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## IDENTIFYING COLLABORATIVE TRENDS IN A PROJECT TEAM ENVIRONMENT

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HOW CAN COLLABORATIVE TRENDS BE IDENTIFIED IN A PROJECT?

*Jeroen Eversdijk*

4148428

*August 2019*

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“The hard stuff is easy; it is the soft stuff that is really hard”

- Michael Hammer

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By

J. Eversdijk

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An electronic version of this thesis is available at <http://repository.tudelft.nl/>.

# PREFACE

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Over the last six months I had the pleasure to work with great people to uncover the complexity of collaboration. Where at first, I assumed it to be an easy objective where, like in math, things are clearly explained, a common understanding about collaboration throughout was expected. I have never been so wrong. With almost all scientific papers having a different conclusion, a different set of 'elements' critical to collaboration, I quickly realized that I had to find my own way through the fog surrounding collaboration. During this research I had the opportunity to talk with a lot of people and share experiences on all sorts of matters, and of course collaboration.

Over the months I came to understand where the complexity of collaboration was coming from. With the interviews and discussions, it became clear that there is no common definition of collaboration. Where for some it meant to work pleasantly with your colleague, where for others it became almost philosophical. One common aspect which everyone pointed out was the benefits a project could have when having a good collaboration with all parties involved are endless. As Marco Eykelenboom mentioned after the first progress meeting: "It is wonderful that you as a student can already see the importance of collaboration in projects then your possibilities are endless."

During my research I had great help from a lot of people from Fluor, all members of the client, the TU Delft and the RSM. A special thanks to Marco Eykelenboom for creating the time to discuss the endless complexities and possibilities of collaboration. And to Sjoerd-Jan Ribberink for assisting me during my research, helping me during workshops and helping me think outside the box when I got stuck. This was not always making it easier but did make it more fun to explore the boundaries of collaboration. I also would like to thank all people in the project involved in the workshops and filling in the surveys, without them this research would not have been possible.

A special thanks to my committee members who kept me on track and created a path where I thought it was a dead end. Hans Bakker for providing direction and critical comments during the progress meetings. Marian Bosch-Rekvelde, thank you for time, feedback and the willingness to always provide a critical look on the thesis progress. Anna Nikulina, you have been a great help in the development of this thesis. By being present on the project work floor you always had the time to discuss issues I was running into, assist me during workshops and making sure there was a good theoretical line throughout this research.

Finally, I would like to thank my girlfriend, Pauline and my family in always understanding why I was working late and taking care of me while writing this thesis.

Jeroen Eversdijk  
Delft, 2019

# EXECUTIVE SUMMARY

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Collaboration is critical for the success of projects in the construction industry. With increasing complexity and members of parties involved, sharing of information and knowledge is essential in order to cope with the complexities and mitigate risks. To achieve a well performing project, mutual agreements and joint goal setting must be established. A well performing group should be able to deal with great amounts of information to understand all possibilities and risks. Without the ability to oversee the complexity of the project and lacking communication, projects are often overrunning on cost and schedule.

Literature exist concerning what collaboration encompasses, but little is known how it develops over time. Only static methods exist to assess the collaboration in a project, there is currently no tool known to assess collaboration dynamics during a project. To get a better understanding of collaboration dynamics a tool should be developed to assess collaborative trends. This brings us to the following main research question:

**“How can collaborative trends be identified during a project?”**

Comparing the three collaborative frameworks of Thomson, Suprpto and Dietrich; differences and commonalities are identified to get a broader view on client-contractor collaboration. Based on the frameworks five critical elements are identified: communication, mutual support, aligned efforts, cohesion and trust. Nine collaboration assessment tools are compared with the five identified critical elements from which the RECAP assessment tool has proven to measure all these critical elements. The RECAP is therefore used as a starting point to develop a tool to measure collaborative trends during the project.

Having chosen the RECAP assessment, the method is first implemented in the SELECT phase of the project without adaptations to identify shortcomings and good aspects. One of the findings using the RECAP tool was the extensive number of questions, making it too time consuming to implement more regularly. Another finding is the differences in perception on questions between the management teams and team members. Team members had more difficulty in answering the questions, resulting in many questions answered as “Not applicable” or “Do not know”. The management team is also more positive on all measured categories compared to the team members. Due to the found differences, it is decided to not only focus on client-contractor collaboration, but also include the management teams and team members in the development of the ACT (Assessing Collaborative trends) tool.

Adaptations to the RECAP assessment have been made in order to apply the tool more regularly. Central to development of the ACT tool are four corner stones, the identified critical elements, the frequency of measuring, the length of the survey, and the complexity of the questions. Important changes are the reduction of the number of questions from 72 to 20. It is chosen to focus only on relational attitudes, collaborative practices, and team working quality based on the workshop evaluating the RECAP assessment. To make the RECAP statements/questions also more applicable for team members, the statements have been changed and simplified.

Results of the ACT tool showed that there are significant no differences using a weekly measuring interval. Future implementation should consider using an interval depending on the amount of interventions during the project and the length of the project, since significant changes were found using a larger interval, comparing week 1 and week 7. Another finding is that over time both the client and Fluor aligned in their perceptions towards collaboration, achieving a better mutual understanding of each other. Larger differences have been found in the perception towards collaboration between the management teams and team members, where the management teams were always more positive about the collaboration than team members. Especially towards the ending of the SELECT phase differences became bigger.

Using the ACT tool, it is important to act on the data gathered. Frequent feedback sessions should be planned in advance to be able to formulate a strategic plan to improve the collaboration during the project. In addition, action points can be better monitored and the focus per measuring point can be determined in combination with the focus of the survey on which questions to use. Formal collaborative practices as joint work coordination, formal team integration, joint activities, joint conflict resolution, are the lowest scoring variables on the project. While the SELECT phase consisted of a relatively small team, it is advised that when the team grows in future phases, collaborative practices can be beneficial in order to achieve and maintain a high level of collaboration. Formal procedures aid in resolving conflicts and maintaining a high level of collaboration. Informal collaborative practices such as joint daily meetings and joint review sessions proved to be sufficient in the SELECT phase to cover the formal procedures.

Concluding, the ACT tool is a first step in evaluating collaborations more frequently making it possible to identify variables impacting the collaboration and their effect over time. While the weekly interval did not show significant changes, a larger interval should be used to prevent loss of engagement of respondents. While the tool is developed and tested in the SELECT phase of a project, the tool can be used in any phase with a client-contractor collaboration. During a project the focus should not only lie on improving the client-contractor relationship, but also on internal collaboration between the management teams and team members. The ACT tool makes it able to provide direct feedback on collaboration between the client and contractor and also between managers and team members during a project and show areas of improvement.



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# 1. INTRODUCTION

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The oil and gas sector has been a thriving business over the last decennia. Companies as Royal Dutch Shell, BP and ExxonMobil determined the landscape of oil drilling, refining and distribution. In the Netherlands, the oil and gas sector has a prominent role in the economy. With the first refinery built in the 1936 in Pernis, the refineries nowadays contribute 2 billion to the Dutch economy (NRC, 2019). However, recent years the refineries are facing difficult economic times. The Clingendael International Energy Programme (CIEP) studies show that 73% of the European refineries are strategically vulnerable (CIEP, 2017). In the Rotterdam area, Shell and ExxonMobil invested billions to maintain the strategic advantage of their refineries. The client is now up for the choice whether to invest in their current plant, maintaining its strategic position as one of the world's most efficient refineries or invest elsewhere. With recent environmental goals, not investing in cleaner products would eminently lead to the closure of the plant eventually (NRC, 2019). To decide whether or not the client is going to invest in this refinery, several studies must be performed to establish the economic benefits and cost, and to determine a rough scope for the plant. In 2018 the client started together with Fluor the SELECT phase of the project in order to "Select the right project" (MAIN project). By focusing on collaboration in this phase, both parties hope to increase project performance of the SELECT phase.

This chapter describes the importance of collaboration, the research context, and the reason to measure collaboration frequently. This chapter is concluded with the problem statement central in this research.

## 1.1. Importance of collaboration in projects

The effect of collaboration is not easy to identify, but studies suggest there should be more emphasis on the collaboration between parties in order to increase the performance of mega projects (EY, 2014; Suprpto, 2016). Mega projects are often underperforming, EY reported that 64% of the oil and gas megaprojects are over budget and 73% over schedule (EY, 2014). IPA states that 65% of industrial megaprojects are over schedule or over budget in a global study analysing over 300 mega-projects (Merrow, 2011). More recent studies show that over the past years no progress has been made into improving project performance (Forrest et al., 2017). One of the reasons is that over the years projects became bigger and the number of parties involved in mega projects increased significantly, bringing additional challenges in an already difficult sector (Flyvbjerg, 2014). With increasing scope and complexity, and the presence of adverse incentives for building a project, such as underestimation of costs, overestimation of benefits and risk transfer, these projects keep failing. Due to these adverse incentives and the inability to adopt new technologies, the labour productivity in engineering and construction has even fallen in the US compared to productivity in the past (Renz and Solas, 2016).

While cost- and schedule overruns are nothing new for mega projects, little has been done to turn this around (Forrest et al. 2017). Over the years numerous practices and tools have been developed to improve performance in projects, but these practices and tools have not proven to reduce time and budget overruns consistently (Morris and Pinto, 2004). Studies suggest that one of the major factors of project success is the high quality of inter-firm collaboration (Smyth

and Pryke, 2008). This is also supported by literature on project partnering, where formal agreements have been developed to stimulate the working relations between companies.

Collaboration is critical for the success of projects in the construction industry (Suprpto, 2016). With increasing complexity and parties involved, sharing of information and knowledge is essential in order to cope with the complexities and mitigate risks (Rahman et al. 2014). To achieve a well performing project, mutual agreements and joint goal setting must be established. A well performing team should be able to deal with great amounts of information to understand all possibilities and risks. With one individual not able to grasp the entirety of a mega project, collaboration within a company is essential, but also between the client and contractor. Without the ability to oversee the complexity of the project and lacking communication, projects are often overrunning on cost and schedule (Son & Rojas, 2011).

## 1.2. Relevance of measuring collaboration

Collaboration is critical in the success of projects. The industry, however, appears to be struggling to improve inter-organizational collaboration (Boddy, Macbeth & Wagner, 2000). To assess the effectiveness and improve the collaboration in a project, it must be measured. Several frameworks have been developed to measure collaboration, which point out the importance of soft elements (Flyvbjerg, 2014; Bakker et al., 2018; Suprpto, 2016; EY, 2014). But with many frameworks identifying different essential elements of collaboration, it is difficult to choose and implement collaboration into practice (Thomson, 2007). Due to the uniqueness of projects; there are differences in contracts, team sizes, mentality of project members, etc. each calling for a different collaborative approach for each project.

Measurement of the collaboration is needed to steer and improve it during projects. Methods differ greatly, where one focusses on clarity of goals and formal structures and are only available through the services of a company (Merrow, 2011), others focus more on team dynamics (Duhigg, 2016; Gallup). However, very few methods really measure client-contractor collaboration, using an extensive question list to assess it within a project (Suprpto, 2016). Tools are mostly applied at the end of a project using the knowledge about project failures and successes in the next phases of a project (Bakker et al., 2018). But, by measuring in hindsight, one cannot learn and steer during the project and the measurement provides no indication how collaboration develops over time in a project phase. This calls for a method to assess collaboration frequently during the project to improve it. Based on the information gathered by measuring collaboration regularly, project managers can steer accordingly, maximizing collaboration on the project by installing the right collaborative governance structure and support it with the soft elements accordingly.

## 1.3. Research context

The MAIN project has a total estimated budget of approximately 1.5 billion euros for an extension and revamp of the current refinery in Rotterdam. In the current phase of the MAIN project the feasibility of this upgrade and expansion is investigated. The client has a difficult decision to make whether to expand and renew the refinery in Rotterdam or not. Without the investment, the refinery will lose its strategic advantage and will inevitably be closed on the

long run (NRC, 2019). Fluor is the main contractor in the SELECT phase of the project to aid the client in estimating the total cost of the project. Fluor is partly chosen because of the emphasis on collaboration on a previous project and the successfulness of it. Therefore, collaboration is chosen to be one of the central focus points on the MAIN project, based on the idea that a better collaboration increases the project performance in the end.

The SELECT phase of the MAIN project is executed with only the client and Fluor. With the relatively small scope of this phase, it is not necessary to include more parties. With the emphasis on collaboration on this project, both teams are several days a week allocated in the Fluor office to ease communication and speed up decisions.

### 1.3.1. The client

<Confidential>

### 1.3.2. Fluor

Fluor Corporation (hereafter Fluor) is an international operating engineering firm with offices in 25 countries, founded in 1912 in the United States. With a revenue of 19.2 billion (2018) it is one of the largest engineering firms in the world, specialized in petrochemical, infrastructure and energy. In the Netherlands, Fluor is mostly specialized in petrochemical and a small part is working on infrastructure projects. Fluor is the main contractor in the MAIN project.

### 1.3.3. Organizational context

Both parties are colocated in the Fluor office, where the client is present about three days a week. Management also chose for an integrated team approach with the idea to speed up information sharing, shorten communication lines, and make work more efficient. Integration of teams in the project has a different meaning than used in the literature, as can be read in Chapter 3. In the project, the integration of teams means combining disciplines from both parties and place them next to each other.

To keep all disciplines on track and stimulate information sharing to identify problems in advance, daily scrum meetings are held. There are separate meetings for the process department, engineering department, and the management team. No standard format is used for these meetings and during the phase the scrum meetings were further refined with the help of a coach. Besides the scrum meetings regular review meetings are held to get mutual understanding and support for the work delivered. By involving the client already while developing deliverables, document reviews are becoming just a formality decreasing the amount of changes and increasing support of the client.

### 1.3.4. Project timeline

The SELECT phase of the project under investigation started in January 2018 with mainly the process team of Fluor and the client. This team consisted of about 14 people developing the specifications of the plant. In January 2019 the team grew to nearly 60 people, including engineering, procurement, project controls and construction on the project. The deadline for

the SELECT phase is set on May 31<sup>st</sup> after this the project enters the Bridging phase waiting for greenlight for the Define phase.

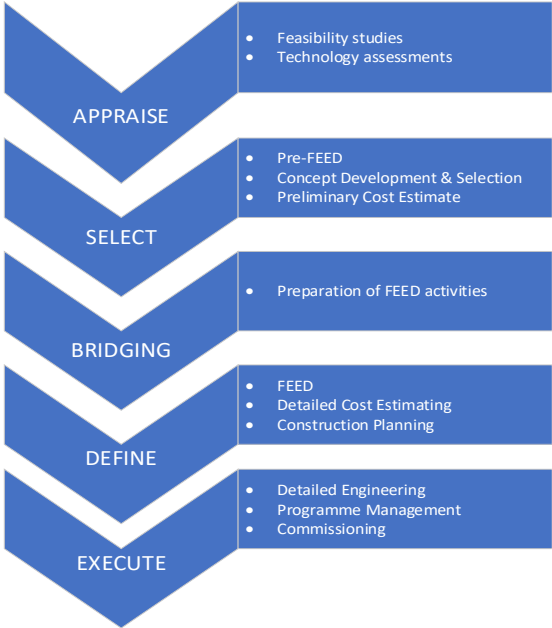


FIGURE 1.1: OVERVIEW OF PROJECT PHASES (SPIERS, 2007)

### 1.3.5. Former research at Fluor

This research is part of a longitudinal study at Fluor performed by students of the master Construction Management Engineering at the TU Delft, following up on the research by Wang (2015), Patil (2016), Eggermont (2017) and Zonneveld (2018). The goal of Fluor is to better understand collaboration in a project and how to influence collaboration during a project. Their vision is that project performance can be increased by incorporating collaborative practices in projects. With the success of the previous ExxonMobil project, using a coalition type of agreement with most subcontractors in the construction phase, Fluor has the confidence to further develop collaborative practices in this new project. While many ideas stand or fall with the goodwill of clients, the client on the project is also interested to put more emphasis on collaborative practices in the project.

### 1.4. Problem statement

While there is a strong focus on collaboration in the project using various collaborative practices, there is no way to assess the effectiveness of these practices over time. With the goal of Fluor to get more insight on how collaborative dynamics impact project performance and how to influence these collaborative dynamics, a tool must be developed to provide these insights. These insights can also be used to aid companies to correctly apply collaboration in their projects and maintain a high level of collaboration appropriate to the project (Boddy, Macbeth & Wagner, 2000). Although a tool able to measure collaboration frequently would help improving projects, the variety of frameworks makes it difficult to develop a uniform supported tool (Hoegl and Gemuenden, 2001; Thomson, 2007; Dietrich, 2010; Suprpto, 2016).



The difficult aspect of collaboration is that it is a social construct, it changes constantly and is not perceivable to the outside world (Thomson, 2007). This means that there are various definitions describing collaboration and with few methods to regularly assess the level of collaboration during a project, there is little data to determine the quality of the collaboration. Dynamics between parties can be identified, as well as factors and events impacting collaboration. With projects getting more complex, the role of people in projects is becoming more important (Bakker, et al. 2018). As Drexler and Larson (2000) mention, owner-contractor relationships are a fragile thing and can improve or deter very quickly, often depending on the character of client, contractor, and the environment. By being able to measure and identify trends in collaborations a deeper understanding of collaboration and of factors impacting collaboration can be gained.

## 1.5. Reading guide

This report has the following structure:

- **Chapter 1 – Introduction:** context and goal of this research are elevated together with scientific background, and introduction of the parties and project are described.
- **Chapter 2 – Research Design:** The research methodology described. General structure of this research is discussed. From the literature review a method measuring collaboration is identified and implemented.
- **Chapter 3 – Literature review:** Using literature to identify critical elements and comparing existing methods measuring collaboration. One method is used to develop further in this research.
- **Chapter 4 – Applying RECAP:** Relational Capabilities (RECAP) assessment tool is implemented in the project. Results are analysed and workshop results provide input for changes in the RECAP tool and applicability of new tool.
- **Chapter 5 – Tool development and data gathering:** Combining findings from the literature and RECAP to develop a modified tool based on the RECAP to measure collaboration.
- **Chapter 6 – Data results and analysis:** Results of the developed tool are discussed and analysed. Trends are discussed with the project team to identify causes of collaborative trends and formulate action points to improve the collaboration
- **Chapter 7 – Discussion:** Research limitations and limitations of the tool are discussed together with scientific contributions of this research.
- **Chapter 8 – Conclusion and recommendations:** Based on this research a summary is made connecting results and providing an answer to the main research question. Further recommendations are made for future research and how to improve client-contractor collaboration. Research results are put into project context, discussing implications for project policies, future project practice and collaboration theory.
- **Chapter 9 – Reflection:** Personal experiences of the author concerning this research are shared in this chapter.

## 2. RESEARCH DESIGN

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This chapter describes the research design, research goal, scope and methodology for this research. First the main research question and sub questions are explained. In chapter 2.2 the scope of this research is described followed by the research methodology in chapter 2.3. The chapter is concluded with the research approach in chapter 2.4.

### 2.1. Research objective

The use of collaborative practices is getting more common to parties in the oil and gas sector. However, using several of collaborative practices, it is difficult to assess during the project if the collaboration is performing well or if aspects need more attention or are performing well. Several tools are already developed to measure collaboration providing a good overview on the current standing on collaboration in the project but cannot provide information on how to steer the project by enhancing positive aspects and correcting negative aspects during execution of the project. With a bigger role of people in projects, identifying how collaboration develops could improve project performance in the end (Bakker et al., 2018).

The goal of this research is to evaluate methods and tools which measure collaboration and develop a tool to regularly assess how collaboration develops over time to improve the client-contractor relationship. By being able to measure collaborative elements over time, more research can be done on how these elements develop during a project and which elements need special attention at a specific point in time. This also provides project managers with specific information on lagging and leading elements of the collaboration giving them the possibility to steer a project in the right direction before it is too late. This brings us to the following research question:

**“How can collaborative trends be identified in a project?”**

The answer to this question is not straight forward and continues on the idea that collaboration is positively affecting project performance. In other words, a project in which collaboration between client and contractor functions well should be more effective and efficient than one in which collaboration is absent (Suprpto, 2016; Thomson, 2007; Baiden & Price, 2011).

To be able to provide an answer to the main research question, the following sub-questions have been formed:

1. What are critical elements of collaboration?
2. What are the criteria for a tool to measure collaborative trends?
3. How can collaborative elements be measured in a project team environment?
4. What collaborative trends can be measured?
5. How should a tool be implemented in a project to measure collaboration and trends?

This research provides an answer to the research questions using the following steps. First, a literature study is performed in chapter 3 to provide an answer on sub-question 1. Secondly, an action research approach is used combining the results from the collaboration assessment (RECAP) and the practical recommendations of the team in the development to answer sub-questions 2. Sub-question 3 is answered in chapter 5 using input from the literature and the RECAP assessment in developing the adapted tool to Assess Collaborative Trends (ACT). Finally, Sub-questions 4 and 5 are answered using data results of the ACT tool in chapter 6.

## 2.2. Scope of this research

This research is performed on the project MAIN with Fluor (main contractor) and the client. The project concerns a possible extension and revamp of the current plant in Rotterdam. Currently the project is in the SELECT phase, the project team size in this phase is limited to around 60 people with only the client and main contractor involved. Due to the successes of the previous project (ExxonMobil) the team has adopted an integrated team approach with collocation with the client. For this project it means that project members are situated alongside their counterpart from their discipline, with the goal to improve the team culture and mutual attitudes (Baiden & Price, 2011; Suprpto, 2016). The idea is that by having an integrated or, in this project, colocated team, communication lines are shorter, and issues can get discovered quicker and are more easily solved. However, integrated teams are not sufficient on their own to get the full benefits of this collaboration. A focus on the softer factors such as teamworking and relations should also be fostered (Baiden & Price, 2011). The project managers acknowledge this by organizing alignment meetings and team building activities.

This research is performed in the SELECT phase of the project and part of the bridging period (from SELECT to the DEFINE phase). The main goal of the SELECT phase is to get an estimate with a 30% certainty of the total budget and a preliminary design of the new plant proving if the project is worth investing in. The SELECT phase has a duration of approximately six months and is planned to be finished at the end of May. After this phase, the project enters a bridging phase until the client provides approval on the project to start with the DEFINE phase in which the plant is developed in more detail and a more accurate estimate is worked out. During the design phase the project team grows, from approximately 60 people in the SELECT phase to 200 people in the FEED phase.

## 2.3. Methodology

To formulate an answer on the main research question *“How can collaborative trends be identified in a project?”* theory-oriented research and action research is performed. A research framework is developed to ensure the goals of this research are achieved and the research questions answered. To select the right method, a literature study is performed in which several frameworks and tools to measure collaboration are compared. An existing tool is chosen and adjusted to measure collaboration frequently. This existing collaboration tool is applied in the project. Input for the tool from members on the project is then used to adjust the modified tool where necessary. Tools and the implication of these tools are explained below. An overview is presented in Figure 2.1.

RQ: How can client-contractor collaboration be improved throughout a project?

Sub-questions:

1. What are critical elements of collaboration?
2. What are the criteria for a tool to measure collaborative trends?
3. How can collaborative elements be measured in a project team environment?
4. What collaborative trends can be measured?
5. How should a tool be implemented in a project to measure collaboration and trends?

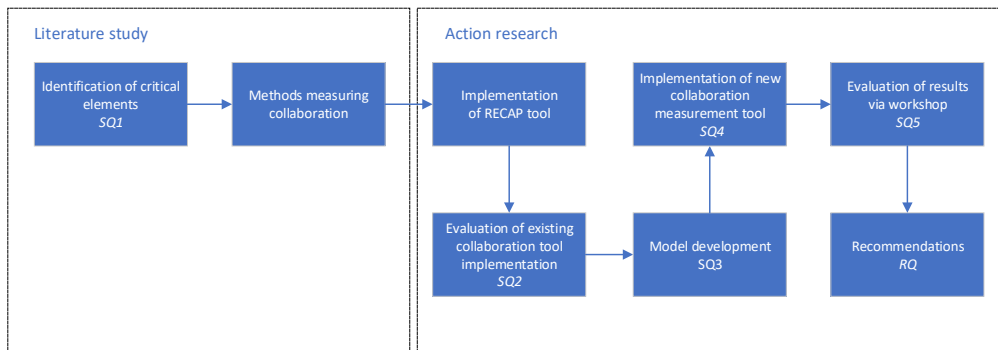


FIGURE 2.1: PROCESS OVERVIEW

As mentioned before, measuring collaboration on a frequent basis has not been done before (Suprpto, 2016). To add to the collaboration literature a method is developed to measure collaboration trends. By measuring these trends insight is gained on how these trends develop over time. For this action research is used to incorporate practitioners view in the development of the new method. To develop a new method a literature study is performed to identify the critical elements of collaboration. This research is based on previous literature on collaboration performed by Suprpto (2016), Thomson (2007) and Dietrich (2010). The new tool is developed based on two pillars, the findings from the literature study and the collaboration measuring methodology. Besides information on how to measure each element, the challenge of measuring frequently is that people must be kept engaged to prevent resistance against the measurements. To provide input on how to engage people in this process workshops are held on what the project teams' perception is on measuring on a frequent basis and how frequent this must be. These methods are further explained in chapter 4 and 5.

This research is performed in an ongoing project using an action research approach (Azhar et al., 2010). A criticized point of academic research is the focus on conceptual ideas and theory while practical problems are neglected. Azhar et al. (2010) mention that an action research approach is especially useful in management studies, including construction engineering and management, in which the researcher is part of the research by implementing changes based on the findings and discussing results with the project team. The benefit of an action research approach is that research is not solely focussed towards theory creation, but practical problems are also addressed due to involvement of the researcher in the project environment. The author is involved in daily scrum meetings and including the team in development of a new collaboration measuring tool using workshops and interview rounds. Gann (2001) also mentions that this involvement is important to improve collaboration between researchers and practitioners. Practitioners are in turn, able to implement academic research more easily. By involving practitioners in this research, it provides alternative insight in solutions to practical problems (Azhar et al., 2010). This benefits this research in order to increase the participation and willingness to fill in the survey and contribute during workshops. Also, valuable input is gained talking to practitioners about their viewpoint on collaboration. This way viewpoints from both practitioners and scholars are included in development of an adjusted collaboration measurement tool.

## 3. LITERATURE REVIEW

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To understand and measure collaboration between involved parties in a project, a literature study is performed to get an overview of what elements collaboration consists of and how collaboration can be measured. This is used to develop a tool to assess collaboration in a project on a regular basis. This literature searches are executed using the Google Scholar database. Several keywords are used as “collaboration”, “measuring collaboration”, “interorganizational collaboration”, “relational contracting”, and “partnering”. The goal of this literature review is not to provide a complete overview on collaboration theory but to compare several frameworks on collaboration. In combination with collaboration measuring methods, a cross reference is performed to assess these measuring methods. During the literature research few articles after 2016 are published concerning collaboration due to unknown reasons, therefore mostly older literature is used in this research.

A literature study is performed to provide an answer on sub-question 1. This chapter provides an exploratory study towards already defined collaborative frameworks and gaps in the literature to show the relevance of this research. First, collaboration is defined according to the framework of the RECAP. Chapter 3.2 describes ways of measuring collaboration. Chapter 3.3 provides an in-depth description of the RECAP framework on collaboration. In this chapter the critical elements are defined. Finally, chapter 3.4 provides literature on the change rate of critical elements as defined in chapter 3.3. This chapter is concluded with findings of this literature research answering sub-question 1.

### 3.1. Decomposition of collaboration

Collaboration is a highly debated and researched topic which has many interpretations and definitions (Thomson, 2007). Implementations of the world collaboration are numerous, as it can be implemented everywhere, such as construction, supply chain, and nursing. The general idea is similar across all disciplines, although the factors influencing the collaboration are highly dependent on the situation. This is also due to the fact that collaboration is a social construct which is not visible in the real world, which makes it difficult to isolate and measure collaboration (Thomson, 2007). This resulted in many studies reporting different results on important factors of collaboration (Thomson, 2007). In addition, collaboration is dependent of the environment in which it happens as well as the technical complexity of the project (Bollen, 1989; Carmines and Zeller, 1983; Drost, 2011). The bigger the technical, organizational and external complexity of a project, the more collaborative practices can contribute to mitigation of project risks (Bosch-Rekveltdt, 2011a).

