



Virtual bouwteams: a qualitative report on how to implement short-distance virtual teams by focusing on collaboration

MASTER THESIS CONSTRUCTION MANAGEMENT AND ENGINEERING

DELFT UNIVERSITY OF TECHNOLOGY

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Preface

Since my bachelor's in civil engineering, I was always interested in how the embedment of technology could improve efficiency and mobilization in construction projects. During my experience in the field, I quickly realized that collaboration was important for the realization of construction projects. This notion was reinforced during my studies at TU Delft. This coupled with the social distancing due to COVID-19 represented an opportunity for me to explore possibilities for the integration of technology in construction project teams.

This report contains my graduation thesis for the MSc Construction Management and Engineering of the faculty of Civil Engineering at the Delft University of Technology. I was engaged in researching and writing this report from July to February 2022. I consider this research project as one of the biggest challenges in my life which took me out of my comfort zone in numerous ways. Therefore, I have many people to thank for their support throughout this process.

First of all, I would like to express my deepest gratitude to my committee who have been with me throughout my journey. My first supervisor, Afshin Jalali, patiently guided me through the research, from giving me his perspective on the different paths the study could take to discussing the contents of the study with me. My second supervisor, Tong Wang, challenged me to be better, to always do my best to produce research I could be proud of. My chair, Professor Dr. Paul Chan, always asked me the right questions that made me reflect on the research and ultimately improve the content of it. My company supervisors at PRO6 managers, Harry op 't Ende and Nadine Tegelbeckers, for their constant encouragement and for instilling confidence in me and my research. Their feedback reflecting their experience in the industry was precious to me as well as their positive attitude and support to help me stay on track.

I would also like to thank the interviewees who took time out of their schedule to answer my questions and share with me their knowledge and experience. Without them, this research would not have been possible.

Lastly, my greatest gratitude goes to my father and mother. Their strength, constant support as well as the confidence they instill in me to achieve my goals, makes me be the best version of myself.

I hope you enjoy reading my thesis!

Tzitly Gomez

February 2022, Tamaulipas México

Executive summary

The construction industry is shifting towards a more collaborative environment through relational contracts following the early contractor involvement approach. In the Netherlands, one of them is the bouwteam process. The peak of collaboration in bouwteam projects and the construction industry is during the pre-construction phases since there is a higher complexity due to the uncertainty and interdependence of elements. On the other hand, technology innovations opened the way to work across boundaries in a remote way, which is known as virtual teams. Taking both aspects into account, the importance of collaboration through relational contracts and the technological innovations, this research seeks to seize the opportunity to expand the traditional working scope into a virtual or hybrid one in a way that doesn't jeopardize the performance of projects but rather improves it. Based on the problem definition and objective of the present research, a main research question is defined:

How focusing on collaboration improves virtual teams in the bouwteam phase?

Four sub-questions were formulated to help find an answer to the main research question which were answered through the four phases of the research method.

What are the factors regulating collaboration and virtual teams?

How is the current collaboration in bouwteams?

Which changes are required to overcome the challenges of virtual collaboration in the bouwteam phase?

Are the developed recommendations considered useful to improve virtual teams collaboration?

The present study is considered qualitative and follows a literature review with a multi-case study. The research is divided into four phases. In the first phase, a literature review was done to collect data regarding the aspects influencing the collaboration between all the parties involved in a high collaborative contract following the early contractor involvement and the factors influencing the adoption and performance of virtual teams. Through this step the necessary knowledge to draw a suitable solution to the problem is acquired. Moreover, a theoretical framework is developed at the end which is used as structure to present the results from the case studies. The framework consist of seven main categories: context, support, tasks, interaction processes, teams, individuals, and overarching factors.

The second phase aim to retrieve from practice the aspects influencing collaboration and virtual teams. As mentioned before, this is done through a multi-case study where two instruments are used to collect the data: desk research and semi-structured interviews. First, a desk research is perform to gather general information about the project from government, organizations and company websites. Second, semi-structured interviews are used to complement the desk research and to obtain the factors influencing collaboration and virtual teams. The interviews delved into the issues faced in the project while working remotely.

The third phase consisted in the analysis of the information. First, as the interviews were recorded, a transcript of the discussion was done. Second, the data was analyzed individually per case study to identify the factors deemed important. Then, a cross-case analysis was done to identify the patterns in the data, that is the similitudes or differences between the case studies and the literature. As mentioned before, the information is presented following the categories of the theoretical framework.

