# Follow the Collaboration Compass


## 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.



**Keyword**s: Collaboration mechanisms, Project management, Practice, Project classification

**Paper type**: Research paper

# 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 have been successfully used on similar projects in the past.

Good collaboration between the client and contractors should lead to win-win situations for both 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 et al., 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

characterized 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 et al. (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.

***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., 2018). 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. (2018) 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) categorize 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 such 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 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) as well as BIM models (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 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, specialized 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).

***Table 1: Collaboration mechanisms***

| 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., 2018) | (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

### *Project classification*

Several frameworks and models can be used as a taxonomy in project management research. The governance framework for project management (Muller, 2017) 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 et al., 2004) includes three other dimensions. In this framework, projects are categorized 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 et al., 2004).

In this paper, we use the NTCP framework (Shenhar et al., 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 recognized in the field with a strong burstiness score and a high citation frequency (De Rezende et al., 2018).

***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 studied. 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 percent of recent published articles on project management use qualitative methods and 31 percent used quantitative methods, while the remaining 20 percent used conceptual or mixed methods.

***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 categorized as contractors. Ten respondents worked for companies that can be categorized 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.

***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 |

***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 anonymized 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., 2009, 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 reviewed and approved by 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.

***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 1. 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 categorized each project according to the NCTP framework (Shenhar et al., 2004) and identified the governing dimension for each project as summarized 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 characterizes 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.

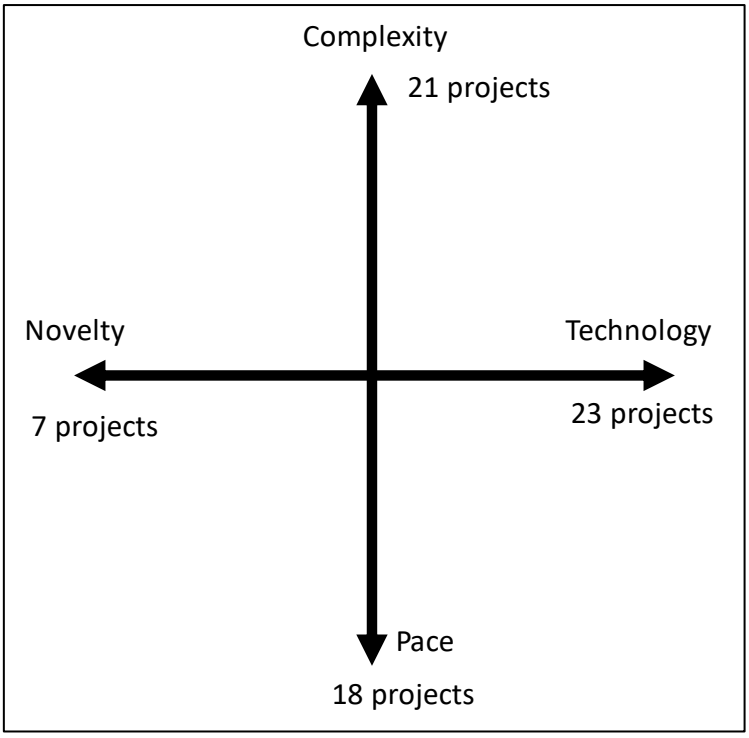


***Figure 1: Grouping of projects based on their governing dimension***

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 1. For each project we ticked off which of the mechanisms, labelled A-L, 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 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 categorized 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.

***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 direct 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 generalize 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 et al. (2004). There is clearly a risk that some mistakes may have occurred when we categorized 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 et al., 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 we present the ranking of the various collaboration mechanisms based on the number of projects in which these were used. We can see that "*Arrange 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 |

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 characterized by its novelty, complexity, technology or pace. A complete list of the rating for each mechanism in each direction is provided in Appendix 1.