#### 3.1.1. Definitions of collaboration

To be able to measure collaboration it is important to have a clear understanding what collaboration encompasses. As mentioned before, the literature concerning collaboration is extant with sometimes little similarities in definitions and frameworks (Grey and Wood, 1991). Grey and Wood (1991) started with the idea that there was a common definition on collaboration but found out that there was very little consensus on the concept. They decided

to develop a roadmap towards common understanding of the concept. Starting at the very beginning of the word collaboration, it originates from the Latin *collaborare* which translates to 'to labour together' or 'to work together'. Over the years it has been adjusted and collaboration is often referred to as a process which needs dedication and continuous effort to succeed. This is also supported by Drexler and Larson (2000) which research reports one of the main causes of project success and project failure was the presence or lack of trust which often was the result of the amount of effort put into the relationship. Including this process in the definition of collaboration, Martinez-Moyano (2006) defines collaboration as: *"Collaboration is the process of two or more people or organizations working together to complete a task or achieve a goal."* (Martinez-Moyano, 2006).

In accordance with Martinez-Moyano's definition of collaboration, several other definitions of collaboration exist, each with its own focus on different aspects of collaboration. One of the most frequently used definitions on collaboration is the one from the Construction Industry Institute (1991) which defines collaboration as: *"A long-term commitment by two or more organizations for the purpose of achieving specific business objectives by maximising the effectiveness of each participant's resources. This requires changing traditional relationships to a shared culture without regard to organization boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other's individual expectations and values. Expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services."* (P. iv). This definition combines several elements of collaboration such as use of joint resources, long-term commitment, trust, shared culture, common goals and understanding of each other.

Thomson (2007) continues on this definition of collaboration and adds an important aspect mentioned by Martinez-Moyano (2006) that collaboration is a process. Thomson defined collaboration as follows *"Collaboration is a process in which autonomous or semi-autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions."* This definition is based on five main dimensions, governance, administration, mutuality, norms, and organizational autonomy. Smyth and Pryke (2008) also emphasize that collaborative relationships are mainly about people and their relationships. Bakker et al. (2018) also notes that new collaboration tools need to be focused on socialization, engagement, trust, collective learning and bottom-up intelligence with people accountable for their actions and learning from mistakes.

Suprpto (2016) builds on this definition from Thomson (2007) but focusing more on the human interactional aspect of collaboration and defines collaboration as: *"a process in which owner and contractor jointly create norms, rules, and structures governing their teams, their working relationships, and ways to act or decide on the issues emerging during the course of a project, in order to bring about mutually satisfactory project outcomes"* (Suprpto, 2016; p. 114). Interesting dimension in this definition is the more focus on the social side of collaboration, supported with mutually created governance structures.



### 3.1.2. Comparison of collaborative frameworks

While collaboration is mentioned to be one of the major factors to achieve high project performance, it is still unclear which elements should be considered and how these elements should be managed. Literature has defined many elements of collaboration, with most mentioned elements: trust, communication, team identity, mutual support, cooperation, coordination, and participation in a team (Suprpto, 2016). As presented in the literature, most parties accept the importance, but can fail in executing it. This has several reasons, such as too much focus on the formal side of collaboration. Hereby the governance structure of projects is set up in a collaborative way, but the unwillingness to show leadership of clients or commercial pressures often cause the project to fail despite the collaborative governance structure (Ng et al., 2002). Suprpto (2016) identified a list of collaborative relationships from empirical studies with each study putting emphasis on the importance of these elements. This shows the complexity of what a collaborative approach encompasses in projects.

There is extant literature concerning collaboration in construction and beyond. To narrow down the scope of this research only three frameworks are compared on what collaboration encompasses and how it is influenced. The three frameworks are chosen based on their different viewpoints on collaboration to get a broader understanding of collaboration in projects. There are several collaborative frameworks described in literature. By comparing the three frameworks below, three different viewpoints are compared. The framework developed by Thomson (2007) is developed using data from various industries to achieve a multidisciplinary view on collaboration and not limit the study to just one sector. The study by Suprpto (2016) does focus purely on collaboration client and contractor in major Oil and Gas sectors scoping down the framework. Finally, Dietrich (2011) is used more as a comparison of different researches on elements contributing to collaboration. All frameworks study collaboration in an inter-organizational context in a complex environment and acknowledge that collaboration is a process which needs time and resources in order to be maintained to achieve collaboration. As shown in Table 3.1, the three frameworks are divided on which elements collaboration encompass.

As Thomson (2007) mentions, the world is getting more complex and networked increasing worldwide interorganizational collaborations. Published in the Journal of Public Administration Research and Theory Advance Access, Thomson's paper (2007) includes various industries in the research, varying from public and private parties creating a multidisciplinary perspective on collaboration. By using this multidisciplinary approach to define collaboration, Thomson tries to clarify the highly complex process of collaboration. One of the difficult aspects of collaboration is the fact that none of the elements is fully independent of the other elements and might be the reason that several studies find different statistical frameworks of collaboration, but most still statistically viable. In contrast to Thomson (2007), Dietrich (2010) and Suprpto (2016) focus on project-based construction projects. The viewpoint of Dietrich on collaboration is quite different from Suprpto's. Dietrich (2010) defines a high collaboration quality mainly as the ability to share and integrate knowledge between parties. With knowledge integration is meant "*the ability to turn knowledge into action*" (Dietrich, 2010. P. 61). A high level of knowledge sharing would also mean a high level of collaboration between different parties. Interestingly, knowledge integration is not something mentioned in the other frameworks by Thomson (2007) and Suprpto (2016). In turn, Suprpto

(2016) studies collaboration with the goal to improve project performance of projects. By assessing collaboration from a multidisciplinary viewpoint, a broader understanding of collaboration can be achieved and more coherence across disciplines can be gained.

TABLE 3.1: DIMENSIONS OF COLLABORATION

Dimensions of collaboration (Thomson, 2007)	Collaboration quality (Dietrich, 2010)	Relational capabilities Suprpto (2016)
Governance	Communication	Relational attitudes
Administration	Coordination	Collaborative practices
Mutuality	Mutual support	Teams capability
Norms	Aligned efforts	Teamworking quality
Organizational autonomy	Cohesion	

Literature is divided over the definition and elements of collaboration (Thomson, 2007; Suprpto, 2016). Where some emphasize the appearance of formal agreements and procedures, others lean more towards informal or soft aspects of collaboration. The collaborative frameworks by Thomson (2007), Dietrich (2010) and Suprpto (2016) vary in the number of elements concerning the formal, contractual side of collaboration and attention to the informal, softer side as Dietrich (2010) based the elements on (see Table 3.1). There is little consensus about the importance of the formal side of collaboration. There are different definitions of formal collaboration, the most used definitions are ‘relational contracting’, ‘partnering’ or ‘alliance contracts’ (ACA, 1999). Relationship contracting is developed driven to formalize relationships and building on collaborative elements such as trust, respect, commitment (Suprpto, 2016). The success rates of these contracts differ, where some projects flourish using relational contracts, others fail greatly (Alderman and Ivory, 2007). One of the main reasons of failing is the lack of attention to the social dynamics of these projects.

Of the three collaborative models, Thomson (2007) and Suprpto (2016) focus on formal and informal elements, where Dietrich (2010) focusses mainly on the social aspects of collaboration. Thomson’s (2007) theoretical model on collaboration consists of five key dimensions: Governance, administration, mutuality, norms, and organizational autonomy of which Governance and Administration can be seen as the formal side of collaboration. The focus of this model is to understand the interactive process behind collaboration. This model emphasizes the multidimensional aspect of collaboration and is based on literature on collaboration, interorganizational relations, and organizational behaviour, and is also strongly based on the research by Wood and Grey (1991) on collaboration. The multidisciplinary approach provides an insight in the complex nature of collaboration.

The three collaborative frameworks all used structural equation models to determine the statistical validity of the elements considered critical to collaboration (for visual representation of the models see appendix A). To prevent overlooking factors Thomson (2007) also performed an exploratory factor analysis to identify factors not specified in the original model. Interestingly, while all three authors have proven statistically significant structural equation models, including exploratory factor analysis, the three frameworks are still different.

Interestingly, the models by Dietrich (2010) and Suprpto (2016) show that collaboration is a means, used to improve information sharing, project success or project performance, where Thomson's model is only used to conceptualize collaboration, without mentioning the goal it is used for. Also, Suprpto does not mention collaboration in the structural equation model but uses teamworking quality to refer to the collaboration of teams based on the literature by Hoegl and Gemuenden (2001) and Hoegl et al. (2004).

### *Antecedents*

The structural equation models consist of several antecedents and mediators. A *“Collaboration antecedent refers to a factor that is proven to have a direct effect on the quality of collaboration”* (Dietrich, 2010, P.65). In short, an antecedent is directly impacting another element, where mediators are in between antecedents and outcomes, as can be seen in the models by Dietrich (2010) and Suprpto (2016). There are three antecedents of Suprpto's framework which, do not influence project performance directly, but through teamworking quality, as shown in Appendix A. Where Dietrich (2010) and Suprpto (2016) see collaboration as a mediator, as a means to improve project performance, Thomson (2007) defined only antecedents of collaboration.

When looking into detail, the three frameworks share many common elements. Joint decision making, coordination, communication, mutual support, win-win, cohesion, and trust are among several matching elements. Table 3.2 shows the elements covered by the three frameworks. As shown by the table, Suprpto and Dietrich share several common elements in determining collaboration quality and teamworking quality, both based on the literature by Hoegl and Gemuenden (2001) and Hoegl et al. (2004). Apart from coordination and affective trust both frameworks consist of the same four elements. The framework by Thomson is different in that it does not define collaboration as a limited set of elements but describes collaboration as a combination of the five dimensions combining both formal procedures as soft elements in collaboration.

Suprpto (2016) and Dietrich (2010) do acknowledge the role of formal procedures but argue that collaboration could also exist without formal procedures. The reason for this, also elaborated by Bresnen and Marshall (2002) and the Australian Construction Association (1999), is that formal procedures are often not sufficient when principles such as commitment, trust, respect, innovation, fairness, and enthusiasm are lacking and that these formal procedures even become adversarial when projects come under pressure (Alderman & Ivory, 2007). Although these antecedents do not directly influence project performance, they have a significant impact on the teamworking quality (Suprpto, 2016).

Of the Relational capabilities model, the relational attitudes have the highest impact on teamworking quality, determined by the relational norms and senior management commitment. The relational attitude elements are unique compared to the other two frameworks as it is a set of agreements between two organizations to govern their relationship in terms of how they should interact by developing joint agreements and creating a shared culture on the project (Poppo et al., 2008). These can be translated to elements such as trust, transparency, a no-blame culture and commitment of senior management to support the project teams (Cheung et al., 2006). Lencioni (2009) supports this and mentions that without

trust, commitment, constructive conflict, and accountability, the desired results will not be achieved.

TABLE 3.2: OVERVIEW OF ALL ELEMENTS (MAIN DIMENSIONS IN BOLD)

<b>Dimensions of collaboration (Thomson, 2007)</b>	<b>Knowledge-integration capability (Dietrich, 2010)</b>	<b>Relational capabilities assessment (Suprpto, 2016)</b>
<b>Governance</b>	<b>Collaboration quality</b>	<b>Relational attitudes</b>
Joint decision making	Communication	Relational norms
<b>Administration</b>	Coordination	Senior management commitment
Coordination	Mutual support	<b>Collaborative practices</b>
Client-contractor roles and responsibilities	Aligned efforts	Team integration
Communication channels	Cohesion	Joint working procedures
Monitoring mechanisms	<b>Sub-elements</b>	<b>Teams capability</b>
<b>Mutuality</b>	Existence of clear roles and a process for collaboration	Owner and contractor teams' competencies
Joint goal setting	Trust between actors	<b>Teamworking quality</b>
Win-win	Physical and cultural proximity	Cohesion
Shared interests	Alignment of incentives	Communication
Joint identification of commonalities	Commitment to collaboration	Aligned effort
Mutually beneficial interdependencies or complementariness	Goal congruence and collaborative goals	Balanced contribution
Commitment	Conflict resolution	Mutual support
Shared culture	Expectations fulfilment	Affective trust
<b>Norms</b>		
Reciprocity		
Trust		
Reputation		
<b>Organizational autonomy</b>		
Collective interest		
Teams integration		

Suprpto defines relational norms as “Norms of no blame culture, win-win, and communication openness” (Suprpto, 2016. P.184). The element covering the existence of clear roles and a process for collaboration (Dietrich, 2010) also mentions the need for joint creating norms.

Besides the relational norms, literature also emphasizes the importance of leadership and senior management commitment (Carolynn et al., 2000). In the RECAP this is translated to “*How well the senior management of the owner and the contractor commit to support the collaboration*” (Suprpto, 2016. P.184). The need for senior management commitment is not used in other frameworks despite the importance of it, according to Suprpto (2016). However, the commitment to collaboration acknowledges Dietrich (2010) and is also one of the key elements in interorganizational collaboration.

Two other impacting elements are the team integration, and joint working procedures according to the RECAP model. Team integration facilitates an environment in which members of either the client or contractor can share information or knowledge can be shared freely (Baiden and Price, 2011; Bosch-Rekvelde et al., 2011b). While the goal of team integration is to improve information sharing or knowledge, Dietrich (2010) finds no literature basis for the need of it, where Thomson (2007) does mention that it has a positive effect, but the effect is marginal. The reason for this could be due to the complexity of truly integrating teams in which the interdisciplinary work with multi-disciplinary teams is combined resulting in an inevitable complex environment engineers and managers must cope with. One of the problems is communication, interdisciplinary teams often find it difficult to communicate and coordinate (Bakker et al., 2018). Integrated teams yield several important benefits, such as improved information sharing which contributes to the team’s ability to anticipate on external changes more quickly reducing their risk (Bosch-Rekvelde, 2011b).

The joint working procedures formalize this working together in a joint strategy on how to overcome risks or disputes. With a focus on teamwork as mediators, formalizing joint working procedures creates certainties and streamlines expectations, mitigating possible problems (Meng, 2011). As Suprpto (2016) also mentions, joint working procedures are not sufficient for collaboration on their own but are necessary to achieve high levels of collaboration. Another often mentioned benefit of joint working procedures is that it improves schedule performance of a project. But as mentioned before, while the antecedents are necessary to client-contractor collaboration, they do not suffice on their own and merely influence collaboration as antecedent. Through collaboration, in the framework by Dietrich (2010) and Suprpto (2016) a mediator, project performance can be improved.

#### *Mediators*

In line with the definitions of collaboration and the focus on the people involved in collaboration, is the need of team working in which people work together in teams to achieve a common goal (Smyth and Pryke, 2008). They argue also that the effectiveness of this team working largely influences the project efficiency and effectiveness (Pryke and Smyth, 2006; Smyth and Pryke, 2008). In models of Dietrich and Suprpto can be seen that project success and project performance are influenced by two different mediators. The teamworking elements defined by Suprpto and Dietrich overlap the previously mentioned frameworks by Hoegl and Gemuenden (2001), Chan et al. (2010) and Baiden & Price (2011) and use the following elements, cohesion, communication, coordination, aligned effort, balanced contribution, and mutual support. Suprpto (2016) also includes affective trust to his definition of teamworking quality, where Dietrich mentions the essence of coordination, Suprpto sees this more as an antecedent.

TABLE 3.3: CRITICAL ELEMENTS OF COLLABORATION (MAIN DIMENSIONS IN BOLD)

<b>Dimensions of collaboration (Thomson, 2007)</b>	<b>Knowledge-integration capability (Dietrich, 2010)</b>	<b>Relational capabilities assessment Suprpto (2016)</b>
<b>Mutuality</b>	<b>Collaboration quality</b>	<b>Teamworking quality</b>
<i>Mutual respect</i>	<i>Communication</i>	<i>Communication</i>
Win-win	<i>Mutual support</i>	<i>Mutual support</i>
Use of joint resources	<i>Aligned efforts</i>	<i>Aligned effort</i>
<b>Norms</b>	<i>Cohesion</i>	<i>Cohesion</i>
<i>Trust</i>	Coordination	<i>Affective trust</i>
<b>Autonomy</b>		Balanced contribution
<i>Alignment of collaboration goal and organizational goal</i>		

It is not possible for the model by Thomson (2007) to identify mediators, since the model consists only of antecedents. Where Dietrich and Suprpto see collaboration as a means to improve project results, Thomson (2007) tries to add to the collaboration literature by purely defining collaboration. Of the five identified dimensions, mutuality and norms have proven to have the highest impact on collaboration. The mutuality dimension consists of seven elements, of which mutual respect, win-win and maximum use of joint resources score highest. Of the antecedents, three highest impacting elements come forward, which are trust, joint identification of commonalities and collective interest. Two highly impacting elements identified by Thomson (2007) are trust, and alignment of collaboration goals and organizational goals. These elements resemble the affective trust dimension by Suprpto (2016) and the aligned effort(s) of both Dietrich (2010) and Suprpto (2016).

Based on the three collaboration frameworks, five commonly used elements are deemed critical to collaboration based on the previous literature. Communication, mutual support, aligned effort, cohesion and trust are further used in this research as benchmark for collaboration. To get a full understanding of the critical elements, each of them are briefly discussed. Based on the teamwork research by Hoegl and Gemuenden (2001) and Pinto et al. (2009), communication, mutual support, aligned efforts, cohesion, and trust are described in Table 3.4. These critical elements are further used to assess the methods measuring collaboration in the next chapter.



TABLE 3.4: DEFINITIONS OF CRITICAL ELEMENTS

Definitions of critical elements based on Hoegl and Gemuenden (2001) and Pinto et al. (2009)	
Communication	The degree of frequent, informal, direct, and open communication
Mutual support	Supporting team members in a cooperative way without interference of individual competitiveness
Aligned effort	The amount of effort exerted by team in relation to another
Cohesion	Motivation and team spirit to maintain team functioning
Trust	Acceptance of vulnerability within the team (Pinto et al., 2009)

### 3.2. Measuring collaboration

Over the years, several tools have been developed to assess the level of collaboration in projects. Broadleaf Consulting (BC) provided an extensive list of tools measuring collaboration. The tools vary greatly in the applicability and form. Many tools provided are solely usable in a healthcare environment, mainly assessing collaboration between nurses and patients, and nurses and doctors. More interesting are the tools focusing on organizational behaviour or the tools focusing more on the collaborative relationships between organizations. The list provided by Broadleaf Consulting is complemented with the widely used Gallup-12 employee engagement survey, the IPA assessment survey for mega projects and the Relational capabilities assessment, together with a more scientific contribution to measure collaboration by Thomson (2007). Collaboration measurement tools provided by Broadleaf Consulting are noted with “(BC)”.

TABLE 3.5: OVERVIEW OF METHODS MEASURING COLLABORATION

Name (Industry)	Goal	Method	Frequency of measurement
RECAP (Oil and Gas)	Improve collaborative relationships	72 item survey	No information
IPA (Various)	Industry benchmarking	Combination of survey and interviews	No information
Gallup-12 (Various)	Employee engagement	12 item survey	No information
(BC) Institute of organizational Excellence (Various)	Employee engagement perception	21 item survey	No information
(BC) FSG (Various)	Measure collective impact	Combination of methods	No information
(BC) Wider collaboration Factors Inventory (Various)	Measures interorganizational collaboration	40 items	No information

(BC) PARTNER (Various)	Measure and monitor among people & organizations	Social Network approach	No information
(BC) Organizational Trust Index (Various)	Measure organizational trust	7 items	No information
Collaboration questionnaire (Various)	Measures (inter) organizational collaboration	56 items questionnaires	No information

As can be noted from Table 3.5 most tools use an extensive question list to be able to capture the complex construct of collaboration. The tools using less questions such as the Gallup-12 survey and the Organizational Trust Index, mostly focus on a specific area of collaboration. To get a full view of collaboration and the elements mentioned in chapter 3.1.2, tools should be combined to get relevant results.

All methods measure collaboration in a certain way, however all with a different focus on the elements critical to collaboration. To assess the methods described above, these methods are valued against the previously defined critical elements as seen in Table 3.6. As shown in the table below, the RECAP assessment, the WCFI, PARTNER, and Collaboration Questionnaire all use more than three of the predefined critical elements in their method. The RECAP, however, is the most elaborate tool, using all the critical elements to measure collaboration.

TABLE 3.6: COMPARISON OF METHODS

Name	Communication	Aligned efforts	Cohesion	Mutual support	Trust
RECAP	X	X	X	X	X
IPA	X	X	-	-	-
Gallup-12	X	X	-	X	X
IOE	X	X	-	-	-
FSG	X	X	X	-	-
WCFI	X	X	-	-	-
PARTNER	X	X	-	-	-
OTI	X	-	X	-	X
Collaboration questionnaire	X	X	-	X	X

As can be seen from the table above, the Relational Capabilities assessment is the most complete measurement tool to measure collaboration. Suprpto (2016) also mentioned in his research that very few tools exist truly measuring collaboration as a whole. Of the tools mentioned above, only two, RECAP and Collaboration Questionnaire, are built from a scientific perspective assessing collaboration as defined in the literature. Others are mostly designed from an operational point of view, assessing areas of interest in specific projects or sectors, lacking the overall collaboration perspective.

The Collaboration Questionnaire is built for the collaboration framework of Thomson (2007) and consists of 17 questions assessing governance, administration, autonomy, mutuality and norms. It does not include any questions relating to the performance of a project and is developed to further define collaboration. While it does assess collaboration, it is not built as a tool to measure the collaboration level within a project. The questionnaire is inspired by the organizational trust index by Cummings and Bromiley's (1996) and measures using a seven-point Likert scale, ranging from "1 = not at all" to "7 = to a great extent" for the questions relating to governance, administration, autonomy, and mutuality. For norms a seven-point Likert scale is used ranging from "1 = strongly disagree" to "7 = strongly agree". However, the Collaboration Questionnaire itself might be difficult to implement in a project environment since the questions are focussed on providing insight in the theoretical collaboration framework and not for practical recommendations. The RECAP assessment tool is more helpful since it combines theoretical insights and practical benefits to the project team as is desired using an action research approach (Azhar et al., 2010).

The RECAP assessment tool is designed to help improving collaborative relationships between client and contractors. The tool consists of 72 questions, assessing relational attitudes, collaborative practices, team's capability, teamworking quality, project performance, relational continuity, and front-end development. While the tool is perceived as a practical application to measure collaboration, the extensiveness of the tool makes it not suitable to apply the tool frequently during a project. A downfall of this is that lessons learned are often not carried over to other projects, since project managers are already put on new projects before the results of the evaluation are gathered (Bakker, 2018). Problem with this is that project managers are not learning from their mistakes and if they are learning, it can be that the new project has a completely different context where a different approach is needed. The RECAP tool contains the most critical elements as defined in chapter 3.1.2. and is therefore most suitable to assess collaboration.

### 3.3. Conclusion

As Grey and Wood (1991) mentioned, to get to a universal understanding of collaboration, a common definition should be used. Considering the nature and goal of this research the definition used by Suprpto (2016) is chosen in this research focusing on human interactions, joint mechanisms, and team structures. To continuously keep improving the client-contractor collaboration, this chapter defined what collaboration is and which elements are essential. Combining the collaboration frameworks by Thomson (2007), Dietrich (2011) and Suprpto (2016) an answer on the first sub-question can be formulated: "*What are critical elements of collaboration?*". Based on the three collaboration frameworks, five critical collaboration elements are defined: communication, mutual support, aligned effort, cohesion and trust. These elements are used to assess different collaboration measurement tools for further use in this research and should form the basis of the development of an adapted tool.

Currently no methods exist to measure collaboration on a regular basis. To provide an answer on which tools are most suitable to measure collaborative trends, the critical elements are compared with nine existing tools measuring collaboration. While most tools claim to measure collaboration, only the collaboration questionnaire by Thomson (2007) and the Relational Capabilities (RECAP) assessment by Suprpto (2016) measure the elements defined as critical to collaboration, where the RECAP provides a more complete assessment than the tool by Thomson, including all of the five predefined critical elements. While the RECAP assessment is able to measure collaboration statically, the RECAP assessment is further analysed and implemented to see if it is also able to measure collaborative trends.

## 4. APPLYING RECAP

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In this chapter the results of the RECAP are discussed followed by the evaluation workshop on the RECAP. As mentioned in the previous chapter, the results of the RECAP are used to get a base level measurement on collaboration in the project between the owner and contractor, and between different management layers. Firstly, the RECAP assessment is explained, and project context is provided. After applying of the RECAP, results are shown comparing the client and Fluor, and the management team with the team members. Secondly, input gathered from the RECAP assessment is discussed and evaluated during a workshop. This provides insight on possible explanatory factors of the RECAP assessment which can be used in a new tool. Development of the tool is further explained in chapter 5.

### 4.1. RECAP assessment

The RECAP is used as starting point for this analysis to get an image of the status quo. This method is used for measuring collaboration between client and contractor and the level of alignment between these parties. Suprpto (2016) mentions that elaborate research has been done in the field of collaboration, although there are no earlier reports which developed an assessment tool to measure the relations between parties. The RECAP tool provides a way to measure the collaborative relationship between an owner and client on management levels (Suprpto, 2016). The tool consists of an assessment form with 72 questions divided into six main aspects of collaboration: 1) Front-end definition, 2) Collaborative practices, 3) Project performance, 4) Relationship continuity, 5) Relational attitudes, and 6) Inter-teamworking. So, the RECAP tool not only measures the 'hard' side of collaboration, but also the 'soft' side.

However, the RECAP is focused only on (executive) management level, not including the team workers, since it is designed to measure the relational capability between the owner and contractor. This research tries to get a view of how collaborative elements evolve during the project, which makes it necessary to also include team members in the assessment. It may be necessary to adjust the questions in the tool to make it more relevant on team member level. The RECAP tool also measures more elements than relevant for this research. Based on the results from the RECAP and the literature study an adaptation of the RECAP tool is developed.

#### 4.1.1. Survey results

For the distribution of the survey, an online survey tool, Qualtrics was used. The survey is slightly adapted from the original RECAP assessment, two elements were added; the company represented in the project (the client or Fluor) and the role within the team (Team manager or Team member/Lead). Questions of the RECAP are also adjusted to the project, where contractor is replaced by Fluor and client by the client. Questions concerning sub-contractors and construction are eliminated since these questions are not relevant to the project phase.

The RECAP assessment results are discussed on two different levels, at company level and at management level. This provides a base measurement for the development of the new tool. The RECAP survey is completed by 29 participants, which is a response rate of approximately 50% of the whole project team. The project team consists out of 22 client employees and 39

Fluor employees. Of the 29 participants, 23 respondents are from Fluor, and 6 participants are from the client team. These 23 participants from Fluor consist of 7 team managers and 16 team members. The client team consisted of 5 team members and only one manager. The unequal distribution of team managers versus team members could have impacted the RECAP results.

The combined project team of Fluor and the client, consisting of managers and team members rate the highest on front-end definition and teamworking quality and the lowest on collaborative practices. In this RECAP assessment managers are considered members of the core management team. The team leads and supporting engineers are considered Team members in this analysis. Due to the limited team size compared to other phases, project leads are considered to be part of the Team member category. An in-depth analysis of team manager perceptions versus team member perceptions is performed in paragraph 4.1.3.

The RECAP assessment answers consist of a high number of questions answered as “Not applicable” or “Do not know”. On average 20% of the questions is answered “Not applicable” or “Do not know”. In general, more questions are answered “Do not know” than “Not applicable”, with a ratio of 5-1. The question with the highest number of “Do not know” answers is about project satisfaction with a 37% of the answers rated as “Do not know”. This leaves questions about the clarity of the definitions about “Not applicable” and “Do not know”, also concerning the clarity and relevance of the questions asked. Although, it can be questioned if there really is a difference in “NA” and “DK”. The authors’ interpretation of the “NA” is that the question is not relevant with function of a participant in mind. “DK” is assumed to be interpreted as that a participant should know the answer but is poorly informed. Additional research is needed to get a clear understanding on what participants perceive as “NA” and “DK”. Due to the unclarity of the definitions and doubt of the difference between them, results are aggregated to “can’t answer”.