In the fourth and last phase, the proposed recommendations were validated in a virtual session with two experts with experience in bouwteam projects developed in a virtual environment. The recommendations were validated for its usefulness, applicability and clarity. Taking into account the comments of the experts, the recommendations were rearranged and a roadmap in a form of a framework was develop as a strategy for professionals on how to implement or improve the application of teams in a virtual environment.

Based on the findings of this research, it is recognized that there is a relationship between collaboration and virtual teams where the performance of virtual teams can be improved through collaboration by focusing on the aspects they have in common. Moreover, the findings from practice sheds light on the aspects regarded as enablers, disablers or both in virtual teams and collaboration. Taking this information into account and the comments from the expert session, a framework to implement virtual teams is presented in figure 18. The framework presents an overview of the steps considered crucial to improve project performance and collaboration in a virtual environment. It is divided into three main phases: tender, project start-up and design. The last two are developed within the bouwteam phase. Within the tender phase two recommendations are given: selection criteria for the organizations, and the resolution of negative previous experience. The project start-up contains three recommendations: selection criteria for the team members, the creation of a culture for the project and the structure of collaboration. There are two recommendations in the design phase: the implementation of the agreements made (culture and structure) and a feedback session that act as a loop to modify the necessary aspects in the culture and structure. It is recommended for all bouwteam projects in the construction industry to follow said framework during the pre-construction phases, that is the tender and bouwteam phase.

