 | 2 | C | | | | | | | | ✓ | | | | ✓ |
| P43 | Early phase and detail engineering for an oil company | R15 | 2 | 3 | 3 | 2 | C | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| P44 | Early phase and detail engineering for an oil company | R15 | 2 | 3 | 3 | 2 | C | | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | |
| P45 | Develop national IT infrastructure between hospitals | R16 | 2 | 3 | 3 | 1 | C | | ✓ | | | ✓ | | | ✓ | | ✓ | ✓ | |
| P46 | Develop new nationwide IT solution for public health services | R17 | 2 | 3 | 3 | 1 | C | ✓ | ✓ | | | ✓ | | | ✓ | | | | |

*Detailed spreadsheet with findings from interviews (continued)*

| *Project and respondent information* | | | *Project classification* | | | | | *Collaboration mechanism* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Project no.* | *Project description* | *Respondent ID* | *N: novelty (1–3)* | *C: complexity (1–3)* | *T: technology (1–4)* | *P: pace (1–3)* | *Governing dimension* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* |
| P47 | Railway infrastructure project | R18/19 | 1 | 1 | 2 | 2 | P | | ✓ | ✓ | | | ✓ | | | ✓ | ✓ | | |
| P48 | Construction of a large building use massive-wood technology | R20 | 2 | 1 | 2 | 2 | P | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| P49 | Construction of an apartment building | R21 | 1 | 1 | 1 | 2 | P | | ✓ | | | | | | | | | | |
| P50 | Implementation of new ERP system for a large retail company | R22 | 2 | 2 | 3 | 2 | T | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | |
| P51 | Implementation of new ERP system for a large retail company | R23 | 2 | 2 | 3 | 2 | T | | ✓ | | | ✓ | ✓ | | ✓ | | ✓ | | |
| P52 | Develop and implement new IT system for a government agency | R24 | 2 | 3 | 3 | 1 | C | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | |
| P53 | Develop new IT banking solutions for a large financial institution | R25 | 2 | 3 | 3 | 1 | C | | | | | ✓ | ✓ | | | | ✓ | | |
| P54 | Construction of apartment buildings | R26 | 1 | 2 | 1 | 2 | P | | | | | | ✓ | ✓ | | | | | |
| P55 | Construction of apartment buildings | R27 | 1 | 2 | 1 | 2 | P | | ✓ | | | | ✓ | | ✓ | | | | |
| P56 | Construction of a public school building | R28 | 1 | 2 | 1 | 2 | P | | ✓ | | | ✓ | ✓ | | ✓ | | | | |
| P57 | Construction of a public health service building | R29 | 1 | 2 | 1 | 2 | P | | ✓ | ✓ | | | | | ✓ | | | | |
| P58 | Construction of a new hotel | R29 | 1 | 2 | 1 | 2 | P | | ✓ | ✓ | | | ✓ | | ✓ | | | | |
| P59 | Construction of a student housing complex | R29 | 1 | 2 | 1 | 2 | P | | ✓ | ✓ | | | ✓ | | ✓ | | | | |
| P60 | Construction of a student housing complex | R29 | 1 | 2 | 1 | 2 | P | | ✓ | ✓ | | ✓ | | | ✓ | | | | |
| P61 | Construction of a student housing complex | R29 | 1 | 2 | 1 | 2 | P | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | | |
| P62 | Construction of 2000 apartments | R30 | 1 | 2 | 1 | 2 | P | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | | |
| P63 | Construction of office building | R31 | 1 | 2 | 1 | 2 | P | ✓ | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | ✓ | |
| P64 | Construction of office building | R32 | 1 | 2 | 1 | 2 | P | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | |
| P65 | Construction of underwater pipelines in the North sea | R33/34/35 | 2 | 3 | 3 | 2 | C | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| P66 | Construction of underwater pipelines in the North sea | R33 | 2 | 3 | 3 | 2 | C | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | | |
| P67 | Construction of underwater pipelines in the North sea | R33/35 | 2 | 3 | 3 | 2 | C | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| P68 | Construction of a North sea wellhead platform | R36/37/38 | 2 | 3 | 3 | 2 | C | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | | |
| P69 | Construction of underwater pipelines in the North sea | R39 | 2 | 3 | 3 | 2 | C | | ✓ | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ |

*Detailed spreadsheet with findings from interviews (continued)*

| *Collaboration mechanism* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *All projects* | | | | | | | | | | | | |
| All projects (out of 69) | 13 | 46 | 21 | 13 | 31 | 45 | 6 | 29 | 11 | 28 | 18 | 11 |
| *All projects (in percentage)* | *19* | *67* | *30* | *19* | *45* | *65* | *9* | *42* | *16* | *41* | *26* | *16* |
| *Novelty, complexity, technology, pace* | | | | | | | | | | | | |
| Novelty projects (out of 7) | 0 | 4 | 4 | 4 | 1 | 2 | 0 | 1 | 0 | 1 | 5 | 0 |
| *Novelty projects (in percentage)* | *0* | *57* | *57* | *57* | *14* | *29* | *0* | *14* | *0* | *14* | *71* | *0* |
| Complexity projects (out of 21) | 7 | 14 | 5 | 4 | 13 | 13 | 3 | 11 | 6 | 16 | 6 | 7 |
| *Complexity projects (in percentage)* | *33* | *67* | *24* | *19* | *62* | *62* | *14* | *52* | *29* | *76* | *29* | *33* |
| Technology projects (out of 23) | 3 | 13 | 2 | 2 | 12 | 18 | 0 | 5 | 1 | 5 | 5 | 3 |
| *Technology projects (in percentage)* | *13* | *57* | *9* | *9* | *52* | *78* | *0* | *22* | *4* | *22* | *22* | *13* |
| Pace projects (out of 18) | 3 | 15 | 10 | 3 | 5 | 12 | 3 | 12 | 4 | 6 | 2 | 1 |
| *Pace projects (in percentage)* | *17* | *83* | *56* | *17* | *28* | *67* | *17* | *67* | *22* | *33* | *11* | *6* |

# Paper 4

This paper is awaiting publication and is therefore not included.