While the RECAP tool measures client-contractor collaboration showing differences between both parties, an average of both parties is shown (see Figure 4.1). This does not say much about the collaboration itself but provides a rough picture on the general collaboration dimensions. On average the project scored decent, with five out of six elements rated a four or higher. The collaborative practices are scored lowest, particularly on team integration with a score of 3.6. This is interesting, seeing that teamworking quality ranks as one of the highest factors. It might be that formal team integration is not necessary to achieve high teamworking quality. From interviews held with project managers of both parties, the focus in this project lies on collaboration, which in their eyes is more about teamworking and colocation than the formal structures supporting collaboration. This could be a reason why collaborative practices score quite low in comparison with other factors. Another high ranked factor is the front-end definition of the project. This consists of combined goal setting, clear alignment of responsibilities, and joint reviews of the technical requirements and project execution plan.

Below the differences between both companies are discussed and differences between the management team and the team members. The results are discussed only on the main-dimension level as shown in Figure 4.1, further in-depth analysis of the sub-criteria can be found in Appendix B.



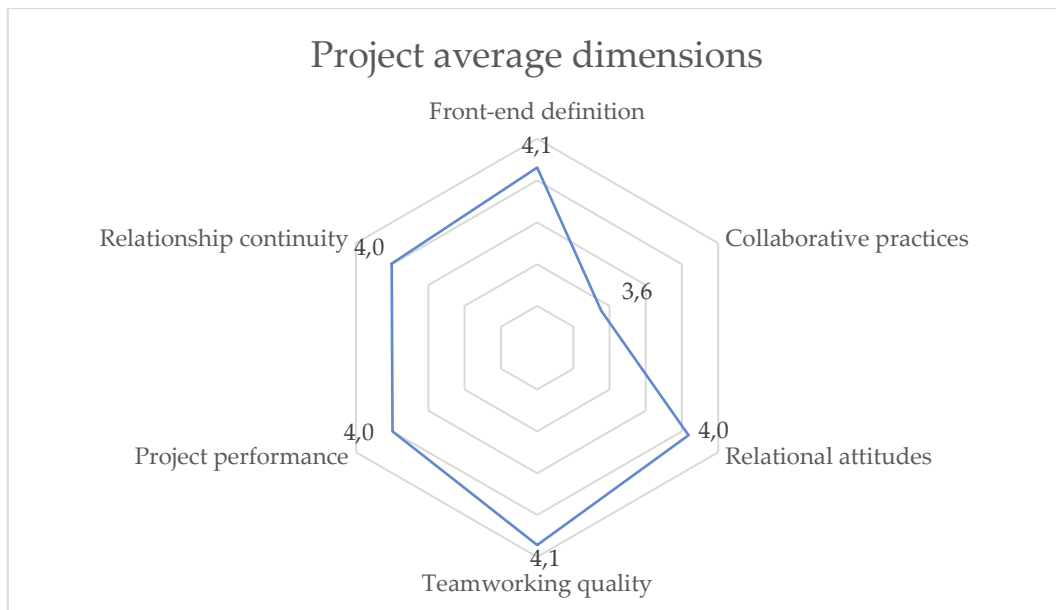


FIGURE 4.1: OVERVIEW RECAP RESULTS

#### 4.1.2. Company level

As seen in Figure 4.2, both companies are aligned on most criteria, with similar perceptions on all criteria. The biggest difference is noted in the relationship continuity of both parties. The contractor team (4.1) rates the relationship continuity 0.3 points higher than the client team (3.8). This might be due to the phase the project is in. With the select phase running until June and considering tendering the next phase, the client might be a bit reluctant to already accept Fluor as a partner for the next phase. More information about the spread in answers can be found in Appendix B.

Interesting is the fact that in previous cases in which the RECAP assessment is applied, the contractor rates the relationship continuity always higher than the client does (Suprpto, 2016; Eggermont, 2017). This could be inherent to the client-contractor relationship, of which the contractor is dependent on the client for additional work.

One factor both parties are content with, is the teamworking quality. With a score of 4.3 by the client versus 4.1 rated by the Fluor team, teamworking is rated high. With high scores on communication, cohesion and aligned effort by both the client and the contractor (see Figure B.3 B), one explaining factor might be the focus within the project on teamworking. Daily scrum sessions and, colocation, where Fluor and the client counterparts are located close to each other, might explain the high scores.

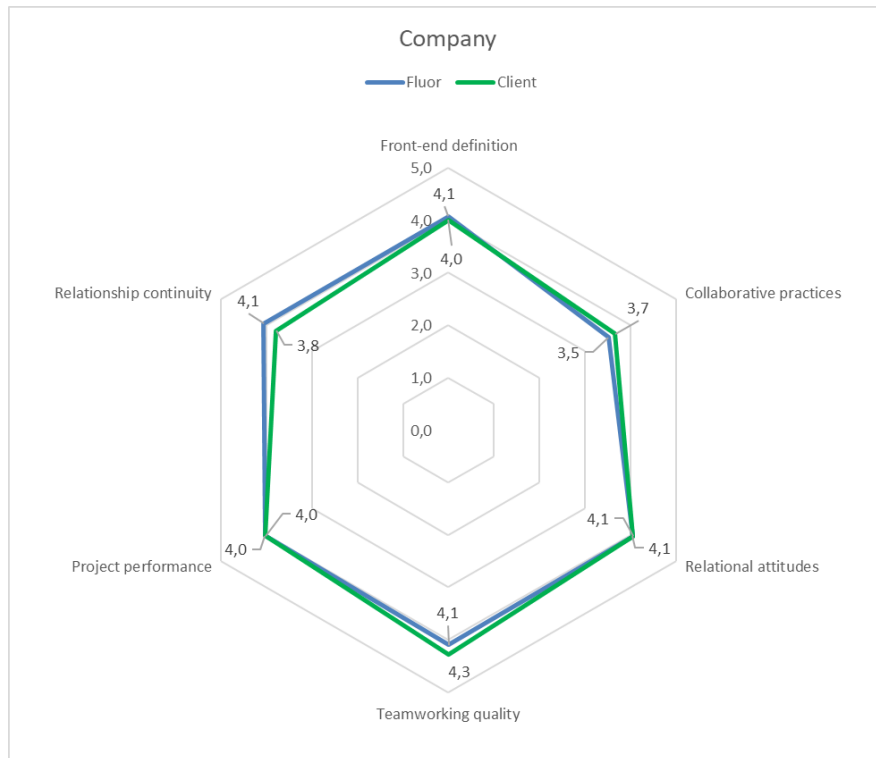


FIGURE 4.2: RECAP RESULTS COMPANY LEVEL

The high scores on teamworking quality contradict with the low scores on collaborative practices. With Fluor scoring only a 3.5 and the client a 3.7 there is some room for improvement here. With low scores on team integration and joint working processes by both the client and the contractor, there is room for improvement. This could be due to the duration of the project. While the process team already started on the project last year, the rest of the team joined in January 2019. Due to an already ongoing part of the project, it could have been hard to establish new norms and protocols. Although, the project is started as a colocation with intention to establish an integrated team, the aspect scored the lowest for Fluor and second lowest for the client, with a score of respectively 3.4 and 3.6. Besides this, studies by Suprpto (2016) and Eggermont (2017) show that collaborative practices are often not well established and agreed on by both parties at the beginning of a project.

#### 4.1.3. Management level

The intent of the RECAP is to measure collaboration between client and contractor, but with teamworking quality as the most important criterion in collaboration, team members are also key in delivering a successful project (Bakker et al., 2018; Hoegl and Gemuenden, 2001; Salas et al., 2005). For this reason, the team is also included in the RECAP assessment and to get a better understanding on how the RECAP criteria are perceived by both parties. The RECAP is completed by 21 team members and 8 team managers. By combining results of the client and Fluor, data is not useable to form an advice for either parties on differences between management team and team members. However, due to the small sample size of 16 Fluor team members, 5 client team members, 7 Fluor managers, and only 1 client manager, the data does not have enough data points to provide relevant results by splitting the results between the client and Fluor. More information about the spread in answers can be found in Appendix B.

As shown in Figure 4.3, there is less alignment between management and team members compared to the alignment between Fluor and the client. There is a 'big' gap in relationship continuity (delta = 0.4). Besides this gap, it can be noted that all criteria are ranked lower or equal by the team members compared to the management team. It can be noted that collaborative practices are again ranked lowest by both the team members as the managers. The only criterion on which both parties are aligned is the level of front-end definition. Although there is a big difference in the questions answered with "Can't answer". While the management team only answered on about 4% of the questions "Can't answer", the team responded in almost 20% of the questions "Can't answer". Especially on the question concerning the satisfaction on the project, almost 45% of the participants responded, "Can't answer". This could be due to the fact that the RECAP assessment is not developed for team members, but for the higher management team. This cannot be derived from the data; further research is needed.

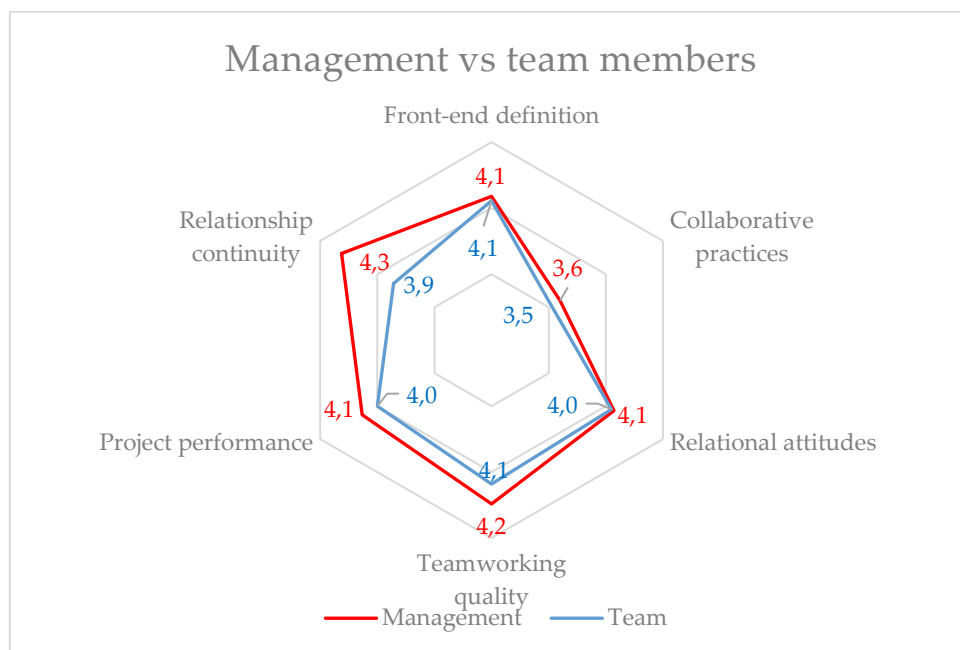


FIGURE 4.3: RECAP RESULTS INTRA-TEAM LEVEL

It can be noted that there are some differences in perceptions between the management team and the team members. Due to specific tasks, team members have less information concerning strategic decisions or governance structures. The management team has a better perception on the long-term vision of the project and is able to make decisions impacting also team members. This could be a reason why the management team is more positive towards all aspects compared to the team members, however further, more regular measurement must be performed to validate this.

#### 4.1.4. Conclusions RECAP assessment

In general, this project scores quite high on all criteria, except for collaborative practices. While this is no exception comparing to previous assessments, this could be a criterion to focus on when entering a next phase (Eggermont, 2017; Suprpto, 2016). Improving collaborative practices such as team integration and joint working processes could improve teamworking even further. While the project scores high on teamworking, looking at the sub-criteria, coordination is an element to be improved. Still, Fluor and the client rate this project high. With minor gaps between both parties, they are well aligned. Besides collaborative practices, elements to improve are efficiency on the project and the relationship continuity with both rated below 4.

Compared to the client-Fluor results, the management teams and team members results contain bigger gaps on most categories. While seven sub-criteria rated the same by management and team members, there are bigger differences in other sub-criteria mostly related to relationship continuity. Five sub-criteria do need some more attention. With gaps of 0.5 on relationship continuity and aligned effort this needs to be addressed to improve the collaboration on the project, where relationship continuity becomes more important towards the end of the project. Still, the relationship continuity may provide useful information when measured during the project, providing the teams to improve on possible gaps before it is too late. Another point of attention is the coordination on the project. The team members perceive a lot more rework being done than the management does. These differences indicate that there is a larger difference between how the management teams and team members look towards collaboration, than between the client and Fluor.

For development of a new tool it should be considered that there is a considerable number of questions answered by “Can’t answer”. With team members answering approximately 20% of the questions “Can’t answer” it raises the question whether the team members are poorly informed about some issues, that they interpret the definitions differently, or that the assessment is mostly not relevant for team members. This is used as input for the evaluative workshop about the RECAP.

## 4.2. RECAP workshop

To evaluate results of the RECAP assessment and to provide input for a new tool, a workshop has been held. The goal of this workshop is to gather input from the project team to assess their point of view on measuring collaboration. Input from this workshop provides an answer on the following questions:

1. What is the perception of the project team about the relevance of critical success factors?
2. How should collaboration be measured according to the project team?
3. What is the willingness of the project team to participate in a collaboration measurement tool?
4. How often does the project team think factors of collaboration should be measured to gain relevant input?
5. What does the project team expect from a collaboration measuring tool?

The workshop consisted of three rounds. First, evaluation of the RECAP is done, providing an answer on sub-question 2: *“What are the criteria for a tool to measure collaborative trends?”*. Secondly, input is asked from the team concerning their willingness to invest time in a tool to measure collaboration on a regular basis, how often the project team thinks that the criteria of collaboration should be measured to gain relevant results, and finally, what methods should be used to maximize the response rates of the project team and keeping them engaged. Finally, the group is asked what they expect of a tool measuring collaboration, in terms of output and relevance. Another benefit of organizing a workshop is that people feel more engaged with the research (Azhar et al., 2010).

The workshop took about an hour in which a mixed group of project managers, project leads, and team members from Fluor were present. The client did not participate in the workshops due to several deadlines. Results are therefore biased by Fluor perceptions, which is considered in analysing results. This could have influenced the results of the workshop. To get a better representation of perceptions in the project, the client should also be present future workshops. The group consisted of around 20 people of which 3 managers, 16 team members and one external lean consultant. During this hour the results of the RECAP are shown and evaluated. Extra information concerning the structure of the workshop can be found in Appendix B.

#### 4.2.1. Workshop results

The team was shown the spider diagram with perceptions of the management team and the team members on the RECAP (Figure 4.3). With many responses rated ‘NA’ or ‘DK’ the goal was to evaluate the relevance of the questions to the project team. The group was asked to evaluate whether they thought the criteria should be measured only at team managers, team members, or both. As shown in the Figure 4.4 the group was somewhat divided. As also seen in the table, it is clear that there are very few people who think the RECAP questions should only apply to the team. Mainly the group agreed that the whole team is responsible, so these criteria should apply to the management team and the team members. Only one clear criterion is answered to be mainly relevant for the management team, which is project performance, with 11 votes for relevance only for the management team, and 5 votes for both the management team and the team members.



FIGURE 4.4: RELEVANCE OF RECAP QUESTIONS

When evaluating the results, the team argued that they are working as one team, so the questions should be answered by the complete project team, not only the management team, or only the team members. However, project performance was hard to answer for team members, since it requires some strategic knowledge on how the project is progressing. They argued that it is hard for the team to know these aspects if they are not shared with the team. This was also found to be a point of discussion on relationship continuity, since it also contains some strategic knowledge on the project. Still, the team agreed that strategic information should be shared with the entire team and should not be limited to the management teams.

TABLE 4.1: OVERVIEW OF RESPONSES

	Project management	Team members	Both
<b>Front end loading</b>	4	2	10
<b>Collaborative practices</b>	0	0	16
<b>Project performance</b>	11	0	5
<b>Relationship continuity</b>	6	0	10
<b>Relational attitudes</b>	8	0	8
<b>Teamworking quality</b>	0	1	15

Another aspect discussed during this round is the relational attitudes, with 8 votes for relevance for only project management, and 8 votes for relevance for both parties, people were divided on it (see Table 4.1). This is mainly due to the questions concerning the attitudes of the client party. There was sometimes little knowledge on what the commitment of the client was and whether the client is intentionally open, since they have only contact with the client on basic level where strategic behaviour is less apparent. Another aspect why the management team got many votes is due to the questions concerning relations between higher management levels on which the team members have no influence. Still, other aspects were considered relevant in assessing the collaboration between both parties.

#### 4.2.2. Input on measuring collaborative trends

With feedback gathered concerning the RECAP assessment, the next four questions are focused on developing a new tool to capture collaborative trends. To answer the questions the group is provided with some context on why such a tool should be developed and what the challenge is. After the group was provided with the context, they were asked questions divided into four rounds, firstly assessing how to measure collaborative trends. Secondly, the group was asked input on how often the criteria have to be measured in order to have relevant results. Thirdly, it is discussed what such a tool should deliver for the team. Finally, the willingness to invest time in the tool is assessed. Photos of the results can be found in appendix C.

“How to measure collaborative trends?” was the first question the group had to answer. To provide some direction on measurement techniques there were three provided answers and one option to suggest an alternative method. The respondents could choose from ‘computer survey’, ‘tablets on the work floor’, ‘interviews’, and ‘other (specify)’. Respondents chose mainly to use interviews to assess the collaboration on the project, or to use a combination of surveys, short ‘smiley’ analysis and interviews. The reason for choosing interviews was the



fact that collaboration is a difficult thing to measure where people have different perceptions on. It is also too complicated to assess solely in a survey and to show the numbers.

During the discussion it was mentioned that the main reason not to choose for surveys is previous negative personal experiences. While surveys are frequently used within the company, some respondents argued that all the answers “end up in a black box” without feedback of the results to the respondents. This is an interesting observation arguing that the outcomes of the survey do not say much, it needs to facilitate a discussion on what is observed within the project and how to improve these aspects. The numbers just facilitate this discussion but have no apparent meaning on their own.

Secondly the respondents were asked how often the main criteria have to be measured to get relevant results. They were asked to put a post-it with the corresponding colour to that criterion and write on the post-it how often they thought it changed. As can be seen in Figure 4.5, most criteria are considered relevant to measure monthly (or several times a month), except for front-end development and relationship continuity. During the discussion of the results, respondents argued that the front-end definition should be clear at the beginning of the project, with clear goals and objectives. Relationship continuity, however, becomes relevant much later during the project. When a phase is ending it becomes much more important how both parties think about their relationship with each other and how to continue with this. Some post-its concerning teamworking quality (3) and relational attitudes (3) are perceived to be very dynamic. They argue that these criteria should be measured daily, since they can change very quickly due to problems which could arise.



FIGURE 4.5: FREQUENCY TO MEASURE COLLABORATION

To keep people engaged and interested in the tool, respondents are asked what they expect back from the tool. Respondents were asked to write on a post-it what they would like to see in return. Some quotes are “Trends, analysis, take measurement when needed, and praise the team” others wrote “Improvement” or “visibility” on their post-it. This adds to the comment above, mentioning the lack of feedback from a filled in survey. Outcomes should be visible and actionable. This adds to the fact that the outcome of a tool should not be numbers, but a discussion and feedback on things to improve and things that should be praised. The numbers help in facilitating this discussion, making the ‘invisible’ aspects of collaboration visible.

Another way to increase the engagement is to provide a name to the new tool, such as the ACT (Assessing collaborative trends) tool.

Finally, also to maximize the response rate of a new tool, respondents were asked how much time they are willing to invest in such a tool. Answers ranged from 10-15 minutes a day to 5 minutes per project phase. Most respondents were willing to spend 20-30 minutes a week on the tool, or 30 minutes to an hour a month on the tool. This should be considered in developing a new tool. During the discussion it was mentioned that it depends on the measurement method how much time respondents are willing to invest in the tool. As one of the responses also mentioned he was willing to invest "5 min measurement + 30 minutes team conversation". Respondents were willing to put more time in interviews or group discussions, than surveys.

### 4.3. Conclusions

The results of the RECAP assessment and the workshop provide an input for development of the tool. Using the results sub-question 2: *"What are the criteria for a tool to measure collaborative trends?"* can be answered. The answer on this question is twofold, first the results provide a first selection of the dimensions which should be used for further development of the tool. Secondly, the workshop discussion shows what to take into consideration when developing the tool in terms of engagement and feedback of the tool.

The dimensions to take into consideration are based on the applicability of the questions to the management teams and team members, therefore project performance and relationship continuity should not be considered for further development. Based on the differences between the management teams and team members, the split between both can provide an interesting view on collaboration dynamics. While both are helpful in assessing the collaboration between both parties and measuring the project performance, the workshop proved that the questions were more suitable to answer for only the management teams than for the entire team. The Front-end loading variable was considered also less relevant in measuring the collaboration regularly.

The second aspect to take into consideration is that a new tool should not only provide values but should facilitate a discussion on what criteria to improve and what criteria are performing well, a clear feedback loop should be present in order to maintain engagement of respondents. Increasing engagement can also be achieved by naming the tool such as the ACT tool. The tool should also include the whole team in answering criteria, but there are some differences in how often they should be measured. To define a method to measure collaborative trends, it must be considered that respondents do not like being measured with a survey tool, unless they are provided with clear feedback and actions on what to do with the results. Respondents were willing to spend more time on interviews; however, they indicated that they thought the best method to measure collaborative trends is to combine a computer survey, tablet on the work floor, and interviews.

## 5. TOOL DEVELOPMENT AND DATA GATHERING

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This chapter describes the development of the adapted tool, from now on called the ACT (Assessing Collaborative Trends) tool. The goal of the tool is to measure and visualize how the collaboration in this period changes over time and identify collaborative trends. Chapter 5.1. describes the hypotheses used as backbone for the development of the tool. The decisions and design choices made to develop the tool with input from previous chapters are discussed in chapter 5.2. In chapter 5.3. the data gathering is explained and in 5.4. a conclusion is provided.

### 5.1. Hypotheses

The goal of the ACT tool is to identify trends, but with no literature showing that there are trends, it must be proven that collaborative trends exist. Currently, as shown in Table 3.6, only collaboration measurement tools are available which are not developed with the goal to measure collaboration over time. For this research, these measures are classified as “static”. With currently no found literature concerning trends in collaboration, the hypotheses are used to show the presence of trends in collaboration and possibly the need for further research. To prove the need to measure over time, six hypotheses are developed to test whether measuring over time is useful or that measuring collaboration statically is sufficient. The hypotheses are based on three goals, which are further explained down below. First, it should be meaningful to measure collaboration over time. Second, it should be useful to make a distinction between the management team and team members, and finally, the survey should provide useful insight in the quality of the collaboration.

Without any collaborative trends present to measure, static measurements could be sufficient to assess collaboration. The goal of the hypotheses is to explore if measuring over time is useful. With only sporadic literature concerning dynamic trends, theoretical background is sometime limited. Since the tool should be able to measure collaborative trends the formed hypotheses are considered when developing the tool. The hypotheses are not used to validate the tool, only to confirm the presence of trends in the data. Using further statistical data analysis, the hypotheses are tested and accepted or not accepted (see chapter 6).

#### 5.1.1. Measuring over time

With few scientific researches covering the dynamics in collaboration there is little empiric evidence that collaboration changes over time. Collaboration is different in every project, due to the characteristics of the project phase, people working on the project, the project budget and the scope. While projects change when shifting from one phase to another, or even within a project phase due to scaling up or scaling down of staff, it is expected that collaboration changes also over time as Tuckman (1965) describes in his group forming theory. The collaboration changes not only within a party, but also between parties as team building workshops are performed or joint meetings are held. Projects can change over time due to changes in group composition, the type of work changes and upcoming milestones can change dynamics in projects over time, therefore it is expected that the collaboration between client and contractor changes over time.

This brings us to the first two hypotheses where hypothesis 1 is developed to assess whether collaboration changes over time, whereas hypothesis 2 looks at the magnitude of change.

**Hypothesis 1: Measuring collaboration regularly yields significant differences over time on all collaboration variables during a project;**

**Hypothesis 2: Collaboration between client and contractor changes over time;**

Another aspect of measuring over time is when both parties are actively putting effort into the collaboration, that both parties get a similar perspective on collaborative elements. As research showed, communication is an important aspect of collaboration (Thomson, 2007; Dietrich, 2010; Suprpto, 2016). Not only using the right communication channels helps improving collaboration, also understanding each other helps in this aspect (Cramton, 2001). Often team development activities are used to achieve a mutual understanding about each other. However, mutual understanding has not been measured often. By identifying differences and commonalities between the client and contractor, it can be evaluated if both parties truly understand each other or that there are gaps in mutual understanding. Expected is that better aligned parties and higher mutual understanding can achieve a higher score of collaboration (Cramton, 2001).

**Hypothesis 3: Alignment between client and contractor improves over time;**

### 5.1.2. Measuring management and team members

Evidence from the RECAP implementation showed that there are differences in how the team perceives collaboration and how the management team does. The results show that the team members have a greater difficulty in answering questions concerning strategic decisions. This provides an indication that project participants at different management levels do not have a similar view on collaboration. This is supported by Bakker et al. (2018), which mentions that people do projects. Collaboration does not stop at management level but is done by the entire team. Interviews performed by another researcher on the project show expectations and perceptions on collaboration can be different, where the manager can influence the relationship more, team members might have another perception on collaboration. Therefore, it can be expected that there is a difference in collaboration perception, which brings us to the following hypothesis:

**Hypothesis 4: There is a difference in perception on collaboration between the management team and team members;**

### 5.1.3. Other trends in collaboration

Hypothesis 5 is based on the expectation that people who strongly believe in collaboration perceive the collaboration more positively. This hypothesis is based on the collaboration framework of Thomson (2006). Thomson (2006) mentions when people are more committed towards collaboration and therefore believe more in collaboration the implementation of collaboration in a project becomes easier. To test whether this holds when measuring more regularly, this control variable added to see whether the belief in collaboration increases

outcomes of the other variables. Thomson (2006) also mentions that when there is insufficient commitment or belief in collaboration, implementation of collaboration in projects can become more difficult. To test this relation the following hypothesis is developed:

**Hypothesis 5: The belief in collaboration affects scores in collaboration variables;**

Finally, team working researches show that the working environment is key to effective team building (Duhigg, 2016; Eggermont, 2017; Suprpto, 2016; Gallup). This includes a no blame attitude within the project, presence of trust, and a place where people are comfortable on providing each other feedback. The three variables are also used as control variables as a better working environment is expected to improve collaboration better than an environment lacking a good work environment. Also, with a more open environment, information sharing, and openness are also expected to increase. The work environment is even more important due to the colocation of the client and contractor several days a week. As the interviews showed, there is a positive attitude towards colocation and employees believe it helps improving the collaboration due to shorter communication lines and better cohesion. The ability to provide feedback in a project where there is an atmosphere of trust and a constructive attitude to look for opportunities instead of blaming each other could not only be beneficial for the client and contractor themselves, but also between the client and contractor.

**Hypothesis 6: The work environment affects scores on collaboration quality.**

## 5.2. Tool development

Considering the developed hypotheses, literature and RECAP results are combined to develop the tool. The literature research showed that collaboration consists of five critical elements in order to have a successful collaborative relationship. With the results from the RECAP indicating a difference between the management teams and team members, this should also be considered when developing the tool. Another disadvantage of the RECAP is the large amount of questions to assess the collaborative relationship between a client and contractor. To measure more regularly, the RECAP assessment needs adjustments to include team members into the measurement and the amount of questions should be decreased.

To be able to answer the main research question, the following three aspects need to be considered when adjusting the RECAP. First, the adjusted tool should provide information about significant trends over time, proving the benefit of measuring regularly. Secondly, the survey should prove significant differences between the client and contractor, and at different management levels based on the findings of the RECAP results as described in previous chapter. Third, the survey should be able to provide useful insights in client-contractor collaboration.