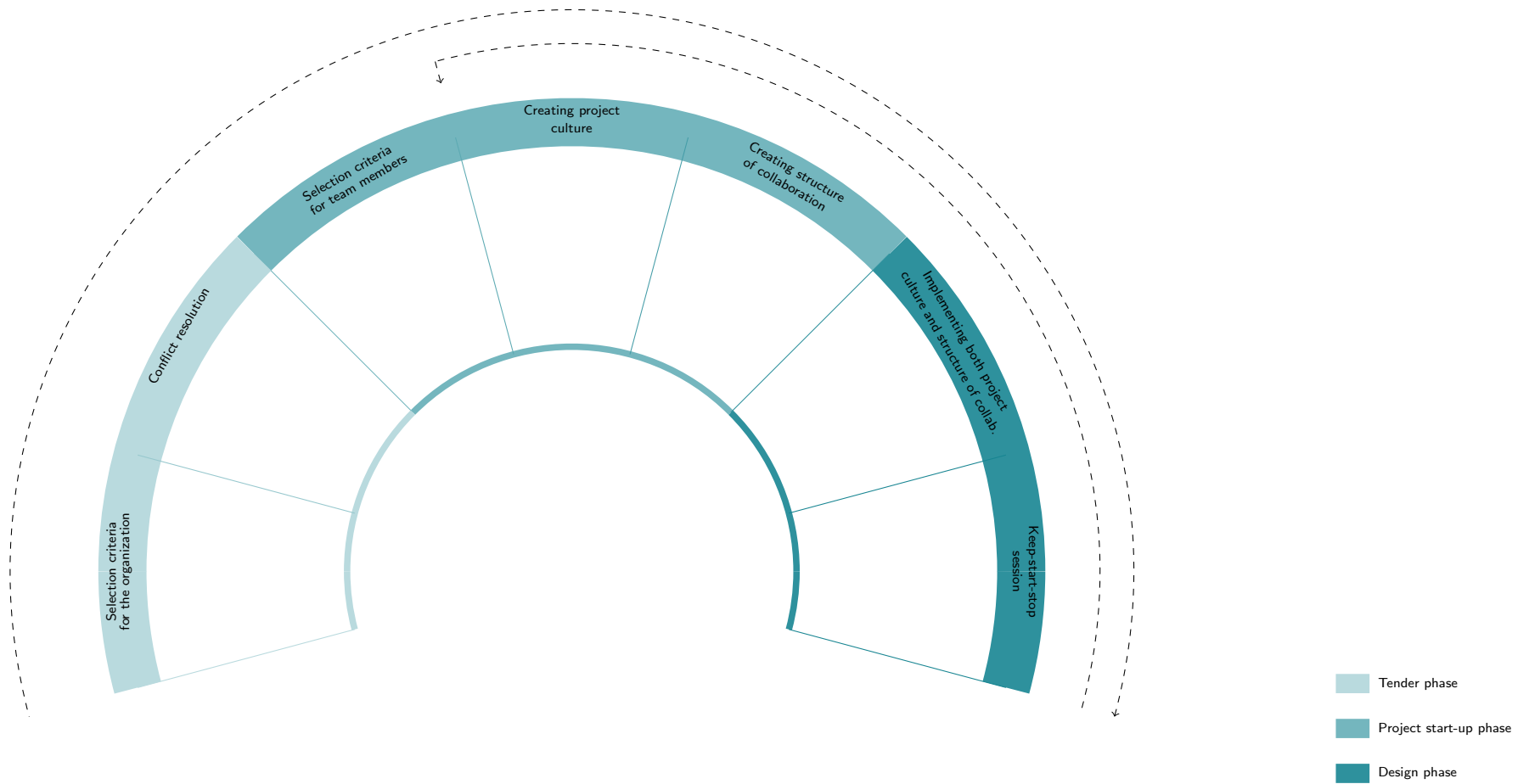


Figure 1: Roadmap to a healthy virtual collaboration

Terminology and list of abbreviations

Term	Description
Traditional contract	The traditional contract refers to the separation of design from construction where typically the focus of the contract is on monetary value.
Relational contract	Type of contract that focus on the integration and relationship of the stakeholders with the aim of creating a more collaborative environment.
ECI	It is an acronym and stands for early contractor involvement. It is an approach used in the industry that aims to integrate the contractor from early phases to improve the performance of the project.
Bouwteam agreement	This research adopt the bouwteam agreement definition of de Hoog (2020) in section 2.1.2 which is defined as 'The bouwteam is a temporary collaboration agreement during the design phase in which the participants - including at least client, contractor, and designer - cooperate towards a feasible design with an associated risk log and a building contract. To this end, each of the participants performs the tasks related to their experience and expertise while retaining their independence and responsibility.'
Bouwteam process	The bouwteam process in this research refers to four phases that the bouwteam agreement goes through: tender, bouwteam phase, price negotiation, and the construction phase
Bouwteam phase	The bouwteam phase in this research refers to the commonly known design phase.
Virtual teams	This research defines virtual teams in section 2.1.3 as "Teams collaborating mainly through ICTs who are geographically and culturally dispersed".
Collocated working	Contrary to virtual teams, a collocated team will be referred to as a unit of members located at the same physical location where face-to-face interaction and collaboration are possible.

Term	Description
Intra-organizational	The study will adopt Heery and Noon's definition of inter-organizational in their book "A Dictionary of Human Resources Management". They define it as an aspect within the organization, for instance, "intra- organizational conflict means conflict within the organization—for example, between different functions, or between managers and employees" (Oxford reference, 2021a).
Inter-organizational	Similarly, Heery and Noon defined inter-organizational as between organizations, for instance, "inter-organizational communication is communication between two or more organizations—for example, a company and its suppliers" (Oxford reference, 2021b).
Hoogheemraadschap Hollands Noorderkwartier	Hoogheemraadschap Hollands Noorderkwartier is the water authority for the northern part of the province.

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1 Introduction

This chapter provides an overview of the research. The goal is to explain the need to address this topic, the focus of the research, and how the study is going to be conducted. The chapter starts with a description of the research context followed by the problem statement. Then, the objective, main question, and the scope of the research are mentioned. Afterward, it presents a brief description of the methodology. The chapter finalizes with a description of the following chapters as a guide to the content of this report.

1.1 Context of the problem

Traditional contracting tends to foster win-lose situations which have proven inadequate for project performance (Brazier et al., 2018). Different aspects such as working together as a team, involving the key stakeholders early on in the process, and paying attention to the soft side of projects have been emphasized as a way to improve project performance and to achieve success (van Belzen, 2020). This notion goes in line with the changes facing the construction industry. Over the past decades, there has been a growing trend in the use of collaborative practices or relational contracts (Whyte, 2019; Malvika et al., 2021). In other words, there has been a promotion of new forms of collaboration in the industry as a solution to increase the performance of projects. The early contractor involvement (ECI) approach is an example of this. This method aims to engage the contractor at the start of the project. Incorporating the experience of the contractor early in the process can provide benefits such as an increase in the value of the project through optimizations in terms of constructability, risks, construction methods, and material assessment (Wondimu et al., 2020).