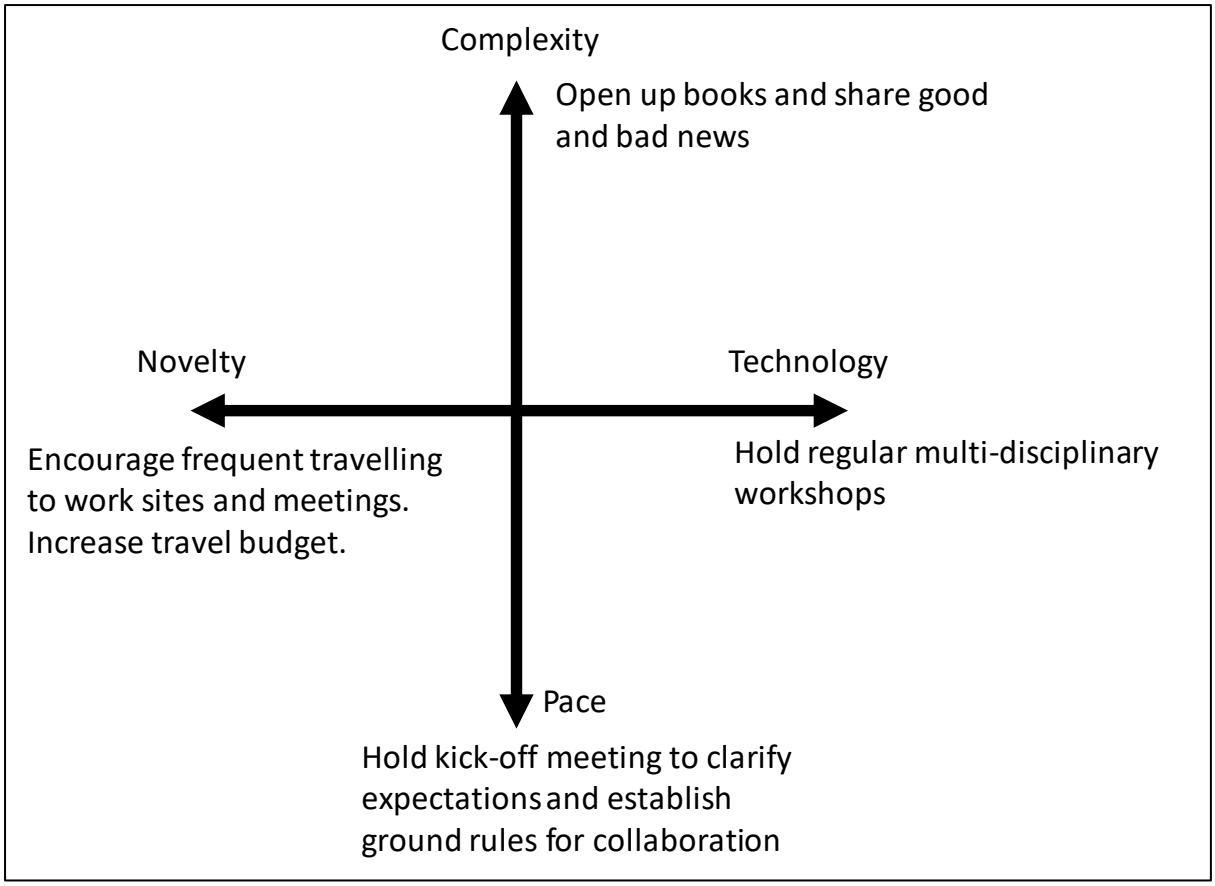


***Figure 2: The collaboration compass – Most used collaboration mechanisms for projects with different characteristics.***

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 characterized by the pace dimension the most used mechanism was "Hold kick-off meeting to clarify expectations and establish ground rules for collaboration".

In Appendix 1 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.

***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 7$^{th}$ 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 et al., 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 project (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 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.

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 minimized (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.

***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 et al., 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* who were working *on the same 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-

***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 organized 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.

***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 et al., 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.

***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 et al., 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 8$^{th}$ 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 et al. (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 et al. (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 et al., 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 prioritize 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 generalize 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.

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# Appendix 1

Detailed spreadsheet with findings from interviews

| Project and respondent Information | | | Project classification | | | | | Collaboration mecahnism | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project no. | Project description | Respondent ID | Novelty (1-3) | Complexity (1-3) | Technology (1-4) | 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 sensors and 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 | | ✓ | | | | | | | | | | |
| 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/R11 | 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 | ✓ | ✓ | | | ✓ | | | ✓ | | | | | |
| 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 | | ✓ | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ |
| 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 17) | | | | | | | | 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 % |