Development of the tool is structured based on the research process described by Field (2018) (Figure 5.1): first a selection is made to reduce the dimensions of the RECAP from six to three based on the input gathered in the RECAP workshop as described in chapter 4.2. and the five identified critical elements. By reducing the number of RECAP dimensions, the number of questions can be narrowed down, this is further explained below. Secondly, the questions

corresponding to the three remaining dimensions are selected corresponding with the identified five critical elements, reducing the number of questions. Finally, the remaining questions are selected and adjusted to be appropriate for team members.

Combining the input from the RECAP results and the theoretical foundation, a tool is developed. Using preliminary data analysis, the tool is validated, and reliability is tested (see chapter 6). Taking preliminary data analysis results into account, a choice for the data analysis is made depending on the normality of the data, missing values and outliers. Using the hypothesis, it can be determined whether there can be trends identified or not. Finally, a conclusion is provided based on the data analysis

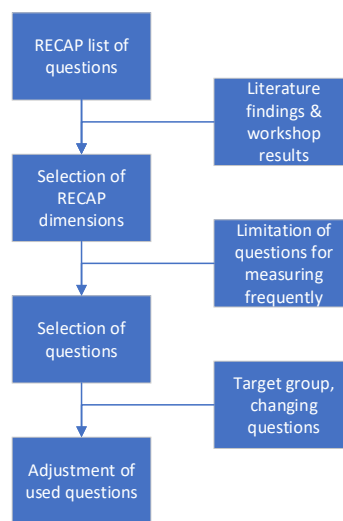


FIGURE 5.1: INPUT FOR DEVELOPMENT OF ACT TOOL

### 5.2.1. Input from literature and RECAP assessment

The RECAP consists of six dimensions: front-end loading, collaborative practices, relational attitudes, team working quality, project performance, and relationship continuity. However, of these dimensions, front-end loading is considered to be only relevant in the beginning of the project, limiting the frequency of necessary measurements according to workshop results (see chapter 4). While front-end loading helps increasing project performance, it is not always related to the successfulness of a collaboration (Smyth and Pryke, 2008). Relationship continuity and project performance are two other dimensions created by Suprpto to assess the successfulness of the project. Where project performance measures whether the project is still on schedule, within scope, and within budget, relationship continuity measures if the client and contractor would like to work with each other in the future. Both dimensions do not measure the collaboration on the project, but instead measure the results of collaboration. Combined with the findings of Chapter 4, front-end loading, project performance and relationship continuity dimensions are eliminated, since the goal of the ACT tool is to assesses client-contractor collaboration on management and team member level.

Literature suggests evidence for the relationship between collaborative practices and collaboration, as well as for relational attitudes and team working quality (Baiden and Price, 2011; Poppo et al., 2008; Hoegl and Gemuenden, 2001). Collaborative practices and relational attitudes are both not sufficient in itself but facilitate an environment in which collaborations



can perform better. Collaborative practices encompass joint working agreements and processes as well as governance and team structures such as integration of teams. Even though these agreements are made, without a collaborative mindset, collaboration quality could still be low. Relational attitudes are part of this mindset, considering the interactional norms and trust on a project. Like collaborative practices, relational attitude elements positively affect collaboration, but are not directly related to the collaboration quality and act as a facilitator. Team working quality and collaboration quality are a measure for collaboration and consist of aspects such as communication, coordination, mutual support and aligned efforts (Hoegl and Gemuenden, 2004). To assess both the collaboration as the environment in which a project takes place, collaborative practices, relational attitudes and team working quality are used in the modified tool.

A total of 54 questions are covering the three selected dimensions; collaborative practices, relational attitudes and teamworking quality (total question list can be found in Appendix C). In order to measure collaboration frequently, a further selection must be made within these dimensions. Workshop results on the RECAP assessment showed that participants in the project were willing to invest on average about 20 minutes per week on the survey. This includes filling in surveys, potential interviews and group discussions about the collaboration. Response quality is also impacted by the length of the survey. With a survey length longer than 10 minutes, response quality/rates drop by 40% (Lindemann, 2018).

Also, to keep respondents engaged during the measuring period, the number of questions has been reduced. Therefore, it is chosen to have a maximum survey length of 10 minutes, consisting with approximately 16-20 questions in order to keep respondents engaged during this research. It is expected that respondents take longer to fill in the survey the first time, but since the questions do not change, response time is expected to decrease over time. To increase survey responses a more personal approach is used, where paper surveys are handed over in person to respondents. Research shows that survey responses improve as it gets more personal (Lindemann, 2018). Where in-person surveys have an average response rate of about 57%, the response rates drop severely to 30% when an online survey or email survey is used.

To reduce the number of questions from 54 to approximately 20, a first selection is made looking at the collaborative practices, consisting of “Team integration” and “Joint working processes”. With the focus in the project on a form of team integration and co-location of employees with their counterparts, it is interesting to see whether cohesion and aligned efforts improve. Therefore, questions concerning team integration and joint working activities such as joint planning and other work-related aspects are chosen (see Table 5.3).

TABLE 5.1: COLLABORATIVE PRACTICES QUESTIONS RECAP (SUPRAPTO, 2016)

<b>Collaborative practices</b>
<b>Team integration:</b>
We form an integrated project team (IPT) where the owner and the contractor teams are structured and integrated as a single team with no apparent boundaries.
<b>Joint working processes:</b>
We jointly conduct planning.
We jointly perform monitoring, controlling, and reporting.

The relational attitudes dimension of the RECAP is a more extensive dimension than the collaborative practices, consisting of three categories: Senior management commitment, Senior management trust, and Established relational norms. An important category in this dimension is the focus on a certain atmosphere in the project. No blame, trust, and an open environment are elements contributing to a safe work environment improving team working (Gallup-12; Eggermont, 2017; Suprpto, 2016; Duhigg, 2016). A positive work environment enables better communication and cohesion during a project. Due to this positive effect, questions are chosen based on elements contributing to a project atmosphere and the critical elements.

TABLE 5.2: RELATIONAL ATTITUDES QUESTIONS RECAP (SUPRAPTO, 2016)

Relational attitudes
<b>Senior management commitment:</b>
Senior management of the owner commits to provide necessary resources and support to the project teams.
Senior management of the contractor commits to provide necessary resources and support to the project teams.
Senior management trust
There is an atmosphere of mutual trust between senior management of both parties.
<b>Established relational norms:</b>
The owner intentionally adopts ‘no blame culture’ when problems arise.
The contractor intentionally adopts ‘no blame culture’ when problems arise.
The owner is intentionally open and honest in any interactions with no hidden agendas.
The contractor is intentionally open and honest in any interactions with no hidden agendas.
The owner strives for business outcomes whereby both parties either win or both parties lose.
The contractor strives for business outcomes whereby both parties either win or both parties lose.

Finally, the team working quality dimension is narrowed down. The dimension consists of seven sub-criteria: communication, coordination, balanced contribution, mutual support, aligned effort, cohesion, and trust. While literature does mention the benefits of a balanced contribution towards a project of all project members, the questions have the second lowest effect on team working quality and are therefore not used (Suprpto, 2016). The other sub-categories are limited to two questions based on the critical elements defined in chapter 3 (see Table 5.3).

TABLE 5.3: TEAM WORKING QUALITY QUESTIONS RECAP (SUPRAPTO, 2016)

<b>Team working quality</b>
<b>Communication:</b>
Project-relevant information is shared openly by both teams.
<b>Coordination:</b>
The work done in the teams is closely synchronized between the teams.
<b>Mutual support:</b>
Both teams help each other as well as they could.
Whenever problems occurred, they are resolved constructively.
<b>Aligned effort:</b>
Both teams put their best effort into this project.
<b>Cohesion:</b>
Members of both teams are integrated as one team.
Members of both teams feel proud to be part of the project team.
<b>Trust:</b>
Both teams keep their promises.

### 5.2.2. Design choices

Although the questions chosen above consist of the maximum amount of 20 questions, the RECAP assessment by the team showed that an average of 19% of the questions could not be answered by team members. Besides adjusting questions there are two other design choices in the survey: the use of smileys to indicate respondent's mood while filling the survey, and the use of paper surveys to gather data which are further explained below.

To make the questions more applicable for team members and to get a clear structure in the survey, the questions have been divided into three categories, the general project factors, client-Fluor reflective questions, and collaboration perception questions. The categories chosen to rely on three ideas, first the survey should provide an indication on collaboration mechanisms and the atmosphere in the project. These variables are a result of both parties making agreements and working towards a good working place. General project factors provide insight how the project is performing in terms of the culture within the project, formal (joint) procedures in place, atmosphere in the project, and work coordination between client and contractor employees.

The client-Fluor reflective questions are based on the questions concerning the senior management of both parties. Where most questions concern performance of the team as a whole, at the senior management part, questions are asked from a client side as well as from the contractor side. Splitting both teams into separate questions contradicts the idea of a good collaboration, acting as one team. Although it can be questioned in how many cases parties really act as a single team during a project. Measuring collaboration is based upon perceptions of employees, all having their own view on each topic. By asking these questions it can be assessed whether both parties look at a project the same way. If both parties rate themselves higher than the other party does, it can be questioned if they have the right perception about themselves. By measuring this, it can be assessed how both parties perceive themselves, where

this perception might be different and why. Alignment on perceptions can enhance improvement and improve team performance (Beer et al., 2005).

Finally, the remaining questions about happiness, whether employees feel part of one project team, and if employees believe that collaboration helps improving project performance are shown. These elements provide insight in whether employees feel happy at work, providing an indication of employee satisfaction. As mentioned in the Gallup-12 survey, employees are more productive when they feel happy at work. Together with the variable if people feel part of one team, it shows if employees from the client and contractor work integrated, even without formal integration procedures. Also added is the perception whether people feel that collaboration helps improving project performance. If a respondent does not 'believe' in collaboration, he/she might score lower on collaborative variables.

Q#	Variables	Statements	Corresponding hypotheses
20	Happy	Smiley rating	1
1	Team integration	The teams of the client and Fluor are integrated as a single team with no apparent boundaries	1, 2, 4, 5, 6
2	Work coordination	My work is coordinated with my colleagues and counterparts	1, 2, 4, 5, 6
3	Joint activities	My team jointly conducts activities with our counterpart(s) (e.g. such as planning, monitoring, controlling and reporting)	1, 2, 4, 5, 6
4	Joint conflict resolution	There are methods to jointly resolve conflicts/disputes within the project	1, 2, 4, 5, 6
5	No blame	There is a no blame culture	1, 2, 4, 5, 6
6	Trust	There is an atmosphere of trust	1, 2, 4, 5, 6
7	Client mgt. collaboration commitment	The project management team of the client is committed to collaboration	1, 2, 3, 4, 5, 6
8	Fluor mgt. collaboration commitment	The project management team of Fluor is committed to collaboration	1, 2, 3, 4, 5, 6
9	Client win-win	Client supports a win-win situation	1, 2, 3, 4, 5, 6
10	Fluor win-win	Fluor supports a win-win situation	1, 2, 3, 4, 5, 6
11	Client best effort	Client is putting their best effort into the project	1, 2, 3, 4, 5, 6
12	Fluor best effort	Fluor is putting their best effort into the project	1, 2, 3, 4, 5, 6
13	Client information sharing	Information is shared openly by the client	1, 2, 3, 4, 5, 6
14	Fluor information sharing	Information is shared openly by Fluor	1, 2, 3, 4, 5, 6
15	Client promises	The client keeps their promises	1, 2, 3, 4, 5, 6
16	Fluor promises	Fluor keeps their promises	1, 2, 3, 4, 5, 6
17	Feedback	I feel comfortable to provide feedback on the work of both colleagues and counterparts	1, 2, 4, 5, 6

18	One project team	I feel part of one project team	1, 2, 4, 5, 6
19	Collaboration and project performance	Collaboration helps improving project performance	1, 2, 4, 5, 6

TABLE 5.4: VARIABLES AND QUESTIONS

Combining the input from the literature review, workshop, the research by Suprpto (2016) and selection of relevant questions (Table 5.2 and Table 5.3), this has resulted in the following survey questions (see **Fout! Verwijzingsbron niet gevonden.**). In order to test the hypotheses concerning the difference between client and contractor, and the differences between the management team and team members colour coding is used in the tool in the top left corner.

The survey uses a 1-5 Likert scale ranging from 'Fully disagree' to 'Fully agree'. The Likert scale is a much-used scale in social sciences, as it is able to measure attitudes of respondents (Likert, 1932). As opposed to the Likert scale used in the RECAP assessment and in the research by Thomson (2007), the option of 'Not applicable' or 'Do not know' is excluded since the survey is specifically tailored to fit the project and respondents. Excluding the 'Not applicable' and 'Do not know' option, respondents are forced to provide an answer on the given statements, enabling respondents to think about the responses and the perception on collaboration at that moment. In further data analysis the questions are referred to according to the corresponding variable as shown in Appendix E.

### 5.3. Data gathering

The goal of the data gathering and data analysis (chapter 6) is twofold, first to provide evidence that there are collaborative trends, and second that the tool developed, is a valid way to measure collaborative trends. The data is gathered from April 16<sup>th</sup> until the end of May, resulting in 7 weeks of data collecting. As mentioned in Chapter 1, the SELECT phase was already ongoing when the data collection started. In the period between January and April 16<sup>th</sup>, several trends could have already been going on. This is could not be captured due to the tight schedule of this research. Due to the inability to measure the entire SELECT phase, results can only be accounted to the measured period. Since the beginning of April, the group size varied around 70 people. Some client employees are put on the project to aid Fluor counterparts in their current activities. Near the end of the SELECT phase, some employees leave the project, because of finished activities and no or limited work in the bridging period. Data gathering is also impacted during the May holiday break from April 27<sup>th</sup> until May 12<sup>th</sup>, reducing the amount of people available to fill in the survey.

The data is gathered via a paper survey every Tuesday starting from April 16<sup>th</sup>. Respondents were asked to return the survey within two days, preferably the same day, to reduce the impact of external events. The choice for handing out weekly paper surveys is to increase the response rate within the project and to give respondents the opportunity to ask questions concerning the survey. Because this choice, responses resemble almost 100% of the number of respondents available that day (see Figure 5.2). However, due to the limitation of a weekly paper survey, only respondents physically in the Fluor office are included in this research excluding support staff or staff working from outside the project area. In total about 230

surveys have been filled in of which 228 were useable. Two surveys have been rejected due to multiple numbers filled in the response column where only one number was required.

To increase the honesty on answering the questions, the survey is made anonymous, apart from the two coding attributes mentioned before. Respondents were asked to provide a mark beneath the corresponding smiley on how they felt that day, and to put a score, ranging from 1, 'Strongly disagree', to 5 resembling 'Strongly agree'. In case of questions or remarks, respondents could write these in the box below the questions or ask them directly. An example of the survey is given in **Fout! Verwijzingsbron niet gevonden..** Due to the nature of this action research and weekly feedback it is expected that results are influenced by the author, possibly impacting results of the survey. Interesting is that while in the beginning some participants did not know how to answer certain questions, people were forming an opinion on it while progressing each week. The results of the data gathering can be found in the appendix E.

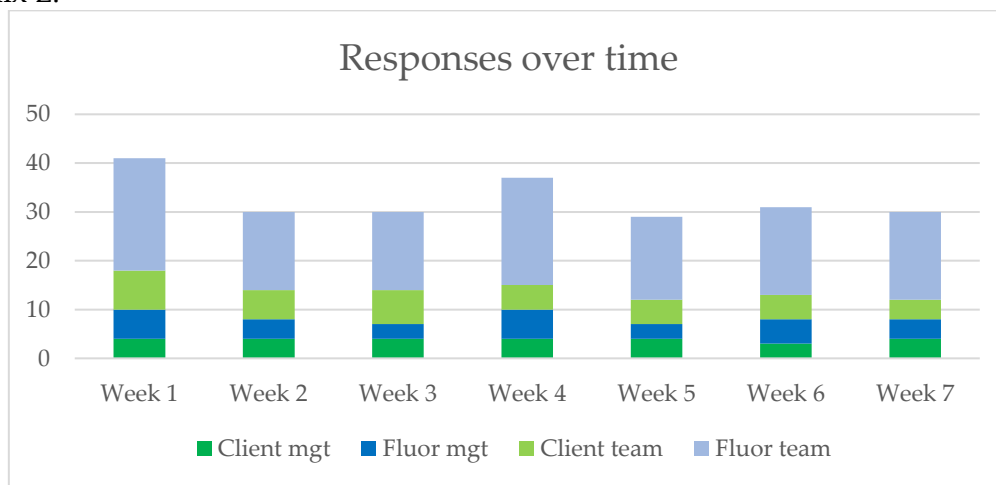


FIGURE 5.2: RESPONSES OVER TIME

## 5.4. Conclusion

The answer on sub-question 3 can be formulated: *“How can collaborative trends be measured in a project team environment?”*. Central to this question are five corner stones, the developed hypotheses to provide evidence of collaborative trends, the theory to measure collaboration using five critical elements, the frequency of measuring, the length of the survey, and the complexity of the questions. The tool is an adapted version of the RECAP assessment. Important changes are the reduction of the number of questions from 72 to 20. For this it is chosen to focus only on relational attitudes, collaborative practices, and team working quality based on the workshop evaluating the RECAP assessment. To make the RECAP statements/questions also more applicable for team members, the statements have been changed and made clearer.

By clarifying and reducing the number of questions, the RECAP assessment is adapted to be able to measure collaborative trends by measuring frequently. The frequency of this measurement is set to be weekly to be able to gather enough data during the SELECT phase.



## 6. DATA RESULTS AND ANALYSIS

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This chapter describes the data analysis of the survey results. Based on the hypotheses discussed in chapter 5 the data analysis is performed. The structure of this chapter is as following: first a preliminary data analysis is performed in chapter 6.1. This is followed by the descriptive data analysis in chapter 6.2. Chapter 6.3 compares the outcomes from chapter 6.2 with a workshop to identify trends and possible causes of these trends. The hypotheses are answered using statistical analyses in chapter 6.4. Hypotheses 1 and 2 are discussed in the time related trends chapter (Chapter 6.4.1.), hypothesis 3 is discussed in chapter 6.4.2. management and team member trends, and hypotheses 4, 5 and 6 are discussed in chapter 6.4.3. “Other collaborative trends”. Finally, chapter 6.5 provides a conclusion.

### 6.1. Preliminary data analysis

Before an answer can be provided on the hypotheses, a preliminary data analysis is performed. The goal of the preliminary data analysis is to identify outliers, check if there is data missing and how the data is processed. In this preliminary data analysis, the following aspects are discussed: missing values and outliers, normality is checked, and the reliability and validity are discussed.

#### 6.1.1. Missing data and outliers

While due to anonymity surveys could not be traced back to respondents, using a personal approach in handing out and collecting surveys missing values could be identified directly and corrected reducing the amount of missing values. However, while this was mostly the case, it must still be checked if there are missing values due to data processing. In one case, someone was not able to answer a question concerning alignment of work with their counterpart, this was considered to be a missing value on that question. Other participants had no trouble filling in the surveys.

Looking at the data there are some missing values. As discussed on the question concerning alignment of work, the answers are reported missing for the measurement period due to a participant unable to fill in the question. Other values reported missing are on joint conflict resolution and Client promises, due to unreadable answers or data processing. To prevent excessive data removal, “pairwise exclusion of cases” is used, rather than listwise exclusion. Pairwise exclusion means that rather than not using the entire sample, only the data for that particular value is not used. This prevents decreasing the sample size (Field, 2018).

#### 6.1.2. Normality check

The sample size is not considered very large (i.e. sample size larger than 500). To assure right interpretation and choice of statistical tests it must be tested if the data is normally distributed. To assess normality the Kolmogorov-Smirnov test is used with listwise deletion. The scores on all variables show a  $p = 0.000$  indicating that none of the variables is normally distributed. While this does not necessarily mean that the data cannot be used for further analysis but that further analysis must pay more attention to significance (Field, 2018). With non-normal

distributed data, other tests such as the Mann–Whitney test, the Wilcoxon signed-rank test, Friedman’s test and the Kruskal–Wallis test can be performed to identify trends in the data (Field, 2018).

### 6.1.3. Reliability

To analyse the data first must be established whether the data is a reliable measure of collaboration. A sample size of larger than 300 is considered to be reliable. However, the data set contains 228 samples, indicating that reliability could be an issue. A sample size is deemed to be reliable if all communalities of all variables score above 0.6 or a Kaiser-Meyer-Olkin (KMO) score of larger than 0.5 (Field, 2018). The KMO score is used to test if the data is suited for a factor analysis. In the dataset, communalities of the variables range between 0.2 and 0.7, meaning the data cannot be considered reliable based on the communalities. So, a KMO test must be performed. The KMO test yields a score between 0 and 1. A score closer to 1 indicates that the data is correlated, and the dataset yields reliable factors. With a KMO score of 0.862, the data passes the KMO test and data can be deemed reliable.

The KMO statistic varies between 0 and 1. A value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations (hence, factor analysis is likely to be inappropriate). A value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. For all individual variables the KMO scores are higher than 0.5 so all variables should be included (Kaiser & Rice, 1974).

Looking at the correlation matrix, it can be noted that almost all variables correlate significantly with each other ( $p < 0.05$ ). With only non-significant correlations on joint conflict resolution, indicating that all variables are dependent of each other. Based on the data it can be determined that the developed survey questions are all related to each other indicating the expected correlations between most variables is consistent with the theoretical frameworks the survey is built upon. Data indicates also that the mood or happiness of employees correlates with only two variables, Client information sharing (0.314) and the feeling of being part of one project team (0.338). Correlations between these variables are very weak and since no other variable correlates with happiness, this variable should be excluded from further analysis, however, to prevent loss of meaningful possible relations, this variable is also used in further analyses (Field, 2018). Another low correlating variable is joint conflict resolution which correlates only with the “No blame” variable (0.416). There are no variables having correlations higher than 0.9, so there is no indication for multicollinearity (Field, 2018). The determinant of the correlation matrix is lower than  $1.0 \text{ e-}5$  ( $2.564 \text{ e-}5$ ) so multicollinearity is no problem.

To identify possible relationships within the data and possibly reduce the dataset for further data analysis an exploratory factor analysis is performed. For this factor analysis, principal axis factoring is used with Varimax rotation. Factor extraction suggests that 4 factors or categories can be identified in the data (see Table 6.1). Variables with a loading of 0.4 are deemed significantly contributing to a factor. The table shows that happy is the only variable with a loading lower than 0.4 (0.314), thus barely contributing to any factors. Besides happy, another issue with the dataset is that 7 out of 20 variables load higher than 0.4 on multiple

factors. This indicates that these variables contribute to more than one factor. These variables are marked in red and should not be used in distinguishing the factors (Field, 2018).

TABLE 6.1: SUMMARY OF EXPLORATORY FACTOR ANALYSIS RESULTS (N=227)

Rotated factor loadings				
Item	1	2	3	4
Fluor promises	<b>0.608</b>			
Fluor information sharing	<b>0.587</b>			
Client promises	<b>0.577</b>	<b>0.412</b>		
Joint activities	<b>0.532</b>			
Feedback	<b>0.525</b>	0.361	0.323	
Work coordination	<b>0.48</b>			
One project team	<b>0.465</b>	<b>0.454</b>		
Collaboration and project performance	<b>0.425</b>			0.329
Happy	0.314			
Client mgt. Collaboration commitment		<b>0.689</b>		0.397
No blame	0.313	<b>0.617</b>		
Client win-win		<b>0.612</b>	<b>0.495</b>	
Trust	<b>0.446</b>	<b>0.587</b>		
Team integration	0.368	<b>0.56</b>		
Client information sharing	<b>0.437</b>	<b>0.545</b>		
Joint conflict resolution		<b>0.408</b>		
Client best effort			<b>0.739</b>	
Fluor best effort	<b>0.442</b>		<b>0.585</b>	
Fluor win-win			<b>0.464</b>	<b>0.406</b>
Fluor mgt. collaboration commitment				<b>0.917</b>
<b>Eigen values</b>	3.343	3.226	1.925	1.613
<b>% of variance</b>	16.715	16.132	9.625	8.063
<b>Cronbach's alpha</b>	0.842	0.853	0.757	-

Based on the exploratory factor analysis four factors are identified with significant relations. The three predefined categories are not reflected by the exploratory factor analysis. Besides this, it can be noted that there is a difference in Fluor and the client related questions. With most client related questions grouped and Fluor related questions grouped, further analysis should indicate if there is a difference between both companies. Based on the factor analysis it is predicted that both parties would score differently on the defined collaboration variables. While there is some grouping of the client and Fluor related questions, no overall categories can be defined at first sight. The factor analysis can, therefore, not help in narrowing down

further analyses. A next step to analyse the data is an independent analysis of how the client and Fluor variables score on other variables is performed in the next chapter.

#### 6.1.4. Validity of the survey

Several steps were taken to ensure internal validity of the survey (Tashakkori & Teddlie, 1998). Before the survey was published, it was thoroughly discussed and tested with practitioners and two academics. Adjustments were made based on their feedback, questions were reformulated and simplified without losing the essence of the question. Based on the input of the practitioners, two questions were added, whether people believed collaboration helps improving project performance, and if people feel comfortable in providing each other feedback.

Often surveys include the options “do not know” or “not applicable” to increase data validity. This survey does not have this option, forcing people to provide an answer. Because of the background of this research and including practitioners on the project to provide feedback on the survey, the survey is developed to be applicable for the specific respondents. For this reason, not all people on the project are included in the data sample, only people working in the Hoofddorp office of Fluor involved in daily activities with a direct relation with their counterparts were included.

In the survey three control variables were added. First, the role of the person in the project, second the mood of a person, and finally their perception towards the relation between collaboration and project performance. The control variables are added based on team development research (Duhigg, 2016; Gallup, n.d.), which argues that happier employees are more successful and more positive towards a project. This is checked against the respondent’s ‘belief’ in collaboration. People not believing in collaboration might score lower on collaboration variables. The difference between management and team members is based on the fact that collaboration does not stop at management level but is done by the entire team (Bakker et al., 2018).

The external validity of this survey is very limited since it only uses data from the MAIN project during the SELECT phase with a limited sample size. Results can thus only be applied to this specific phase of the project and not be generalized to other projects or project phases. To increase the external validity more data must be gathered on other projects as well.

#### 6.1.5. Response bias

Bias of respondents can have a large impact on the validity of the data in self-report studies (Jupp, 2006). Self-report studies have as benefit that experiences of respondents can be measured without interference. However, this lack of interference can have some disadvantages. Participants might respond differently to put themselves in a good light or base their answer on other aspects than what is meant with the question (Garcia & Gustavson, 1997). To reduce desired answers, surveys are made anonymous and providing no incentives to fill in the survey.

Besides bias in the desirability of answers, data can also be biased due to weekly reports of results. As discussed in the workshop in chapter 4, it is important that the tool should provide sufficient feedback to maintain the engagement of all parties involved. With a weekly feedback to inform employees on the status of the project and collaboration (Figure 6.1). Secondly, a workshop is given after sufficient input is gathered to get a better understanding of the dynamics in the collected data. The goal of the workshop is to involve employees in discussing results and determine actions to improve or maintain identified elements. These actions are worked out, implemented and measured again, giving feedback on the effectiveness of these actions. Resulting in concrete actions and awareness of collaboration in the project, being able to continuously improve the collaboration. These actions might influence the perception of the respondents on the survey questions. Although data visualization is set up to minimize possible tracing back to corresponding questions, it cannot be excluded.

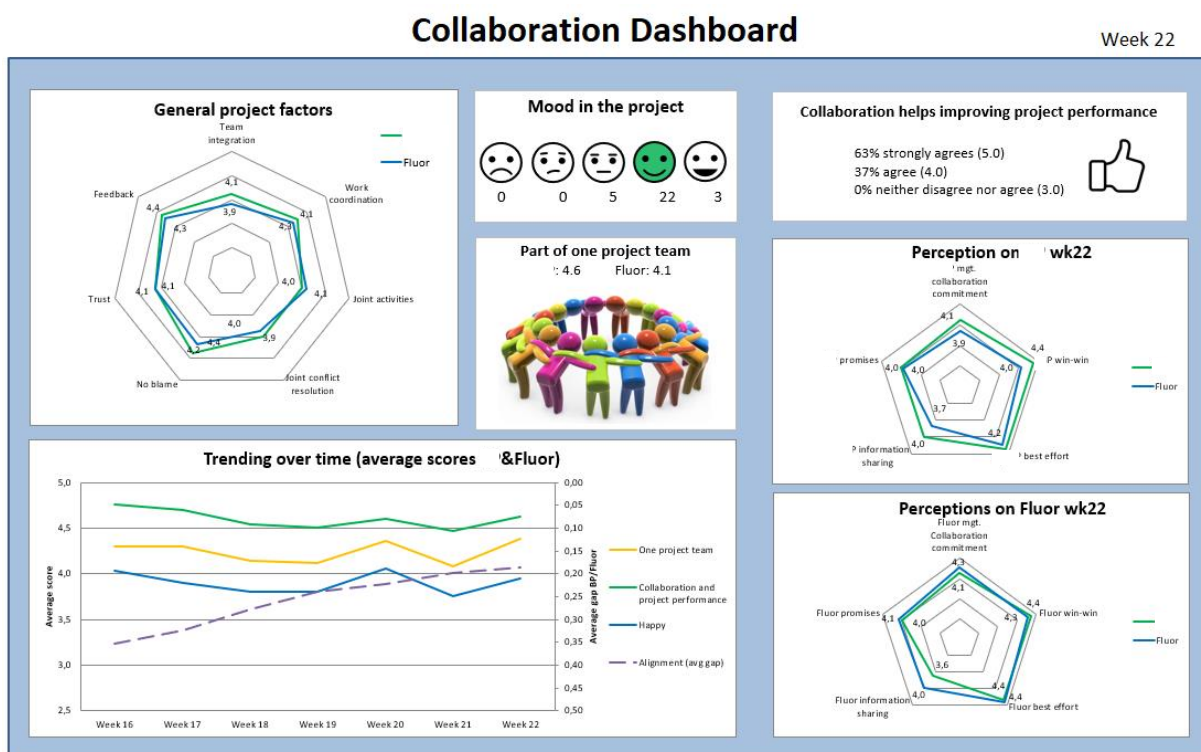


FIGURE 6.1: WEEKLY COLLABORATION DASHBOARD

## 6.2. Descriptive analysis

Descriptive analysis is the first step in further analysing the data. The goal of the descriptive analysis is to identify possible trends in the data which can be quantitatively tested. Identified trends are compared with results from the workshop on identifying and explaining the trends. Preliminary data analysis showed that the survey is a reliable way to assess collaboration, but due to the lack of significant correlations, results of the RECAP assessment cannot be confirmed. The hypotheses described above are first analysed descriptively and in chapter 6.4 a statistical analysis is performed on the data.

### 6.2.1. Trends over time

Trends over time are discussed, in the data is checked what the differences are in perception over time and between the different categories. The discussed differences have a delta  $\geq 0.3$  to look at significant differences. In a factor analysis a value  $> 0.4$  is considered significant, but to prevent possible causes to be overlooked, values  $> 0.3$  are checked and discussed (Field, 2018).

Over time team integration has the biggest change, from an average of 3.5 in week 1 to a 4.1 in week 7. Expected is that the amount of formal team integration would impact the feeling of being part of a project team. During the seven weeks no formal changes were made in terms of collaborative practices, but somehow formal team integration has been perceived to become more positive. Team integration, Work coordination, Client win-win and Client promises are second highest in change over the seven measured weeks.

Looking at the project variables, overall the scores increase, but with only a few variables increasing more than 0.3 over seven weeks, the average increase in scores is 0.2. While two months are not a long period for measuring differences, larger differences might be happening during longer periods of projects.

Until week 21, the client is on every variable more positive, or equally positive as Fluor. Starting with an average delta of 0.36 point, the client being more positive than Fluor. However, week 21, Fluor has become more positive about the collaboration than the client ( $\Delta -0.15$ ). Ending with an average delta of 0.1 in week 22, both parties' perception on the collaboration conversed strongly. Large differences ( $\geq 0.6$ ), occur mostly in week 16 and 17 on the client management collaboration commitment ( $\Delta 0.8$ ), Client win-win attitude ( $\Delta 0.9$ ), Client information sharing ( $\Delta 0.7$ ), and the feeling of being part of one project team ( $\Delta 0.7$ ), where the client rates itself higher than Fluor does.

Looking at the differences between week 16 and week 22, client's scores decreased in total 1.5 point, whereas Fluor's scores increased by almost 4 points. One of the biggest increases can be noticed in team integration ( $\Delta 0.50$ ), joint activities ( $\Delta 0.40$ ) and Client win-win attitude ( $\Delta 0.46$ ). The client's scores dropped the most in trust ( $\Delta -0.38$ ) and Fluor information sharing ( $\Delta -0.38$ ).

Week 18-19 is May holiday period, which may cause a more negative trend. Slightly higher scores are found in week 20, but these lower again in week 21 possibly due to ending of the SELECT phase and uncertainty of the bridging phase (see Figure 6.2).



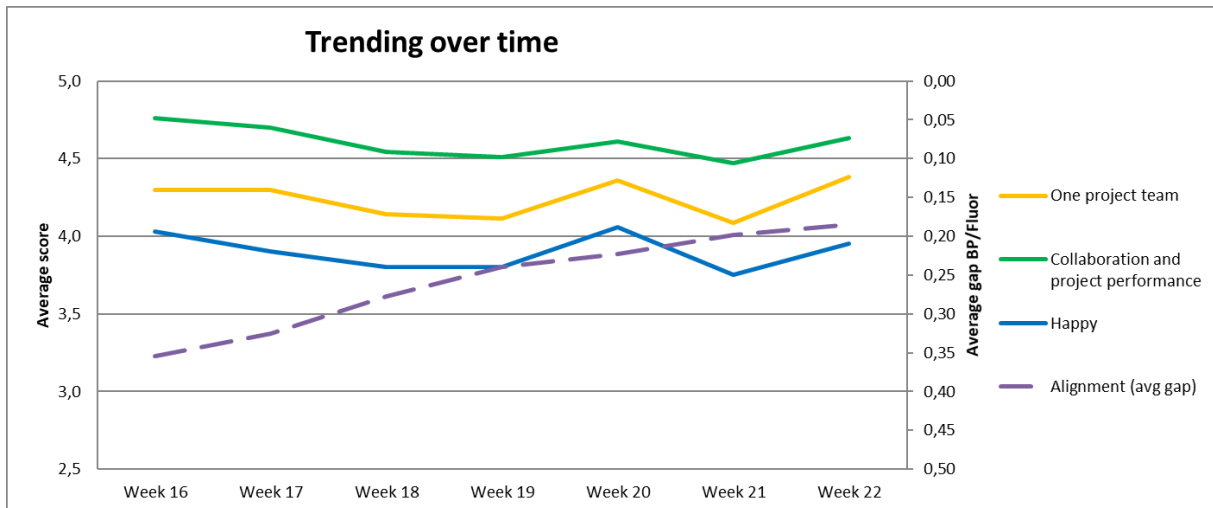


FIGURE 6.2: TRENDS OVER TIME

The standard deviation is calculated per respondent on the answers they provided per survey (see Figure 6.3). With an average standard deviation of 0.590 in week 1, and no respondent having a standard deviation of zero, data shows there is some variation in the answers given over the statements. Over the weeks the standard variation drops to 0.43 with five respondents ranking all questions a four, and one respondent rating all questions a five. Either the perception towards all variables converged, which seems highly doubtful, or some other explanation should explain the standard deviation to drop, such as a higher workload during that week (and less time to fill in the survey), decreasing willingness to fill in the survey, or another external reason. If the decrease in response standard deviation is due to survey tiredness, the frequency of measuring could be too frequent, or may feel less engaged during the measuring period.

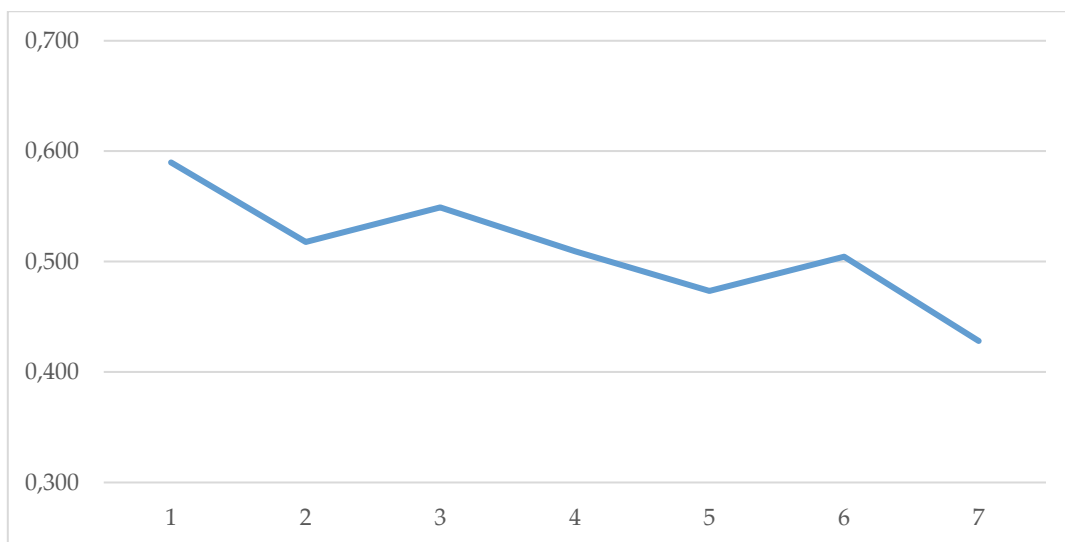


FIGURE 6.3: CHANGE IN RESPONSE VARIATION (N=227)

## 6.2.2. Measuring team members and management

As with the client mostly being more positive than Fluor over the measuring period with both parties growing closer near the end of the phase, the management team proves to be more positive on all variables over the entire measuring period. There is an inverse trend noticeable between the differences between the management team and team members, where the differences are getting bigger towards the end of the project. The only variable on which team members are more positive than the management team is on work coordination. A reason behind this could be that team members have more straightforward tasks and having less strategic decisions to be made simplifies work coordination. The management team has a more strategic level of working together which may frustrate good work coordination.

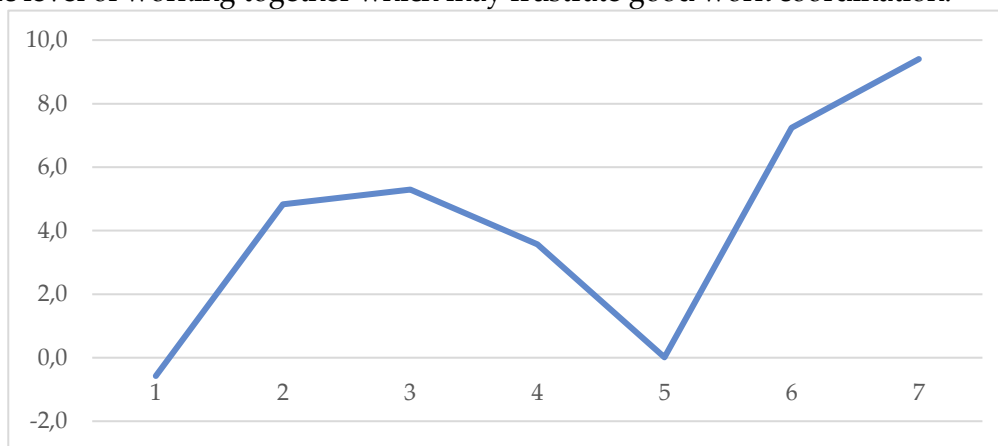


FIGURE 6.4: DIFFERENCES MANAGEMENT AND TEAM MEMBERS (N=227)

While differences between management and team seem to get better in week 20 (total difference =  $\Delta 0.01$ ), differences increase significantly in the final weeks of the project phase. This is mainly due to the management team becoming more positive and the team members becoming slightly more negative.

The biggest differences between the management team and team members can be noted on the feeling of being part of one project team ( $\Delta 3.3$ ), feedback ( $\Delta 3.0$ ), joint conflict resolution ( $\Delta 2.8$ ), happiness ( $\Delta 2.5$ ) and Client best effort ( $\Delta 2.5$ ). Differences between the management teams and team members are bigger than differences between the client and Fluor, so larger differences are expected in the statistical data analysis.

## 6.2.3. Other collaboration trends

Looking at the scores, it can be noted that the respondents score all statements high comparing with the results from Suprpto (2016) and Eggermont (2017). Overall highest ranking is the believe in collaboration (4.6). Second are the best effort of the client and Fluor, and the environment to give other project members feedback on their work (4.3).

Collaborative practices, shown by variables team integration, work coordination, joint activities and joint conflict resolution are among one of the lowest scores during the measurement period. With the lowest score given in week 1 on team integration (3.5), the project scores relatively high. Even though collaborative practices score low in this project, it

seems to have a low impact on the other variables. Besides a low score on collaborative practice, client information sharing (3.8), Fluor information sharing (3.9) and client promises (3.9) all score below 4.0. There is an especially big difference between the perception on client information sharing by the management teams and team members. Where in some cases differences of 0.7 are measured, where the management team was more positive than team members. This might be an indication that there was a poor distribution of information by the management teams concerning decision making and working processes of the client.

## 6.3. Statistical data analysis

Central to this statistical analysis are the six hypotheses described in chapter 5.1. The analysis is split into three categories, trends over time, differences between management and team, and other collaborative trends. The descriptive analysis provides direction towards expectations in the data. Further, choices for the tests are made and expected changes are discussed. When discussing the time related trends, it must be considered that the measuring period did not cover the entire SELECT phase (see Chapter 5.3).

### 6.4.1 Trends over time

**Hypothesis 1: Measuring collaboration regularly yields significant differences over time on all variables during a project;**

To identify changes over the weeks Friedman's ANOVA test is used. By comparing the weekly results of the variables over the seven weeks, it can be identified if there is a significant difference over time and how big that difference is. Based on results of the descriptive data analysis, biggest changes over the seven weeks occurred at team integration ( $\Delta$  0.50), joint activities ( $\Delta$ 0.40) and client win-win attitude ( $\Delta$ 0.46). The client's scores dropped the most in trust ( $\Delta$ -0.38) and Fluor information sharing( $\Delta$ -0.38). Therefore, it is expected that these variables will change significantly over time. For this analysis it is assumed that when  $p < 0.05$  a significant change in time is found.

Starting with team integration variable, using Friedman's ANOVA it can be concluded that the team integration did not significantly change ( $p = 0.246$ ) over the seven weeks of measuring (see Table 6.2). Joint activities did also not significantly change over the time period ( $p = 0.322$ ). client win-win ( $p = 0.581$ ) also did not change and neither did trust ( $p = 0.395$ ). Finally, Fluor information sharing did not change significantly as well (0.873). This indicates that there were no significant changes found on the variables with the biggest differences over the weeks. The lack in change can be explained by the close measuring interval. This test shows that while the differences over the week seem to be large, none of them can be considered significant when looking at the changes per week. It can be questioned if large differences per week are expected.

TABLE 6.2: CHANGES OVER TIME (N=227)

Variable	Test statistic ( $\chi^2(6)$ )	Significance (p)
Team integration	7.899	0.246
Joint activities	6.989	0.322
Client win-win	5.201	0.581
Trust	6.255	0.395
Fluor information sharing	2.460	0.873

To assure that there are no overlooked differences in the other variables, Friedman's ANOVA test is also performed on the rest of the variables. None of the variables proved to have changed significantly over the seven weeks. Possible causes could be that the measuring interval is too small to yield any differences. Another explanation could be that while results were weekly analysed and reported, no actions were taken to improve certain variables of collaboration during the measurement period.

#### Hypothesis 2: Collaboration between client and contractor changes over time;

Friedman's ANOVA proved none of the variables changed significantly during the seven measured weeks, indicating small differences per week. To test if the collaboration has changed over the entire measurement period, even though it might not be significantly, a Wilcoxon test is performed between week 1 and week 7, this might result in other scores than shown in Table 6.2. While no variables proved to be significant using the Friedman's ANOVA, using the Wilcoxon test 'Client promises' proved to have a significant change between week 1 and week 7 ( $r = 0.258$ ,  $p = 0.046$ ). Of the 20 variables, the score of four variables decreased, albeit minor (see Table 6.3). Overall, it can be argued that the collaboration did improve during the measurement period, though not significantly except for 'Client promises'.

TABLE 6.3: WILCOXON TEST RESULTS (N=227)

Variable	z-score	r-score	p-value
Happy	-0.185	-0.024	0.854
Team integration	1.842	0.238	<b>0.065</b>
Work coordination	0.619	0.080	0.536
Joint activities	1.87	0.241	<b>0.062</b>
Joint conflict resolution	1.435	0.185	0.151
No blame	0.557	0.072	0.577
Trust	-0.693	-0.089	0.488
Client mgt. collaboration commitment	-0.243	-0.031	0.808
Fluor mgt. collaboration commitment	0.277	0.036	0.782
Client win-win	1.744	0.225	0.081
Fluor win-win	1.706	0.220	0.088
Client best effort	1.031	0.133	0.302
Fluor best effort	1.057	0.136	0.29
Client information sharing	0.05	0.006	0.961
Fluor information sharing	0.175	0.023	0.861

Client promises	<b>1.995</b>	<b>0.258</b>	<b>0.046</b>
Fluor promises	1.264	0.163	0.206
Feedback	1.713	0.221	0.087
One project team	1.279	0.165	0.201
Collaboration and project performance	-0.775	-0.100	0.439

Hypothesis 3: **Alignment between client and contractor improves over time;**

To test whether the alignment between the client and Fluor improved, a Mann-Whitney test is performed on all variables from week 1 and week 7. Expected is that when alignment increases the differences in the variable distribution between both parties reduce (see Table 6.4). Week 7 is expected to have less significant differences between answers concerning the client and Fluor than week 1. The Mann-Whitney test confirms this hypothesis and shows that differences in the distribution in the data decreases significantly. Where in week 1 three significant variables can be noted, the significance decreased in week 7. For example, the most significant variable in week 1 is the client win-win attitude (0.002). The significance of this variable dropped to 0.298, indicating that there is no significant difference in the distribution of data between the client and Fluor on this variable.

TABLE 6.4: ALIGNMENT BETWEEN THE CLIENT AND FLUOR (N=227)

Variable	Week 1	Week 7
Happy	0.328	0.730
Team integration	0.06	0.565
Work coordination	0.896	0.867
Joint activities	0.205	0.765
Joint conflict resolution	0.402	0.765
No blame	0.25	0.629
Trust	0.113	0.801
Client mgt. Collaboration commitment	0.06	0.368
Fluor mgt. Collaboration commitment	0.703	0.534
Client win-win	<b>0.002</b>	0.298
Fluor win-win	0.068	0.730
Client best effort	0.073	0.662
Fluor best effort	0.453	0.909
Client information sharing	0.142	0.393
Fluor information sharing	0.436	0.320
Client promises	0.455	1.000
Fluor promises	0.788	0.730
Feedback	<b>0.039</b>	0.801
One project team	<b>0.003</b>	0.097
Collaboration and project performance	0.581	1.000

## 6.4.2 Measuring team members and management

**Hypothesis 4: There is a difference in perception on collaboration between the management team and team members;**

Using Mann-Whitney test, differences between client management, client team members, Fluor management and Fluor team members are analysed. With a  $p > 0.05$  the null hypothesis is retained, while a  $p < 0.05$  shows that there are significant differences between answers of respondents. While it is expected that all null hypotheses would be rejected due to the differences between the client and Fluor, and the differences between the management team and team members, the distribution of seven variables is not significantly different across any of the categories (see variables with  $p > 0.05$  in Table 6.5). There is no clear explanation why these seven variables do not vary between the respondents. Although, it can be noted that the variables team integration, work coordination and joint activities all belong to the collaborative practices dimension. In Chapter 4 is described that the collaborative practices score low in this project. With these practices limited present in the project, it could be a reason why no significant differences between all respondents are found.

TABLE 6.5: DISTRIBUTION OF VARIABLES (N=227)

	Null hypothesis	Significance	Decision
1	The distribution of "Happy" is the same across all respondents	0.002	Reject null hypothesis
2	The distribution of "Team integration" is the same across all respondents	0.056	Retain null hypothesis
3	The distribution of "Work coordination" is the same across all respondents	0.081	Retain null hypothesis
4	The distribution of "Joint activities" is the same across all respondents	0.305	Retain null hypothesis
5	The distribution of "Joint conflict resolution" is the same across all respondents	0.001	Reject null hypothesis
6	The distribution of "No blame" is the same across all respondents	0.001	Reject null hypothesis
7	The distribution of "Trust" is the same across all respondents	0.021	Reject null hypothesis
8	The distribution of "client mgt collaboration commitment" is the same across all respondents	0.000	Reject null hypothesis
9	The distribution of "Fluor mgt collaboration commitment" is the same across all respondents	0.002	Reject null hypothesis
10	The distribution of "client win-win" is the same across all respondents	0.000	Reject null hypothesis
11	The distribution of "Fluor win-win" is the same across all respondents	0.137	Retain null hypothesis
12	The distribution of "client best effort" is the same across all respondents	0.000	Reject null hypothesis
13	The distribution of "Fluor best effort" is the same across all respondents	0.001	Reject null hypothesis



14	The distribution of “client information sharing” is the same across all respondents	<b>0.001</b>	<b>Reject null hypothesis</b>
15	The distribution of “Fluor information sharing” is the same across all respondents	<b>0.025</b>	<b>Reject null hypothesis</b>
16	The distribution of “client promises” is the same across all respondents	0.065	Retain null hypothesis
17	The distribution of “Fluor promises” is the same across all respondents	0.056	Retain null hypothesis
18	The distribution of “Feedback” is the same across all respondents	<b>0.000</b>	<b>Reject null hypothesis</b>
19	The distribution of “One project team” is the same across all respondents	<b>0.000</b>	<b>Reject null hypothesis</b>
20	The distribution of “Collaboration and project performance” is the same across all respondents	0.073	Retain null hypothesis

Looking at what explains the distribution differences, the test is performed comparing the client and Fluor, and management and the team members. As shown in the figures below, the distribution of client win-win can be explained due to the differences between the client and Fluor. This was expected looking at the results from the descriptive analysis where an average difference of 0.4 is found, meaning the client scored on average 0.4 points higher than Fluor did. More differences in distribution are explained due the differences between the management team and team members than due to the differences between the client and Fluor.

While the differences of six variables can be explained due to the differences between the client and Fluor, only one variable (client win-win) can be fully explained to the difference between the client and Fluor (see Table 6.6). The reason for the difference can be explained because of the dependency of Fluor on the client. Fluor employees might expect or hope for a better win-win situation of the client. These differences are independent whether employees are managers or team members. Whereas the distinction between the management teams and team members cause differences on nine variables, of which four variables specific to the relation between management and team. While larger differences were expected between client and contractor due to different incentives and corporate cultures, evidence shows that there is a bigger gap between perceptions of the management teams and team members.

TABLE 6.6: LIST OF EXPLORATORY CATEGORIES (N=227)

Variable	P-values CLIENT-Fluor split	P-values management- team split
Happy	0.258	<b>0.000</b>
Joint conflict resolution	0.666	<b>0.000</b>
No blame	0.208	<b>0.049</b>
Trust	0.512	0.222
Client mgt. collaboration commitment	<b>0.000</b>	<b>0.037</b>
Fluor mgt. collaboration commitment	0.280	0.068
Client win-win	<b>0.000</b>	0.087

Client best effort	0.006	0.000
Fluor best effort	0.772	0.003
Client information sharing	0.001	0.019
Fluor information sharing	0.825	0.843
Feedback	0.004	0.000
One project team	0.000	0.000

The difference in variables ‘happy’, ‘joint conflict resolution’, ‘no blame’ and ‘Fluor best effort’ are explained due to the distinction between management and team. Why the team members differ significantly from the management team is unknown and should be further researched. There is no indication why a difference occurred between the management teams and team members on the variables shown below. Future research should aim to uncover the relationship between management teams and team members in relation with the collaborative variables used in this research.

Three variables shown in Table 6.6 (marked in red) are neither explained due to the difference between the client and Fluor, nor the difference between management and team members. A possible explanation for this occurrence is that the difference is caused due to differences between CLIENT managers and Fluor team members or Fluor managers and the client team members.

### 6.4.3 Other collaborative trends

Hypothesis 5: **The belief in collaboration yields affects scores in collaboration variables;**

For this test Kendall’s tau is used. While Spearman’s coefficient is a more popular choice, Field (2018) suggest when having a relatively small dataset with a large number of tied ranks, Kendall’s tau should be used. As shown in Table 6.7, the belief that collaboration increases project performance has a correlation with all variables except with joint conflict resolution ( $p = 0.698$ ). To interpret the correlations, Field’s (2018) categorization is used whereby  $\pm 0.1$  represents a small effect,  $\pm 0.3$  is a medium effect and  $\pm 0.5$  is a large effect. As analysis shows, all variables are positively correlated with the belief in collaboration. This correlation is most noticeable in the feeling of being part of one project team (0.446), the atmosphere of trust (0.432), feedback (0.420), Fluor management collaboration commitment (0.411) and Fluor best effort (0.411). Interestingly, the belief in collaboration is lower correlated with perceptions concerning the client than Fluor, whereby most client related correlations can even be considered medium-small. This could be due to the big group of Fluor team members, where a higher score in collaboration corresponds with a higher score on Fluor variables. This could explain why all Fluor related questions correlate higher with the belief in collaboration than the client related questions.

TABLE 6.7: EFFECT OF BELIEF IN COLLABORATION (N=227)

Variable	Correlation Coefficient	Sig. (2-tailed)
Happy	.238**	0.000
Team integration	.241**	0.000
Work coordination	.320**	0.000
Joint activities	.218**	0.001
Joint conflict resolution	.024	0.698
No blame	.330**	0.000
Trust	<b>.432**</b>	0.000
CLIENT mgt. Collaboration commitment	.310**	0.000
Fluor mgt. Collaboration commitment	<b>.411**</b>	0.000
CLIENT win-win	.220**	0.000
Fluor win-win	.309**	0.000
CLIENT best effort	.272**	0.000
Fluor best effort	<b>.411**</b>	0.000
CLIENT information sharing	.351**	0.000
Fluor information sharing	.393**	0.000
CLIENT promises	.172**	0.007
Fluor promises	.320**	0.000
Feedback	<b>.420**</b>	0.000
One project team	<b>.446**</b>	0.000

\*\*Correlation is significant at the 0.01 level; \*Correlation is significant at the 0.05 level

#### Hypothesis 6: **The work environment affects scores on collaboration quality.**

To check whether this hypothesis is true a correlation test is performed. Just as with hypothesis 5, Kendall's tau is used to calculate correlations due to the limited sample size and the large number of tied ranks (Field, 2018). For this analysis it is checked whether a better work environment is positively correlated with all collaboration variables. This is measured by the correlation between the variables "no blame", "trust" and "feedback". The correlations between these three variables and all other variables are significant ( $p < 0.01$ ). As seen in the table below, all three variables correlate relatively high with all other variables. In Table 6.8 correlations are bold when correlation level on all three variables is higher than 0.4 or when the variable correlation is higher than 0.5.

TABLE 6.8: THE EFFECT OF A GOOD WORK ENVIRONMENT (N=227)

Variable	No blame	Trust	Feedback
Happy	.282**	.269**	.278**
Team integration	<b>.419**</b>	<b>.495**</b>	<b>.406**</b>
Work coordination	.282**	.308**	.379**
Joint activities	.209**	.226**	.317**
Joint conflict resolution	.406**	.247**	.297**
No blame	1	<b>.584**</b>	.354**
Trust	<b>.584**</b>	1	<b>.455**</b>
Client mgt. collaboration commitment	.477**	.489**	.362**
Fluor mgt. collaboration commitment	.343**	.330**	.290**
Client win-win	<b>.461**</b>	<b>.448**</b>	<b>.416**</b>
Fluor win-win	.312**	.305**	.405**
Client best effort	.294**	.329**	.470**
Fluor best effort	.385**	.399**	.460**
Client information sharing	.390**	.472**	.432**
Fluor information sharing	.287**	.381**	.379**
Client promises	<b>.432**</b>	<b>.427**</b>	<b>.481**</b>
Fluor promises	<b>.426**</b>	<b>.445**</b>	<b>.410**</b>
Feedback	.354**	.455**	1
One project team	<b>.448**</b>	<b>.496**</b>	<b>.562**</b>
Collaboration and project performance	.330**	.432**	.420**

#### 6.4.4. Recap on hypotheses

The goal of the hypotheses is to provide evidence of collaborative trends. The trends are divided into three categories, time-related trends, management and team members, and other collaborative trends. As shown in Table 6.9, 4 out of 6 hypotheses are accepted. There is little evidence that the collaboration variables changed over the measured period. This could be due to the limited amount of collaboration interventions during the measuring period. The collaboration between the client and Fluor slightly increased. While 16 out of 20 variables improved, only the client promises improved significantly. When measuring for a longer period results might get significant, so while little evidence is found concerning changes over time, this research cannot exclude that there are no differences.

The difference between management and team members is bigger than anticipated. Whereas the differences between client and contractor got smaller, while the differences between management and team members got bigger over time, especially towards the end of the phase. Due to uncertainties relating to continuing work and non-transparency of decisions, the gap between both parties became bigger.

TABLE 6.9: HYPOTHESES RESULTS

Hypothesis #	Rejected/not rejected	Reason
1	Rejected	No significant changes per week could be identified
2	Partially accepted	While change was not significant, 16 out of 20 variables improved over the seven weeks albeit one significant and 2 almost significant ( $p < 0.1$ )
3	Accepted	With several significant differences in week 1 and no significant differences in week 7, alignment improved.
4	Accepted	Majority of the differences in the data proved to be due to the difference between management and the team
5	Accepted	A higher belief in collaboration positively correlates with 19 out of 20 variables.
6	Accepted	All variables correlate positively with feedback, trust and no blame, indicating that a better work environment is positively related to collaboration variables.

Finally, hypotheses 5 and 6 are both accepted. A higher belief in collaboration increases the scores of all other variables. Interestingly, a higher belief in collaboration only has a strong relationship with Fluor mgt. collaboration commitment and Fluor best effort, and not with their corresponding the client counterpart. The better work environment correlates with all other variables in the tool. The confirmed hypotheses show that there is a need for measuring collaboration regularly instead of statically.

#### 6.4. Workshop explaining trends

To get a better understanding of the results and collaborative trends, project members were asked to identify trends and causes of these trends. During the workshop 30 people attended of which 7 from the client (3 managers, 4 team members) and 23 from Fluor (5 managers, 18 team members). This is a good representation of respondents of the survey. The workshop was divided into four rounds in which participants needed to identify trends, give a cause of the trend, set a goal, and identify what is necessary to achieve that goal.

The group was able to identify trends based on the data presented, such as the increasing alignment between both parties. While both parties get more aligned, participants mentioned that it is more due to the client getting more negative than Fluor more positive. Reasons were that the 'honeymoon phase' is over, indicating that while in the beginning of the phase the client had a too positive image of the collaboration in the project. After several weeks, the client got a better perception of the collaboration in the project, decreasing the scores a bit. This can be compared to the stages of group development by Tuckman (1965) where in the beginning of this project phase the group was still in the 'forming' phase, a phase in which both parties are polite to each other in trying to get to know each other. When this forming part is over, the group shifts into the 'storming', 'norming' and 'performing' phase in which the reality of the project is getting clearer (Tuckman, 1965). Another factor in this is that Fluor has more experience working with other parties than the client does, so could explain the positive

attitude of the client. One also often mentioned aspect was the non-transparency of the client procedures. People had no idea what was happening behind the curtains, which led to uncertainty and miscommunication.

Trends near the end of the phase were explained also due to the uncertainties and transitioning to the bridging phase. While the initial plan was to keep as many current team members on board the project to minimize knowledge loss, it eventually became clear that there was not sufficient budget to maintain this. Unclear communication led to more uncertainty on what the goal of the bridging period was.

One of the most mentioned trends is the alignment and mutual understanding between the client and Fluor. This can be seen in Figure 6.2, where alignment between both parties increased steadily. Reason for this alignment is the colocation and frequent joint meetings and review sessions between the client and Fluor.

## 6.5. Conclusion

Preliminary data analysis showed that the survey proves to be a reliable way to assess collaboration as defined in the three discussed frameworks in chapter 3. Descriptive analysis and statistical data analysis show that 4 out of 6 hypotheses are accepted. Although, expected changes over time proved not significant, 16 out of 20 variables increased in score over the seven measured weeks, partially confirming the hypothesis. It can therefore not be excluded that there are no changes over time. Taking the hypotheses results into account, sub-question 4: *“What collaborative trends can be measured?”* can be answered. While no statistical evidence is found for measuring over time, the tool is able to identify trends on inter- and intra-organizational collaboration, the effect of a good work environment and the effect of the belief in collaboration.

Changes can be measured, although possibly due to the lack of collaboration interventions and the relatively short measuring period, few significant changes over time are found. Sub-question 5: *“How should a tool be implemented in a project to measure collaboration and trends?”* is answered based on the following. With limited evidence showing that there are significant differences using a weekly measuring interval, future implementation should consider using an interval depending on the amount of interventions during the project and the length of the project. This is supported by the decrease in variance in answers over the seven weeks indicating that people were less reluctant to participate in this research or did not have the time for it. Besides the interval, employees mentioned that feedback sessions are necessary in order to improve on collaboration. Whereas the paper surveys resulted in a very high response rate, the method used was time consuming, which might not be feasible in larger project teams without someone dedicated to collecting data.



## 7. DISCUSSION

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The findings of this research are discussed on the theoretical contribution and the practical contribution. In the theoretical contribution, the discussion is split into two different aspects: the contribution of the literature findings to the current collaboration literature and the impact of the data results. The practical contribution puts the results of the data analysis more in project context, discussing the impact of measuring collaboration regularly in a project.

### 7.1. Action research

During this research an action research approach is used to combine the theoretical and practical contributions in this research (Azhar et al. 2010). Action research has several advantages and disadvantages, while it can increase mutual understanding about the research between the researcher and the project team, the researcher does intervene in problem setting in the project (Azhar et al. 2010). Involvement of the researcher, however, does have an impact of the results gathered possibly harming the validity of the research (Eden & Huxham, 1996). In this research, the researcher took part in daily meetings and weekly results about the progress was reported to the project team. The benefit of participating in the meeting and gaining insight in measuring collaboration through workshops provided input which could not have been gained any other way.

Validity of the data, however, does play a role in action research (Aguinis, 1993). When used in traditional experimental researches, action research would be inappropriate to use (Eden & Huxham, 1996). Eden & Huxham (1996) argue that the main concern relating to validity is about the external validity, whether the results can be justified as a representation of a claimed situation. With intervention of the researcher it cannot be excluded that the external validation is guaranteed. Taken this into account, further research should be done towards the validity of the ACT tool, although the tool could not have been designed without the input of participants during this research.

### 7.2. Theoretical contribution

This thesis contributes to collaboration literature in the following ways: 1) it offers a critical assessment of several collaboration frameworks and collaboration measurement tools, 2) it provides a way to measure collaboration on a frequent basis, 3) it provides empirical evidence that there is a difference in perception towards collaboration on a project between the management team and team members therefore collaboration has to be measured not only between client and contractor, but also taking into consideration the management level.

#### 7.1.1. Collaboration frameworks

Nowadays, there is increasing attention for collaboration in projects, however it seems that while in some cases collaboration has been proven successful, there is no uniform manual on how to establish a good collaboration. Companies are often willing to adopt collaborative practices such as partnering or using integrated teams, but they often don't know what this means for managing the project (Baiden and Price, 2011). One of the possible reasons could be

that companies often don't know what a good collaboration encompasses and how to achieve it. In analysing three collaborative frameworks, there still is a difference in what elements are part of collaboration and what definition of collaboration is used, particular in client-contractor relationships.

This research uses the definition of client-contractor collaboration based on the RECAP assessment model in which collaboration is defined as *“a process in which owner and contractor jointly create norms, rules, and structures governing their teams, their working relationships, and ways to act or decide on the issues emerging during the course of a project, in order to bring about mutually satisfactory project outcomes”* (Suprpto, 2016; p. 114). While this definition focuses more on the social side of collaboration, there is less emphasis on the formal side, such as contracts, in collaboration.

The research is a follow up research on the research by Suprpto (2016) and modified the RECAP tool in order to measure collaboration more frequently. Being a follow up research, this research is heavily influenced by the RECAP assessment tool in design choices, questions used and direction of theory. Besides, this research has used two other collaborative frameworks in order to assess the theoretical framework by Suprpto (2016) (Thomson, 2007; Dietrich, 2011). By comparing different frameworks, a more universal and widely accepted framework of collaboration can be defined.

This research agrees with Gray and Wood (1991) to develop a clear understanding of the collaboration concept to build a bridge between literature and implementation. At the moment, there is no clear understanding of how collaboration develops over time. This research provides a first step in assessing collaboration over time. Based on the frameworks five essential collaboration elements are defined: communication, mutual support, aligned effort, cohesion and trust. To take a next step in assessing client-contractor collaboration, the five identified elements should be considered in a client-contractor collaboration.

### 7.1.2. Reflection on the hypotheses

To show the presence of trends in client-contractor collaboration, six hypotheses have been developed. The hypotheses are divided in three categories, time related trends, differences between management and team members, and other trends. Despite the fact 4 out of the six hypotheses were not rejected, the limited data sample and limited external validity it is premature to say that the hypotheses can be fully accepted. The hypotheses did show that some trends could be identified in the data, however, time related trends were only found by comparing week 1 and week 7.

Using the hypotheses, it can be concluded that alignment did improve over time, differences in the data are mostly explained by the differences between management and team members, and the control variables have an impact on the data, the most important aspect concerning the improvement of collaboration over time cannot be accepted. More longitudinal research should be done to exactly investigate how collaborations develop over time and what the impact of events, like deadlines or team development activities, is on collaboration. One of the most important findings of this research is the found gap between the management teams and team members, this is further discussed in Chapter 7.1.4.

Hypotheses 5, regarding the belief in collaboration, and hypotheses 6, concerning the work environment are used as control variables for the collaboration. Thomson (2006) argues that the belief and commitment in collaboration are cornerstones of the process framework of collaboration. A higher commitment to collaboration helps the implementation of collaboration in the organization. When there is a lack of commitment, Thomson (2006) claims that joint decision making becomes unlikely. While no negative relations have been found in this research, a positive relation is found between the belief in collaboration and the other variables, of which joint work coordination, joint activities and joint conflict resolution.

The presence of a good work environment is beneficial for many things, such as creativity, job satisfaction, project performance and employee health (Jain & Kaur, 2014; Amabile et al., 1996; Ilmarinen, 2009). Besides these benefits, this data proved that the presence of a good working environment is also beneficial for the collaboration in a project. A good work environment is measured by looking at the effects of the variables 'feedback', 'trust' and 'no blame'. These variables contribute to an environment in which employees are able to speak out without negative consequences. Comparing these elements to the research by Amabile et al. (1996), the positive effects of feedback, trust and no blame contribute to supervisory encouragement and work group encouragement in which supervisors and fellow employees stimulate each other to collaborate on the project. Although, there is literature mentioning that a good work environment is positively related to job satisfaction and happiness of an employee, this relation could not be established in this research. Neither of the three 'work environment' variables are significantly correlated with the happiness of respondents.

### 7.1.3. Dynamic measure collaboration

This tool to measure collaboration is one of the first ways to assess collaboration more dynamically than current tools. Because it is the first tool in assessing collaboration frequently there is no dynamic reference material to compare the results of the tool with. Study results are compared with static results from the RECAP. While the results are logical in comparison with the first RECAP assessment, no further check of the data is possible. Since the tool is only tested in a small project team environment compared to other project (phases) and not validated with multiple projects, results can only be viewed in context of this particular project and not used to improve project elsewhere. To be able to use this survey in a wider context, it must be used in more projects and a database must be built up to analyse and compare the data over a variety of projects.

This tool is the first in assessing collaboration on a regular basis. Evidence showed that the tool is able to identify several trends. Trends related to the changes over time were not significant, however this does not imply that there are no changes over time. Changes were expected based on outcomes of the workshop on identifying trends. As discussed in Chapter 5.3, the measured period does not consist of the entire SELECT phase. Trends could have already taken place and different effects could have been measured when considering the entire SELECT phase.

With the entire team working together since January 2019, changes were expected based on Tuckman's model of group development (Tuckman, 1965). It is possible that some phases in the group development already took place in the period before start of the measurement.

When comparing week 1 and week 7, trends such as the difference in perception on collaboration between the management team and team members did prove to be significant, as well as the effect of a work environment and the belief in collaboration. Being able to measure more dynamically, identified elements of collaboration such as collaborative practices and team working quality can now be measured over time. Where Suprpto (2016) mentions that team working quality is the only category impacting project performance, it can now be shown when these elements of collaboration matters most.

#### 7.1.4. Difference between management and team members

Statistical analysis provides empirical evidence that there is a significant difference between the management team and team members on the project. While differently anticipated due to cultural and organisational differences, the difference between the management team and team members is larger than the difference between the client and Fluor.

The differences between the management and team members can be explained due to the differences in work. With limited risks present during the SELECT phase, differences are more likely resulting from the selective sharing of information by the management teams to the team members during the project and the feedback received on the work done (Nancarrow, et al. 2013). Whereas team members are more responsible for making sure work is finished at milestones, managers are responsible for developing strategies. This difference between steering and executing work can cause differences in perception between managers and team members. Literature concerning empowerment of team members shows that teams with more responsibilities and decision power creates better performing teams and decreases the gap between the management teams and team members (Seibert, Wang & Courtright, 2011).

## 7.2. Practical contribution

The practical contribution discusses the impact of the data on future collaborations between client and contractor. The practical contribution is divided into three parts, the theoretical framework findings to use in future collaborations. Secondly, the effects of dynamic measurements of collaboration. Finally, implications of the differences in perception towards collaboration between the management teams and team members.

### 7.2.1. Collaboration frameworks

There is plenty of literature concerning collaboration. However, there is also a lot of ambiguity in the results of literature making it difficult to implement advices in projects. Literature study shows that collaboration in projects is mainly related to social aspects of projects, such as communication, mutual support, aligned effort, cohesion and trust. For this reason the definition of Suprpto (2016) is used, collaboration is *“a process in which owner and contractor jointly create norms, rules, and structures governing their teams, their working relationships, and ways to act or decide on the issues emerging during the course of a project, in order to bring about mutually satisfactory project outcomes”* (Supapto, 2016).

A relation with more formal practices such as collaborative practices exists but are not sufficient in order to achieve good collaboration (Thomson, 2007; Suprpto, 2016). Formal practices do help in creating a fruitful environment in which collaboration is able to flourish. When implementing collaboration in future projects, the focus should lie on communication, mutual support, aligned effort, cohesion and trust. These five critical elements are, as the name suggest, essential in establishing a good collaboration.

### 7.2.2. Measuring collaboration

Measuring collaboration provided an indication of how the project developed. With three trends identified, projects can be better steered on collaboration than before. Over time alignment improved marginally, but due to the absence of feedback sessions and interventions it can be doubted whether big changes would be visible. A newly introduced aspect of the tool was the ability to get a better view on how both parties were perceived by the other party and how they perceived themselves. Results showed that differences were larger on the perception about the client than Fluor. This could be due to the fact that the client perceived themselves to be better in sharing information and keeping promises than Fluor did. This information can be useful to identify differences and prevent irritations due to misalignment.

Alignment between both parties grew over time. Though no team development sessions were held during the measurement period, alignment slightly improved anyway. A clarifying factor could be that because of the colocation of both parties, employees of both the client and Fluor got to know each other also on a more personal level. Besides the differences between the client and Fluor, the measurement showed that the work environment has a significant impact on the collaboration. Colocation could enforce this effect because the work environment then not only has effect on Fluor employees, but also the client employees.

Concluding, the tool provides more insight in collaboration processes and shows different views on alignment and collaboration quality. Not only high levels of collaboration are desired, alignment between both parties also positively influences the collaboration within projects. The tool should be further implemented to get a deeper understanding of collaboration processes and providing input for managers to improve the collaboration on the project on different levels.

### 7.2.3. Difference between management and team members

This study proved that there are significant differences between management and team. The study started from the client-contractor viewpoint in order to increase collaboration between both parties. Results of this research showed that there are bigger differences between the management teams and team members than between the client and contractor. It is important to look at both the inter- and intra-organizational collaboration results in improving collaboration. Workshops and feedback moments can help providing insight in improving collaboration between both parties and within companies.

Collaboration literature explaining the difference is scarce, but Zonneveld (2018) noticed also a difference between management and team members. While the management team had the best intentions to improve collaboration, differences in attitudes caused problems. Team

members felt unheard due to non-transparent working processes and due to the way the management team enforced their initiatives, a resistance grew to these initiatives (Zonneveld, 2018).

While there is proof of better performing teams when given more responsibility and resources, team members were not given more responsibilities and resources than usual. Empowerment of team members could positively contribute to project performance. The difference between the management teams and team members is rarely mentioned in collaboration literature, but this research provides evidence of a gap present between the two parties affecting the collaboration performance. At the same time, this research does not provide an explanation for the results.



## 8. CONCLUSION

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In this chapter the main research question is answered: *“How can collaborative trends be identified in a project?”*. First, the five sub-questions are discussed and finally the main research question is answered and limitations of this research are mentioned.

### 8.1. Answers on sub-questions

An answer on the following sub-questions is formulated:

#### Sub-question 1: **“What are critical elements of collaboration?”**

The five critical elements of collaboration are: communication, mutual support, aligned effort, cohesion and trust. This is based on the definition is chosen of collaboration defined by Suprpto (2016): *“a process in which owner and contractor jointly create norms, rules, and structures governing their teams, their working relationships, and ways to act or decide on the issues emerging during the course of a project, in order to bring about mutually satisfactory project outcomes”*. Focusing on human interactions, joint mechanisms, and team structures, a more social side of collaboration is explored. Considered this definition, three different collaboration frameworks are compared. The collaboration quality framework by Thomson, the RECAP by Suprpto and knowledge integration framework by Dietrich, comparing formal and informal forms of collaboration.

To scope this research and deal with the limitations of resources and time, it is chosen to adapt a current method measuring collaboration. To do this, several existing collaboration tools are compared and checked against the critical elements defined above. Currently no tool is known which measures collaboration on a regular basis. Based on the comparison with the five critical elements, the RECAP assessment is chosen to further develop to measure collaborative trends. While the RECAP assessment is able to measure collaboration statically, the RECAP assessment is further analysed and implemented to see the RECAP is also able to measure collaborative trends. This leads to the next sub-question:

#### Sub-question 2: **“What are the criteria for a tool to measure collaborative trends?”**

Having chosen the RECAP assessment, the method is first implemented without adaptations to identify shortcomings and good aspects. The baseline measurement showed that there is a difference in how the management team filled in the survey and how the team members did. Due to the focus of the RECAP on the management team, several questions were too complex and/or not relevant to team members causing many questions which could not be answered. Workshop on the RECAP assessment showed five important aspects of measuring regularly: the frequency of measuring, the length of the survey, time willing to invest, complexity of questions, relevance of questions for the entire team. While a survey is the easiest and least time-consuming way to gather input, a clear feedback cycle is necessary to maintain engagement. To keep engagement of participants high, weekly feedback is provided using a collaboration dashboard and a workshop is given to include the team’s perspective on

collaboration. With criteria identified, the RECAP questions are reduced and made fit for the entire team. Continuing with the following sub-question:

**Sub-question 3: “How can collaborative elements be measured in a project team environment?”**

Central to this question are four corner stones, the identified critical elements, the frequency of measuring, the length of the survey, and the complexity of the questions. Important changes are the reduction of the number of questions from 72 to 20. For this it is chosen to focus only on relational attitudes, collaborative practices, and team working quality based on the workshop evaluating the RECAP assessment. To make the RECAP statements/questions also more applicable for team members, the statements have been changed and simplified. By clarifying and reducing the number of questions, the RECAP assessment is adapted to be able to measure collaborative trends by measuring frequently. The interval of this measurement is set to be weekly to be able to gather enough data during the SELECT phase.

The goal of this research is to identify collaborative trends. However, few sources describe the development of collaboration aspects over time. While there is a suspicion based on Tuckmann’s stages of team development that collaboration changes over time, no empirical evidence is showing this, leading to the following sub-question:

**Sub-question 4: “What collaborative trends can be measured?”**

A reliability analysis showed that the tool proves to be a reliable way to assess collaboration as defined in the three discussed frameworks in chapter 3. Descriptive analysis and statistical data analysis show that 4 out of 6 hypotheses are accepted. 16 out of 20 variables increased in score comparing week 1 and week 7. It can therefore be concluded that there are changes over time on at least 16 out of the 20 variables, but weekly measurement during the SELECT phase did not show much significant changes per week.

Whereas the differences in perception on collaboration between client and contractor got smaller, while the differences between management and team members got bigger over time, especially towards the end of the phase. Due to uncertainties relating to continuing work and non-transparency of decisions, the gap between both parties became bigger. Finally, the belief in collaboration and the effect of the work environment proved to be both impacting the collaboration variables. A higher belief in collaboration increases the scores of all other variables. Interestingly, a higher belief in collaboration only has a strong relationship with Fluor mgt. collaboration commitment and Fluor best effort, and not with their corresponding client counterpart. The better work environment correlates with all other variables in the tool.

Taking the hypotheses into account, sub-question 4 can be answered. While no statistical evidence is found for measuring using a weekly interval, changes are measured using a larger interval. In addition, the tool is able to identify trends on inter- and intra-organizational collaboration, the effect of a good work environment and the effect of the belief in collaboration. The confirmed hypotheses show that collaboration changes over time. Static measurements might not be sufficient to understand the underlying time dynamics of collaboration, so it is advised to measure more regularly.

### Sub-question 5: **“How should a tool be implemented in a project to measure collaboration and trends?”**

Results showed that there are significant no differences using a weekly measuring interval, future implementation should consider using an interval depending on the amount of interventions during the project and the length of the project, since significant changes were found comparing week 1 and week 7. This is supported by the decrease in variance in answers over the seven weeks indicating that people became less reluctant over time to participate in this research or did not have the time for it. Besides the interval, employees mentioned that feedback sessions are necessary in order to improve on collaboration. Whereas the paper surveys resulted in a very high response rate, the method used was time consuming, which might not be feasible in larger project teams without someone dedicated to collecting data.

## 8.2. Answering the main research question

This research tries to provide a first direction in measuring collaborative trends. By being able to measure collaborative trends, more research can be done towards the effects of events and the timing of collaborative practices to implement in projects. This is done by providing an answer on the main research question:

### **“How can collaborative trends be identified in a project?”**

The RECAP assessment tool proved to be an elaborate tool to assess the collaboration quality on a project. However, the main issue in using the tool more frequently is the large amount of questions. By reducing the number of questions of the RECAP and making them more comprehensible for both managers and team members, the ACT tool is developed. The ACT tool measures collaborative practices, relational attitudes and team working quality over time using 20 variables. An added dimension in assessing the client and Fluor differently proved a useful dimension in assessing the alignment of both parties in terms of collaboration. By discussing the results of the tool during a workshop, joint action points are formulated to maintain and improve the collaboration quality.

One of the starting points of this research is that collaboration is an often-underestimated topic where companies are searching on how to implement it right. This survey is a first step in evaluating collaborations more frequently making it possible to identify variables impacting the collaboration and their effect over time. This tool is able to provide direct feedback to managers and team members on collaboration on the project and showing areas of improvement.

Statistical data analyses proved that the tool is able to measure several collaborative trends during the SELECT phase of the project. Time related trends as well as non-time related trends can be identified using the ACT tool. Evidence shows that while no significant changes over have been measured using a weekly interval, the collaboration did improve when comparing data from week 1 and week 7. During the seven weeks the client and Fluor became more aligned in their perceptions towards collaboration, showing that both parties achieved a better

mutual understanding of the collaboration between both parties. Larger differences have been found in the between the management teams and team members, where the management teams were always more positive towards the collaboration than team members. Especially towards the ending of the SELECT phase differences became bigger.

The tool can be used for any project with a client-contractor relationship. When there are multiple (sub-)contractors involved in a project, the survey should be adapted to include them in the mirroring questions. The mirroring questions are useful to identify gaps between client and contractor in the beginning of a collaboration and aligning both parties in mutual understanding and expectations. In more advanced collaborations, questions could be changed to “one team” instead of the difference between client and contractor. The questions have been developed specific to this project in terms of applicability. When used on other projects without colocation or direct use of counterparts the option of “Not applicable” or “Do not know” should be included to remain a high reliability of the responses.

### 8.3. Limitations of research

As mentioned in chapter 5, the external validity is low. With data gathered only in the MAIN project during the SELECT phase from April to the end of May, a limited data sample is gathered. During the measurement period multiple people joined the project during week 1-3 and de-staffing during the project in the final weeks of the project phase could have impacted the measurement results. Measurement also does not contain the full SELECT period, therefore no recommendations can be made before the measurement. During the measuring period, the author was involved in daily meetings and data based on the filled in surveys were promptly analysed and made available the following week. It cannot be excluded that because of measuring collaboration with this intensity, that the results are influenced by the author as discussed in Chapter 7.1.2. The data cannot be used as a clean data sample and with a workshop analysing the trends during week 20, survey results could have been impacted by this in the following weeks. By being present on the project, the dataset has already been influencing the outcome of this research.

A drawback of the survey is the cross-sectional design for measuring both independent as dependent variables in the same survey. There are two issues related with this in relation with establishing causality. First due to measuring both independent and dependent variables through the same survey, correlations among variables could be biased since there is one person assessing all variables at once (Podsakoff et al., 2003). Secondly, causality cannot be tested using a cross-sectional design for gathering data. These issues can be resolved by assessing both variables using a time-lagged design for gathering data, using two different surveys to collect the data (Krishnan, Martin & Noorderhaven, 2006).

During this research the focus lied on collaboration, other project related effects not considered. Therefore, it is not possible to assess the effect of collaboration on project performance. By adding more project performance variables, it can also be assessed what the effect is of for example implementing collaborative practices early on, or only later in a project when there is a need for. The mirroring questions between the client and Fluor are particularly useful in earlier collaborations, when both parties have to get accustomed to each other. The

questions make it possible to identify perception gaps and misalignment, however in further developed collaborations, questions should be changed towards the performance of the team, not differentiate between the client and Fluor.

## 8.4. Recommendations for future research

Still little is known how collaboration develops over time and what variables are more important in the beginning or end of a project. This research proved the presence of trends in a client-contractor collaboration, however further research is needed to assess how collaboration develops over a longer time period and the effect of external events on the collaboration. Furthermore, only a select number of variables are chosen to include in this tool. This research focused only on collaboration variables and did not measure project performance or included the type of contract. In addition, a choice is made to split a number of statements into client related questions and contractor related questions in order to assess the alignment between both parties. Future research should perform criticality analyses to evaluate if all chosen variables are contributing to measuring collaborative trends.

To further develop the tool, more data should be gathered by implementing the tool in future projects and project phases. Also, to establish correlations and causality between dependent and independent variables, separate measurements should be used. In order to benchmark different projects based on the gathered data it is recommended to keep the changes to the survey to a minimum and implement changes before implementing the tool on a larger scale. The frequency of measuring should be adapted to the type of project and the amount of expected changes. In a beginning collaboration the frequency of measuring could start with a weekly or biweekly frequency in order to identify changes in collaboration. When the project proceeds to a more standard way of working with fewer changes a lower frequency of measuring could be used. The researcher should be weary of a decrease in standard deviation over the responses per survey. Responses can be kept high by involving respondents in the research and use results to improve the collaboration.

## 8.5. Practical recommendations

There are several practical recommendations to take into consideration for the client and Fluor for future projects.

- Using the ACT tool, it is important to act on the data gathered. Frequent feedback sessions should be planned in advance to be able to formulate a strategic plan to improve the collaboration during the project. In addition, action points can be better monitored and the focus per measuring point can be determined in combination with the focus of the survey on which questions to use. Measuring regularly is discussing results regularly, and to act on the results.
- Formal collaborative practices as joint work coordination, formal team integration, joint activities, joint conflict resolution, are the lowest scoring variables on the project. Where the SELECT phase consisted of a relatively small team, it is advised that when

the team grows in future phases, collaborative practices can be beneficial in order to achieve and maintain a high level of collaboration. In a small team issues can be resolved more easily due to less complex situations and fewer contractual issues in the SELECT phase. In later phases as the team grows making it difficult to deal with all issues on a personal level. Formal procedures aid in resolving conflicts and maintaining a high level of collaboration. Informal collaborative practices such as joint daily meetings and joint review sessions proved to be sufficient in the SELECT phase to cover the formal procedures.

- There are significant differences in how the team members perceive the collaboration and how the management team perceives it. Especially dealing with uncertain situations or having non-transparent working processes can negatively impact the collaboration perception of team members. It might be fruitful to split the results in inter- and intra-organizational results to improve both the client-contractor collaboration, but also collaboration within the team. Focusing on collaboration within the team, several steps can be taken. First a root cause analysis must be performed to identify the actual cause of the gap between the management teams and team members. In addition, more alignment meetings should be planned, and even team members could be given more responsibility to decrease the hierarchy between both parties and empower team members.
- Very few collaboration improving actions have been taken during the measurement period. It is advised to act on the data collected to also provide the respondents filling in the survey with a sense of recognition. A downfall of survey assessments is the lack of feedback on responses. Advice is to implement more feedback moments to jointly look at the gathered data to formulate points of improvement and celebrate well performing variables. This should be reinforced with team development activities to improve communication and coordination within the project team.
- During this research, the data is collected using a paper survey and the collected data was processed by hand. This gives room for errors especially when the total team grows and also takes time to analyse the data. The benefit of paper surveys is that issues and questions concerning the survey can be immediately answered increasing engagement of the participants. However, the process might become too time consuming in larger groups. A benefit of an online survey is that data processing can be automated, and dashboards could be automatically generated, reducing the time and resources to collect and process the data. A disadvantage of an online survey is that respondents might be less inclined to fill in the survey.
- Besides the choice for paper or electronic surveys, to optimise results a dedicated, preferably independent, person should be appointed which is in charge of collecting the data, scheduling feedback moments and keeping track of the progress. By having an independent person in charge of the data, possible conflict of interest can be prevented. If this is not possible during a project, a manager in charge of quality can also take this responsibility, so there is no conflict between processes and more in-depth discussions about more substantive topics.



- The data has been gathered with a weekly interval to assess the collaborative trends. For future research concerning collaborative trends and actively applying measures to improve the collaboration, this might be a good interval, but in practice evidence shows that the variation in answers decreases. This indicates that participants are filling in the same scores for all variables, indicating a possible loss of engagement and losing value of the data. To prevent this from happening a larger interval could be chosen dependent on the phase of a project and number of interventions during the project. A project with a large number of team development activities, many deadlines, and a regular assessment and improvement of collaboration, a smaller measuring interval is advised than when the project is in a steady state without many activities. Concluding, the interval should be adapted to the needs of the project, which could be different per project.
- To ease the data analysis the survey can be split into several parts, first focus on alignment of both party in the early phases and on maintaining a good collaboration in later phases. This means that in the alignment phase, the client-contractor (client-Fluor) related questions should be used in the survey. Later questions can be changed to 'one team' to emphasise more the collaboration within the project.
- To solve the issue of the presence of dependent and independent questions within one survey, several splits of the survey could be made. This would also reduce the repeatability of the same questions when measuring more often. A different survey for every measurement period makes it able to formulate action points more easily. In addition, the client-Fluor and management-team split can be measured independently. For example, during the alignment phase, data regarding the perceptions of the client and contractor are more important. In a more advanced collaboration, the management-team member difference becomes more important.

## 9. REFLECTION

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My time at Fluor started in November 2018 with the goal to formulate and develop a research proposal for this thesis. While many ideas came by, only during the final two weeks before the kick-off for this thesis, a subject was determined: measuring collaborative trends in a project team environment. At first this seemed a good scoped research, with plenty of literature concerning collaboration. Although I had not suspected that the literature concerning collaboration is so widespread and diverse that there is a lot of ambiguity about what collaboration is and what it should consist of. I learned that collaboration is a far more complex topic than it seems at first glance.

By the time I found out about the complexity of it, I came to realize that the measuring period I was aiming for was also coming to an end pretty quickly. To gather data, a method needed to be developed within a week, putting pressure on making decisions concerning what the tool to measure collaboration should contain. Luckily, there were a lot of people helping me, thinking with me about what is useful to measure. When the tool was finished, measuring went quite smoothly. People on the project had a lot of interest concerning collaboration and were willing to invest time in filling in the surveys and attending the workshops.

Towards the end of the SELECT phase the mood slightly changed. Where in the beginning and during the SELECT phase mostly discussions were about design choices, budgets and schedules, its people became nervous towards the end due to their work coming to an end. With a lot of uncertainty about how the Bridging phase was being developed, the original idea of keeping everyone on the project was not going to happen due to budget restrictions from CLIENT. Discussions shifted from work obstacles to “what am I going to do in a few weeks”. I think that this is also one of the main causes for the big gap between the management team and team members. Team members are completely dependent on the management team on communicating strategic information, there was a relatively long period where the management team was negotiating on the working hours for the Bridging phase while team members were barely informed. Absence of information combined with uncertainty is dangerous and creates an environment where rumours are being spread and gaps between the management team and team members grows.

Luckily, this was resolved before the end of the Bridging phase, but unfortunately the budget was insufficient to keep everyone on the project. People were leaving the project when their work was done, leaving some empty chairs on the work floor. I realized during this period how important the collaboration is. Not only between client and contractor, but also within your own team. Uncertainty and unclear communication can influence this greatly. If there is one thing I learned during this research is that having a good collaboration in the project takes care of half the work, but maintaining a good collaboration requires the right mindset, willingness and most of all, a lot of effort.

When looking in hindsight at this research, there are some things I would have done differently with the knowledge I have now. For example, I was not able to put the desired amount of time in developing the survey, creating a more thought out survey. I also would also have worried less, having in mind that everything would fall into place as it did.

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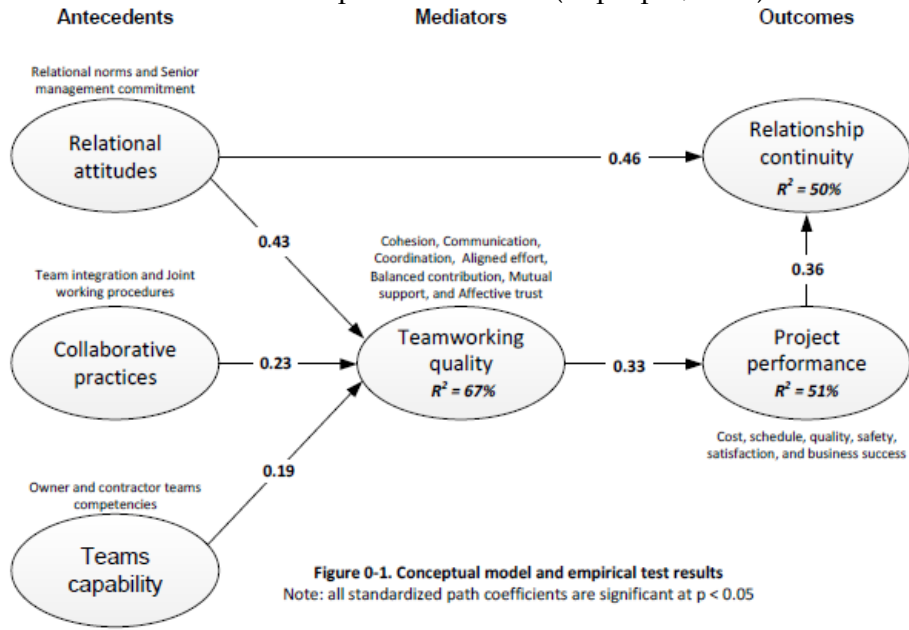
# APPENDICES

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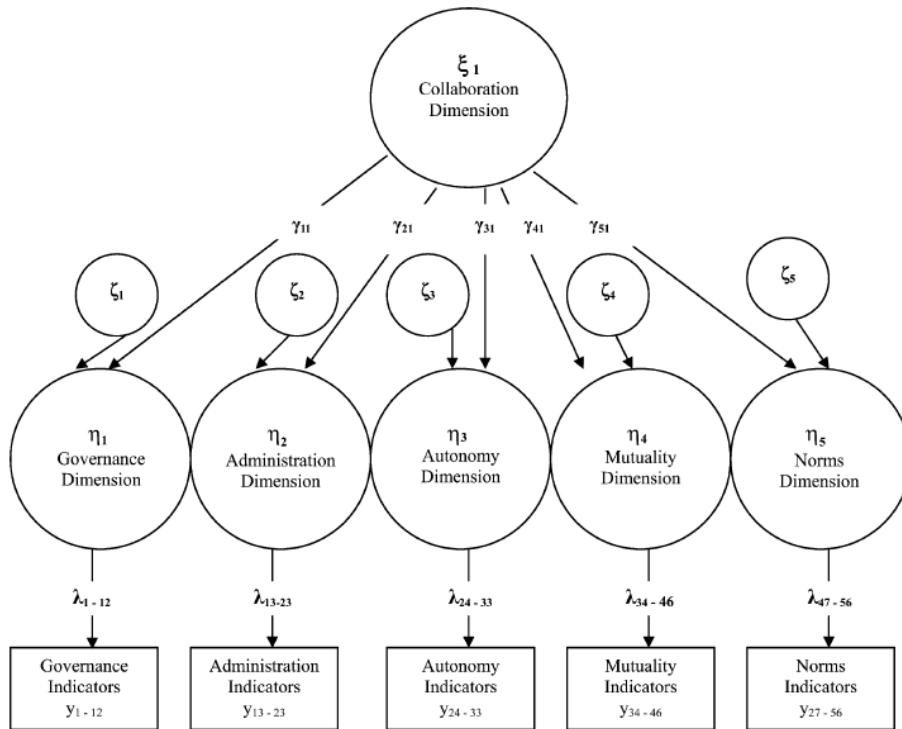
# APPENDIX A: COLLABORATIVE MODELS

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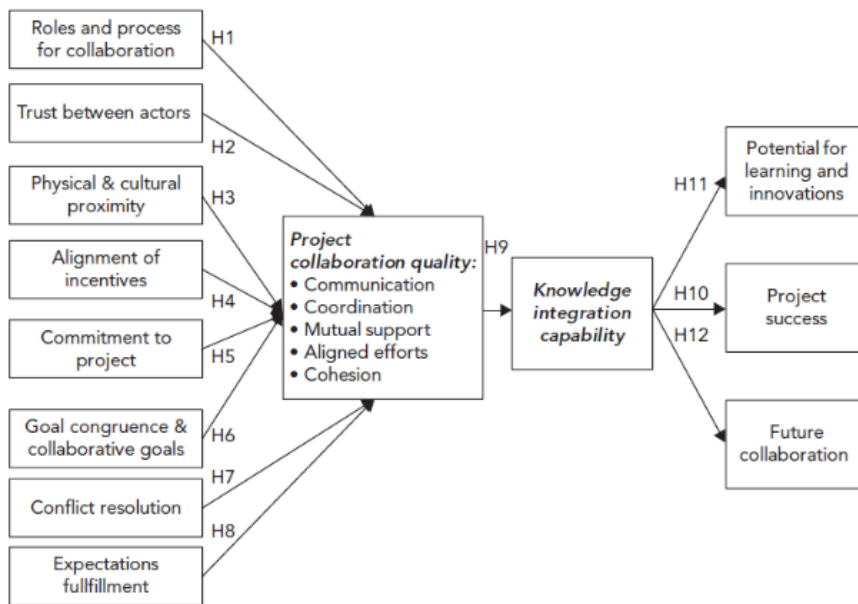
### Relational Capabilities model (Suprpto, 2016)



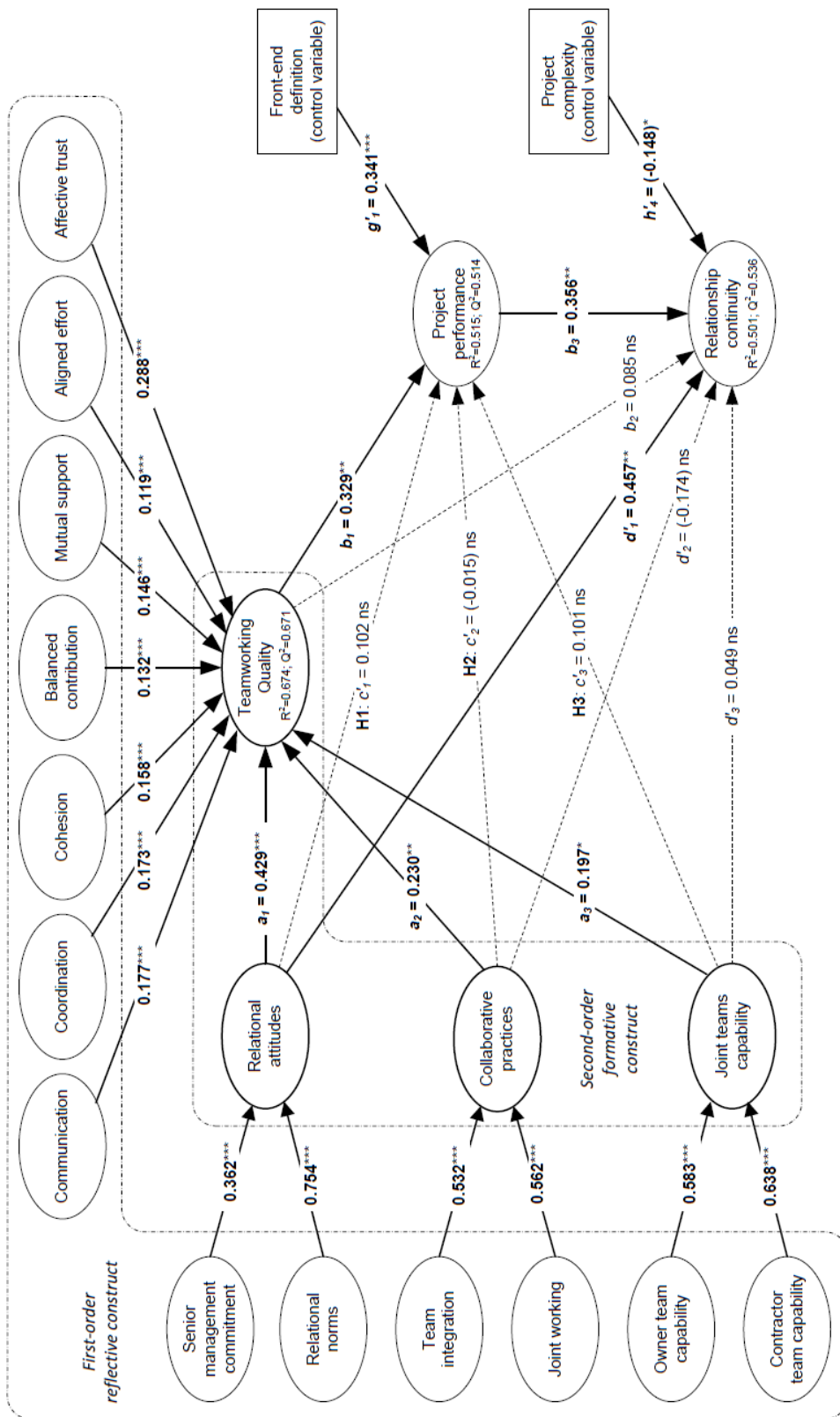
### Collaboration quality model (Thomson, 2007)



### Knowledge integration model (Dietrich, 2011)







**Figure 5-2. Full structural model with first-order constructs.** Note: \* p < .05 (t > 1.96); \*\* p < .01 (t > 2.58); \*\*\* p < .001 (t > 3.29); ns = not significant; only significant control variables (*front-end definition* and *project complexity*) are shown.

Structural equation model used for development of RECAP (Suprpto, 2016)

# APPENDIX B: IN-DEPTH ANALYSIS OF RECAP RESULTS

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### Spread in questions

The spread in answers given per organization are similar between both companies as shown in Figure B.1. The results are standardized based on the number of responses so the results between both companies can be compared despite the difference in respondents. CLIENT respondents are slightly more positive in answering the questions than Fluor people. The spread in the categories NA and DK are relatively similar as well.

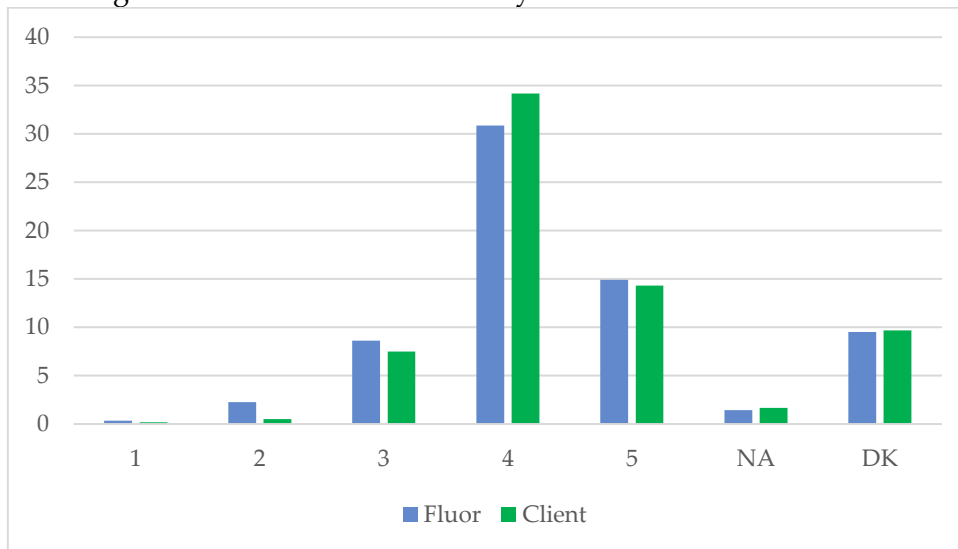


FIGURE B.1: SPREAD IN ANSWERS PER ORGANIZATION

Looking at the spread in answers between the management teams and team members, clear differences can be noted between both groups on answering questions with a 5 and in answers in DK. Results show that managers are more positive than team members and have a better capability and understanding to answer the questions.

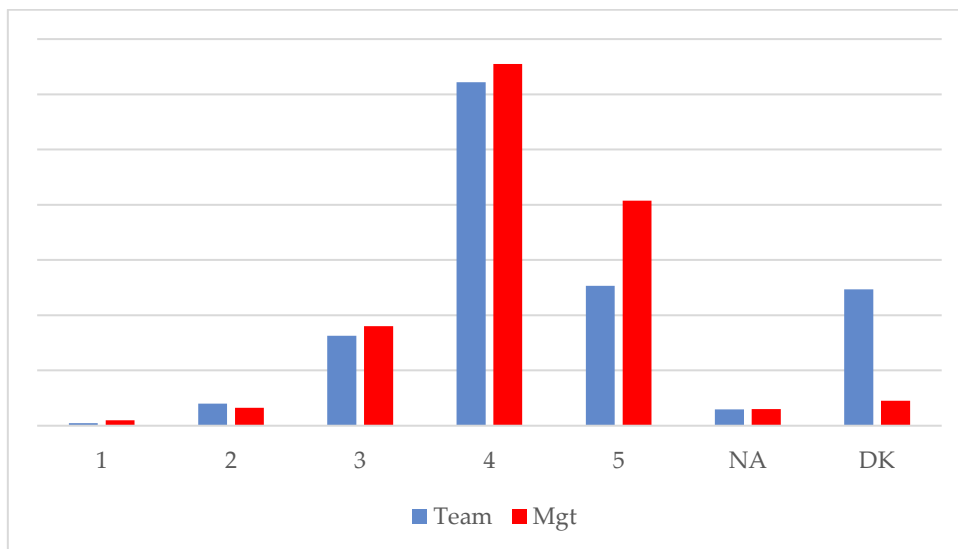


FIGURE B.2: SPREAD IN ANSWERS BETWEEN MANAGEMENT AND TEAM

### Results CLIENT-Fluor sub-criteria

Looking at the sub-criteria, five considerable gaps can be noted as shown in Figure B.3. The first one can be noticed on project efficiency with the largest delta of 0.5. Where Fluor is quite satisfied with the efficiency of the project, CLIENT sees potential for improvement. It is the other way around concerning the quality of the project. Despite the lower efficiency perceived

by the client (3.5), they rate the quality of the work higher (4.4), while Fluor rates the efficiency higher (4.0) and the quality lower (4.2). As discussed above, the perception on relationship continuity differs with a delta of 0.3. Other two sub criteria with a delta of 0.3 are mutual support and cohesion, both perceived higher by the client, than the contractor.

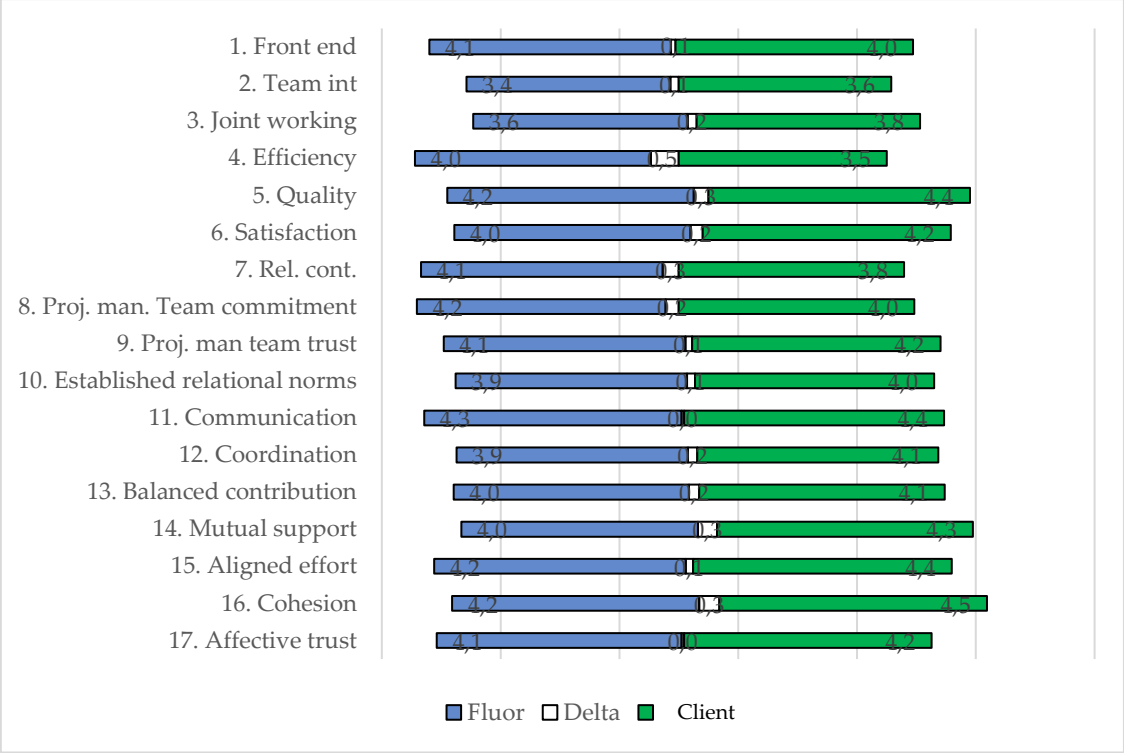


FIGURE B.3: CRITERIA SCORES AND GAPS

Despite the gaps in perception on the presented sub-criteria, the parties are well aligned. The average gap between sub-criteria of 0.2 is one of the best aligned projects compared to results of Suprpto (2016) and Eggermont (2017). This could be due to the phase the project is in. With only a relatively small team of the client and contractor, and with relatively low risks. Even though, there is still room for improvement and lessons to be learned for the next phase. With low scores on collaborative practices and different perceptions of efficiency, more could be invested to get better alignment on efficiency. At the beginning of the next phase, it is also wise to focus more on the team integration practices and joint working procedures. This could potentially improve team working quality and thus project performance.

**Results Management-Team sub-criteria**

On the individual criteria both parties perceive them quite the same. With seven sub-criteria perceived exactly the same. These are, front-end development, team integration, project efficiency, project satisfaction, project management team trust, established relational norms, balanced contribution, and mutual support. As seen in the figure below, only four ‘big’ gaps can be noticed, the quality of work done, relationship continuity, aligned effort, and cohesion.

Starting with the last, cohesion is ranked high by both parties, although the management is much more positive about the cohesion than the team members are. With a delta of 0.4 the cohesion of the team is not as highly ranked as the team managers would think. This is mainly

because the team members rank the level of integration as one team (score 3.7), much lower than the management team does (score 4.4). Interestingly, while no formal procedures have been set in place to form team integration, the project management team perceives the integration of the team quite high, but this feeling is not carried over to the team. There might be a need for additional formal structures to integrate the teams of the team members further. In addition, team members feel less responsible and driven to the project than team managers do. Deeper analysis shows that with a score of 4.8, team managers feel very much personally engaged to the project, the team is personally engaged, but not as highly ranked as the management team is (score 4.3).

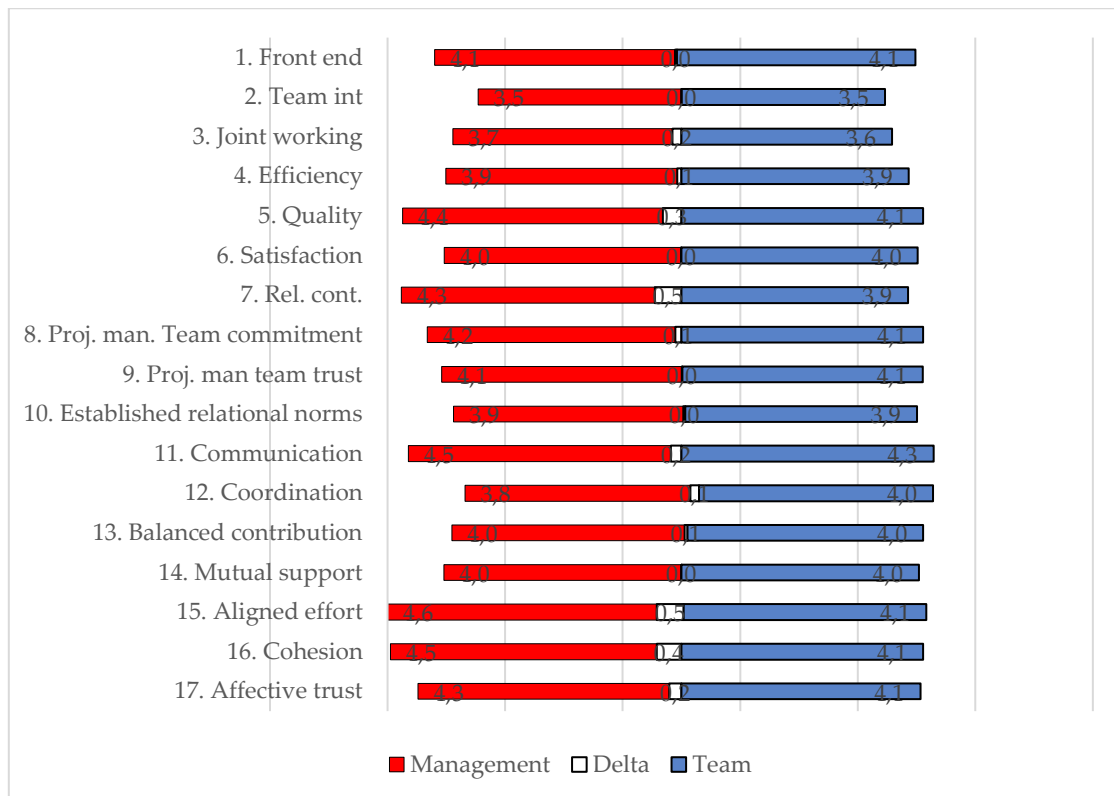


FIGURE B.4: CRITERIA SCORES AND GAPS MANAGEMENT AND TEAM MEMBERS

The second gap in perception is the perceived aligned effort. While both parties rank the aligned effort as high, the management team is again more positive about it in comparison to the team members (delta = 0.5). This could be due to the fact that all managers from Fluor have a direct counterpart from the CLIENT side and vice versa, while there have been some issues on the project to get more team members on the project from the CLIENT side.

This could influence the rating of Fluor team members on alignment of work. Despite the gap on perception of aligned effort, it is the highest scoring sub-criterion on the management side, with cohesion second. This could also be due to misalignment between the management team and the team members and the low score on coordination, 3.8 for management and 4.0 for the team. With team members being less involved in daily scrum meetings except for some team leads this could lead to lower levels of alignment.

As relational continuity has already been discussed, a final 'big' gap can be noted concerning quality. With the management team scoring 4.4 and the team rating quality a 4.1, it seems that the team is experiencing more rework issues, than the management team does. While these aspects are still rated high, there should be better alignment about the scope of work and changes made.

### **Workshop discussing RECAP results**

#### *Background of workshop structure*

The workshop consisted of three rounds: first, the RECAP is evaluated. Secondly, input is gained on development of the tool. Finally, the workshop is evaluated to improve future workshops. The goal of the first round is to provide an answer on the first question shown above. The team is asked to put post-its of the topics provided in the RECAP in the column of who they think is most appropriate to answer the question. This can be the project leadership team, team members or both. Answers are used to make sure the topics in the new tool are asked to the right people, eliminating unnecessary effort for participants to maximize output. After people have put their post-its on the board, the results of the RECAP assessment are shown, and the results on the percentage "Not applicable" and "Do not know" answered in the survey to see if these results show resemblance to the answers on the board.

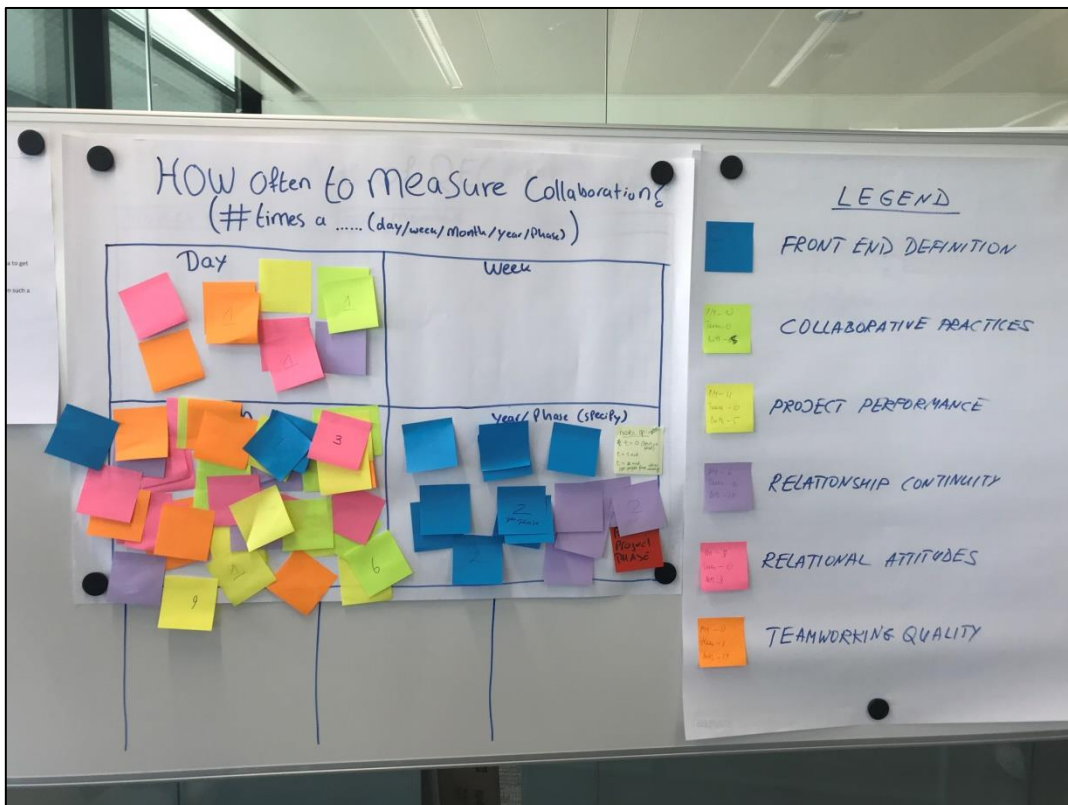
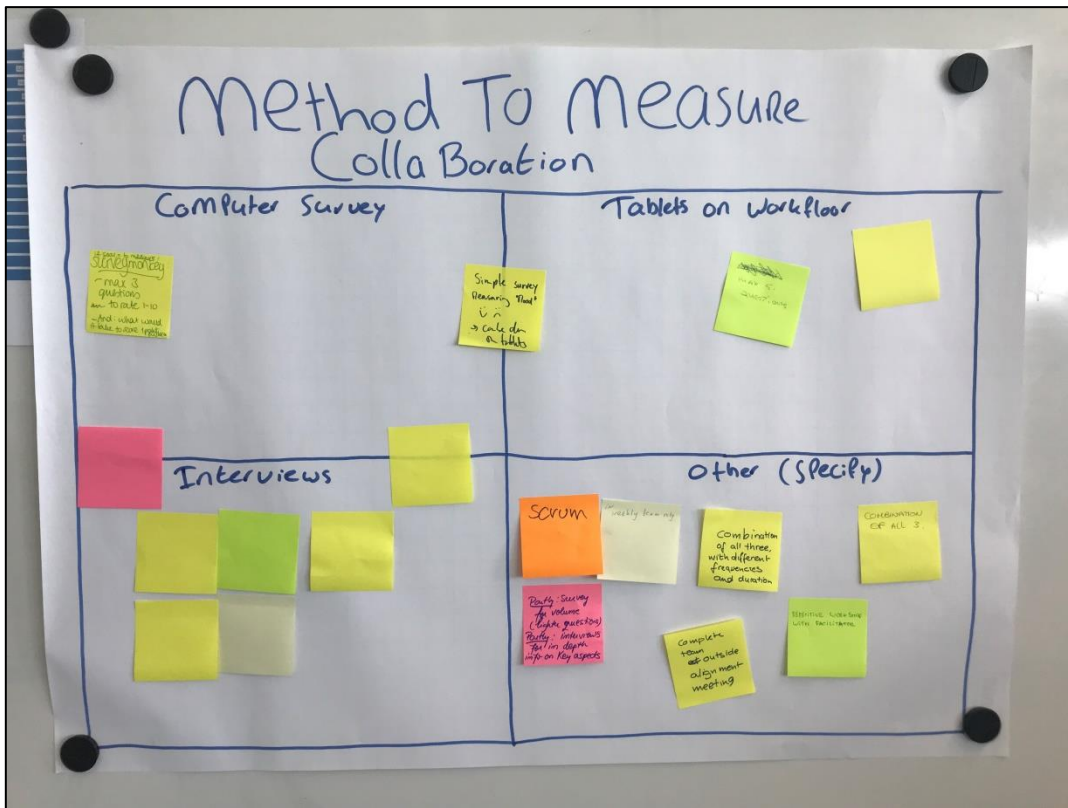
The second round is more focused on the development of the new tool. After a short introduction about the goal of the new tool, participants are asked what they think is the optimal way to measure collaboration. Some examples are provided, such as a survey, smiley method, data analysis on sent emails or such. Second question in this round is how often they think you should measure the critical success factors to get relevant output. Finally, they are asked how much time they are willing to invest into a tool per day, week or month to measure collaboration.

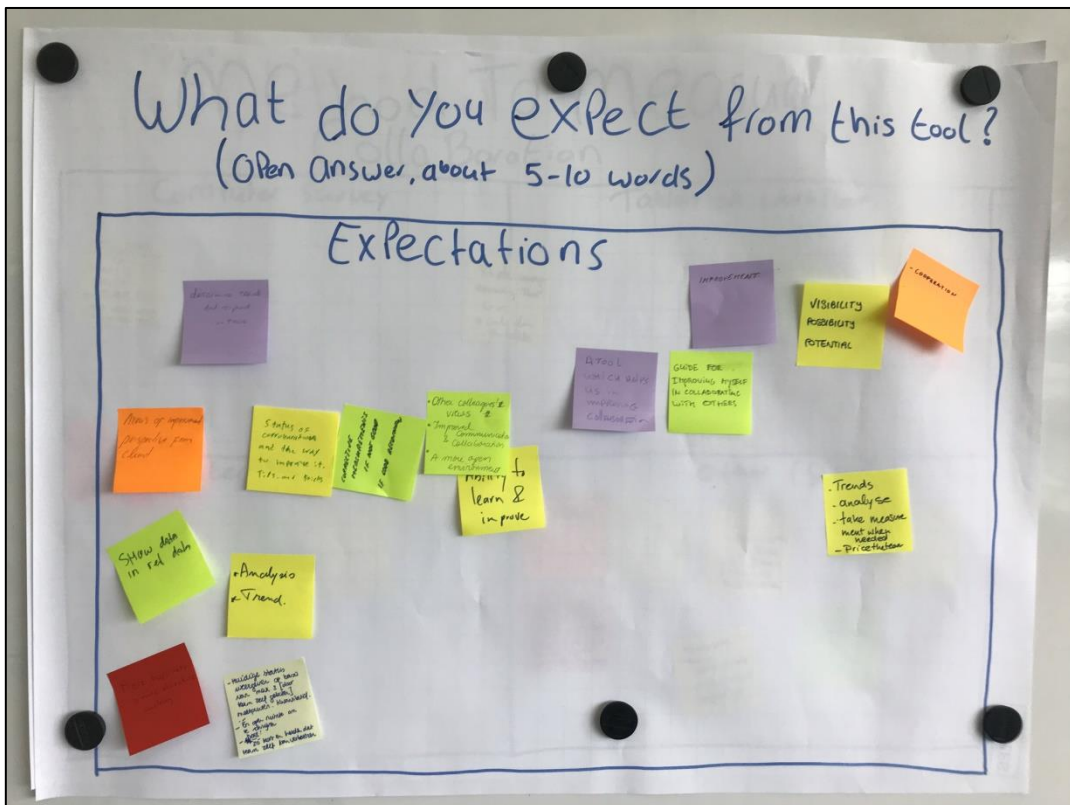
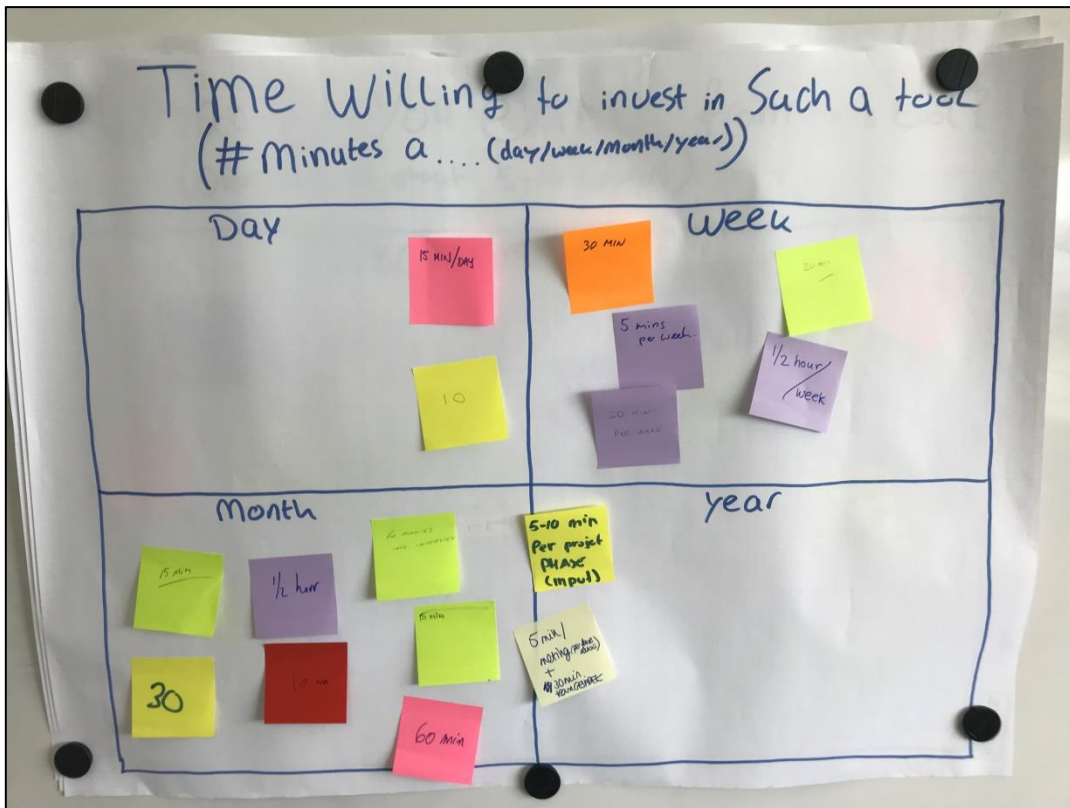
The workshop is concluded with an evaluation and what the project team expects from a collaboration measuring tool in terms of output, visualization and relevance to the project. By gathering input of the project team, they are included in the process of this research, increasing acceptance and participation of the team (Azhar et al., 2010).



# APPENDIX C: WORKSHOP RESULTS

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# APPENDIX D: RECAP ASSESSMENT

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## RELATIONAL CAPABILITY ASSESSMENT FORM

Owner-contractor collaboration represents a unique capability which significantly determines project performance. The ability to collaborate in projects is embedded in the project team, which is a temporary organization that both firms (owner and contractor) establish in order to deploy their resources in projects. Relational capability in projects is the ability of the two parties, their teams and their people in aligning and integrating their knowledge, skills, and energy to perform interdependent project activities for accomplishing a better outcome.

### PURPOSE

This assessment tool is created to evaluate the relational capability at inter-firm and inter-team levels. It is intended for use by a pair of owner-contractor firms working in a project. The assessment results will provide an overview regarding the achievement of specific critical success factors of collaboration in projects.

**What's in it for the participating firms?** By participating in this assessment, the pair of firms will gain insights regarding their (current/past) achievement and identify specific aspects to improve in future. The assessment focuses on how well the firms 'work together' and not on the 'individual performance' of the firms. When used in an ongoing project, the two parties can formulate joint actions more constructively to achieve better project performance. This assessment also identifies for the participating firms the potential value of continuing the relationships in future.

### INSTRUCTION

1. The assessment is designed to be filled-in separately by a pair of senior management representatives or project directors or equivalent position, and/or project managers representing owner and contractor. There are a total of 17 assessment aspects and some open questions. On average, it takes about 45 minutes to complete this assessment.
2. Choose a project you are currently involved in, keep in mind the situation in that project when you rate each statement.
3. Rate each statement by selecting the appropriate level of achievement or realization or performance (**1 = very poor** to **5 = very good**). The rating you give should be based on your own perception that best describes the actual situation occurring in the project.



## A. Front-end definition and collaborative practices

This section examines the extent of how well the *front-end definition* is actually understood/ comprehended by the project teams and how well *collaborative practices* are actually being implemented in the current project. Collaborative practices are additional practices used to enhance the collaboration between parties (owner and contractor) and their project teams.

The words “**both teams**” and “**we**” refer to the owner and the contractor teams. Please mark “X” on the associated rating column, where: 1 = Very Poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Very Good, NA = not applicable, DK = Do not know.

Sub Criteria / Indicators	1	2	3	4	5	NA	DK
<b>1. Front-end definition</b>							
a. The project goals, objectives, and scope are understood by the contractor team.							
b. The project goals, objectives, and scope are understood by the owner team.							
c. All functional/ high level technical requirements ( <i>basic design</i> ) are reviewed together by both teams.							
d. The <i>project execution plan</i> is reviewed together by both teams and adjusted accordingly if needed.							
e. There are clear <i>roles and responsibilities</i> assigned to both teams.							
<b>2. Team integration</b>							
f. We form an <i>integrated project team</i> (IPT) where the owner and the contractor teams are structured and integrated as a single team with no apparent boundaries.							
g. We perform <i>goal setting and alignment meetings</i> with sub-contractors and suppliers.							
h. We perform <i>goal setting and alignment meetings</i> with the owner’s business and operation representatives.							
i. We exercise <i>inter-team building</i> workshops to encourage collaboration via fun and excitement.							
j. We have <i>recognition and rewards program</i> to stimulate individual and team levels collaborative behavior.							
<b>3. Joint working processes</b>							
k. We jointly conduct <i>planning</i> .							
l. We jointly perform <i>monitoring, controlling, and reporting</i> .							
m. We jointly conduct <i>issue management</i> .							
n. We jointly <i>define and monitor</i> the achievement of key <i>performance areas</i> .							
o. We jointly <i>identify and monitor risks</i> and formulate a necessary <i>mitigation plan</i> .							
p. We have robust <i>mechanisms to resolve conflicts/disputes</i> .							
q. We have formal <i>procedures for joint decision making</i> .							

## B. Project performance and Relationship continuity

This section is concerned with the perceived current achievement of the collaboration output, the project performance. The assessment aspects include measures of efficiency, quality of output, and satisfaction, and potential continuity of the relationship in future.

Please rate the following statements reflecting the current achievement or progress of the project so far. Please mark "X" on the associated rating column, where: 1 = Very Poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Very Good, NA = not applicable, DK = Do not know.

Sub Criteria / Indicators	1	2	3	4	5	NA	DK
<b>4. Efficiency</b>							
a. The project is progressing in accordance with the estimated cost so far.							
b. The project is progressing in accordance with the planned schedule so far.							
<b>5. Quality</b>							
c. So far, there are no significant reworks due to major defects regarding the project deliverables.							
d. So far, all project activities are performed or completed safely with no accidents causing severe injury.							
e. So far, the facility or product constructed is taken into operation reliably without major problems.							
f. So far, the facility or product constructed is functioning according to the specified capacity.							
<b>6. Satisfaction</b>							
g. Both owner and contractor are satisfied with the project results and outcomes so far.							
h. So far, this project will make a positive impact on the owner's business.							
i. So far, this project will be a (commercial) success to the contractor.							

Please mark "X" on the associated rating column, where: 1 = Unlikely, 2 = Slightly likely, 3 = Moderately likely, 4 = Highly likely, 5 = Completely likely, NA = not applicable, DK = Do not know.

Sub Criteria / Indicators	1	2	3	4	5	NA	DK
<b>7. Relationship continuity</b>							
j. Beyond this project, we will likely work with each other in future with the same partners.							
k. The relationship experience we gain so far will be useful in future project(s) even with different partners.							
l. Because of collaboration in this project, we gain benefits that enable us to compete more competitively.							
m. This collaborative relationship makes our companies' able to develop unique capabilities (truly innovative products/solutions).							



### C. Relational attitudes

This section is concerned with how well the senior management of both parties (the owner and the contractor) commits to support the collaboration, taking into account the degree of trust and interactional norms to bring together the necessary resources into a project.

The words “**senior management**” refers to high level managers or executives representing a company with the authority to make a final decision about a project. Please mark “X” on the associated rating column, where: 1 = Very Poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Very Good, NA = not applicable, DK = Do not know.

Sub Criteria / Indicators	1	2	3	4	5	NA	DK
<b>8. Senior management commitment</b>							
a. Senior management of the owner commits to provide necessary resources and support to the project teams.							
b. Senior management of the contractor commits to provide necessary resources and support to the project teams.							
c. Senior management of the owner shows consistent and passionate leadership.							
d. Senior management of the contractor shows consistent and passionate leadership.							
e. Senior management of both parties actively work together to resolve potential conflicts when needed.							
<b>9. Senior management trust</b>							
f. There is an atmosphere of mutual trust between senior management of both parties.							
g. There is a mutual enthusiasm from senior management of both parties in achieving the project goals.							
h. Senior management of both parties has confidence in each other to do what is right.							
i. Senior management of both parties keeps their promises truthfully.							
<b>10. Established relational norms</b>							
j. The owner intentionally adopts ‘no blame culture’ when problems arise.							
k. The contractor intentionally adopts ‘no blame culture’ when problems arise.							
l. The owner is intentionally open and honest in any interactions with no hidden agendas.							
m. The contractor is intentionally open and honest in any interactions with no hidden agendas.							
n. The owner strives for business outcomes whereby both parties either win or both parties lose.							
o. The contractor strives for business outcomes whereby both parties either win or both parties lose.							
p. Both parties agree to have an equal say in any critical decisions that matter to both parties.							

#### D. Inter-teamworking

This section is intended to assess how the owner’s team and the contractor’s team work together in a project across their company’s boundaries. Inter-teamworking reflects how two collaborating teams communicate with each other effectively, achieve synergies in coordinating interdependent activities, equally contribute their specific knowledge and expertise, align their effort, help each other in achieving project goals, behave as one team, and personally trust each other. The words “**both teams**” and “**the teams**” refer to the owner’s core team and the contractor’s core team. Either team can be represented by at least one person (team leader or manager or representative). Imagine the interaction between these two teams when you rate the following statements.

Please mark “X” on the associated rating column, where: 1 = Very Poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Very Good, NA = not applicable, DK = Do not know.

Sub Criteria / Indicators	1	2	3	4	5	NA	DK
<b>11. Communication</b>							
a. Both teams communicate directly with each other.							
b. Project-relevant information is shared openly by both teams.							
c. Whenever a problem is detected, it is immediately and honestly communicated to the other team.							
d. Both teams are satisfied with the usefulness of the information shared by other team.							
<b>12. Coordination</b>							
e. The work done in the teams is closely synchronized between the teams.							
f. There is a clear linkage between the teams for their interdependent tasks.							
g. There is no redundancy regarding the work done between both teams.							
<b>13. Balanced contribution</b>							
h. Both teams recognize the specific strengths and weaknesses of each team’s competences.							
i. Both teams are contributing their knowledge/ expertise in accordance with their full potential.							
j. There is a balanced contribution of ideas between the teams.							
<b>14. Mutual support</b>							
k. Both teams help each other as well as they could.							
l. Whenever problems occurred, they are resolved constructively.							
m. Every critical decision is made together by both teams.							
<b>15. Aligned effort</b>							
n. Both teams give this project the priority it needs.							
o. Both teams put their best effort into this project.							
p. There is no conflict regarding the effort that each team put into this project.							

Sub Criteria / Indicators	1	2	3	4	5	NA	DK
<b>16. Cohesion</b>							
q. Members of both teams are personally engaged to this project.							
r. Members of both teams are integrated as one team.							
s. Members of both teams feel proud to be part of the project team.							
t. Members of both teams feel responsible for maintaining the relationships within the project team.							
<b>17. Affective trust</b>							
u. Both teams are comfortable being dependent on each other.							
v. Both teams keep their promises.							
w. Both teams work with high levels of integrity.							
x. Both teams are fair to each other.							
y. Both teams look out for the interests of both companies.							
z. Both teams can rely on each other for not taking advantage of the other team's weaknesses.							

**This is the end of the assessment, thank you for the cooperation.**

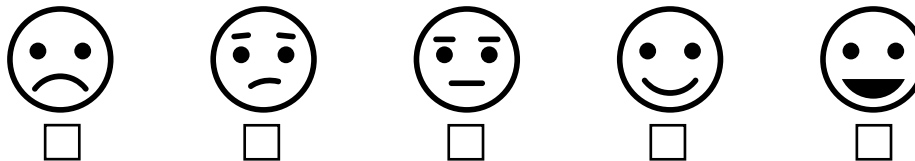
# APPENDIX E: FINAL SURVEYS

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# MEASURING COLLABORATION

This survey is designed to provide an indication of the collaboration in the project. Results are promptly analysed and made available the following week. If you have any remarks or questions, you can leave them in the box at the bottom of the page. Answers are confidential and will not be shared with any other persons.

How do you feel today? (Mark the corresponding smiley)



It is important that you rate the questions with your perception of it within the context of the CLIENT MAIN project. Please write the number of the corresponding statement in the column behind the question. The statements are as following:

1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, and 5=strongly agree.

1. The teams of CLIENT and Fluor are <b>integrated as a single team</b> with no apparent boundaries	
2. My work is <b>coordinated</b> with my colleagues and counterparts	
3. My team <b>jointly conducts activities</b> with our counterpart(s) (e.g. such as planning, monitoring, controlling and reporting)	
4. There are methods to <b>jointly resolve conflicts/disputes</b> within the project	
5. There is a <b>no blame culture</b>	
6. There is an atmosphere of <b>trust</b>	
7. The project management team of CLIENT is <b>committed to collaboration</b>	
8. The project management team of Fluor is <b>committed to collaboration</b>	
9. CLIENT supports a <b>win-win situation</b>	
10. Fluor supports a <b>win-win situation</b>	
11. CLIENT is putting their <b>best effort</b> into the project	
12. Fluor is putting their <b>best effort</b> into the project	
13. Information is <b>shared openly</b> by CLIENT	
14. Information is <b>shared openly</b> by Fluor	
15. CLIENT keeps their <b>promises</b>	
16. Fluor keeps their <b>promises</b>	
17. I feel <b>comfortable</b> to <b>provide feedback</b> on the work of both colleagues and counterparts	
18. I feel part of <b>one project team</b>	
19. Collaboration helps <b>improving</b> project performance	

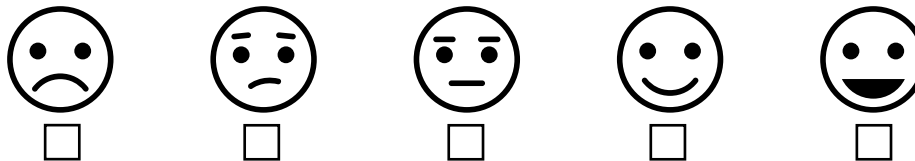
← Your score

If you have any questions/remarks you can put them here

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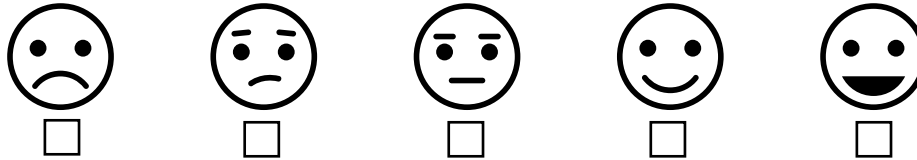
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← Your score

If you have any questions/remarks you can put them here

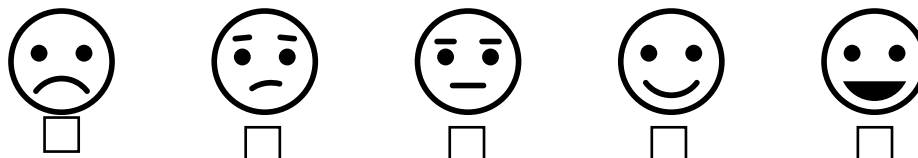


# MEASURING COLLABORATION

07-05-2019

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If you have any questions/remarks you can put them here

## APPENDIX F: SURVEY RESULTS

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# APPENDIX G: DESCRIPTIVE ANALYSIS RESULTS

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Confidential



# APPENDIX H: QUANTITATIVE RESULTS

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### KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,862
Bartlett's Test of Sphericity	Approx. Chi-Square	2309,846
	df	190
	Sig.	,000

### Rotated Factor Matrix<sup>a</sup>

	Factor			
	1	2	3	4
Fluor promises	,608			
Fluor information sharing	,587			
CLIENT promises	,577	,412		
Joint activities	,532			
Feedback	,525	,361	,323	
Work coordination	,480			
One project team	,465	,454		
Collaboration and project performance	,425			,329
Happy	,314			
CLIENT mgt. Collaboration commitment		,689		,397
No blame	,313	,617		
CLIENT win-win		,612	,495	
Trust	,446	,587		
Team integration	,368	,560		
CLIENT information sharing	,437	,545		
Joint conflict resolution		,408		
CLIENT best effort			,739	
Fluor best effort	,442		,585	
Fluor win-win			,464	,406
Fluor mgt. Collaboration commitment				,917

Extraction Method: Principal Axis Factoring.

Rotation Method: Varimax with Kaiser Normalization.<sup>a</sup>

a. Rotation converged in 8 iterations.

### Rotated Factor Matrix<sup>a</sup>

	Factor			
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