Some relational contracts follow the ECI approach, for instance, partnerships, alliances, joint ventures and integrated project delivery. These contracts aim to foster a cooperative culture of mutual respect, good faith, open and active communication, and commitment, i.e., they promote good relationships between all parties and encourage them to work together towards a win-win outcome (Moe et al., n.d.). They also manage confrontation by setting appropriate channels as a way to avoid disputes. Even though these relational contracts aim for the same thing, their approach differs from each other. For instance; the influence of each party in the decision-making

varies depending on the contract form used. In partnerships, the parties might only have a say on the selection of the subcontractors while in integrated project delivery and alliance their influence is broader. Yet, not all projects implementing these contracts have been successful in the construction industry (Brazier et al., 2018).

Normally, contracts are set at the start of the project, which is the point with the highest uncertainty. This tends to lead to budget overruns or delays due to unforeseen complexities causing disputes between the parties (van Belzen, 2020). The bouwteam process is a type of ECI method implemented in the Netherlands. This method comprises the benefits of the relational contracting described above. Yet this contract adds a price negotiation phase at the end of the design. This provides flexibility to both client and contractor to agree on a final price once the details of the project are defined i.e. it enables both parties to renegotiate with lower uncertainty.

The bouwteam process is formed by four phases: tender, bouwteam (design), price negotiation, and construction. The collaborative peak for the bouwteam is in the pre-construction phases. In the tender details regarding the goals, requirements, and expected project value are drawn. In the next phase, the bouwteam is where most of the interaction between the parties happens i.e. during this period there is a great interdependence of elements. Trust plays an important part during this phase since it affects information sharing. To create value together the stakeholders require to exchange information and resources with each other (Matinheikki et al., 2016). Therefore, the construction industry must foster an environment of trust which, in turn, promotes information sharing (Uden & Naaranoja, 2007).

On the other hand, another factor to consider is the increase in innovations, especially in technology. This led to an interconnected world in which collaboration takes a critical part to succeed (Fruchter, 2014). Thanks to these advances dispersed businesses can coordinate more easily which in turn encourages collaboration across boundaries (Mors & Waguespack, 2021). This way of working is known as virtual teams, global virtual teams, or dispersed teams. Lately, it has received the name of remote working or working from home. Yet, a virtual team is not a new concept, around 5.7% of employed people in the EU from 2009 to 2019 usually worked from home (Milasi et al., 2020). The three leading industries implementing remote working were I) IT and other communication services, II) Knowledge-intensive business services, and III) Education (Milasi et al., 2020). For the construction industry, this term has been around for over a decade and it has been implemented in almost purely global teams specifically on units separated by a long distance. Until the year 2020, where the norm of collaboration in short and long-distance teams was remote. Currently, it is still advised to work remotely as much as possible. After some time working in this setting, some corporations plan to improve the experience and make it a permanent option (Pwc-Global, 2020); others intend to embrace a hybrid form of collaboration depending on the functions of each individual (Marshall, 2020). Therefore, there is an opportunity for organizations to expand their scope of traditional collocated working into a hybrid one or completely remote working (Odubiyi & Oke, 2016; Jimenez et al., 2017).

In the construction industry, companies need to prepare for the outlook after the COVID crisis (Mckiney & Company, 2020). Journals encourage researchers to investigate current response strategies, adjust them from reflections and personal insights to obtain a more favorable response in the future (Müller & Klein, 2020). Researchers also foresee the need to investigate workforce-related issues, such as "reliance on and efficiency of virtual teams", "the implication on team/crew size, teamwork, and team building" or "finding a balance between technology use and maintaining a sense of community and shared culture among the workers" (Assaad & El-adaway, 2021). There is a need to investigate the application of remote working in short-distance teams as well as a need to define the future application of these teams in the construction industry. For this, it is necessary to address the impact remote working could generate on contracts agreements such as the bouwteam where collaboration plays an essential part.

1.2 Problem statement

As stated above, the construction industry is shifting towards a more collaborative environment through relational contracts. In the Netherlands, one of them is the bouwteam process which is formed by four phases; tender, bouwteam, price negotiation, and construction. The peak of collaboration is during the pre-construction phases since there is a higher complexity due to the uncertainty and interdependence of elements. The bouwteam process aims to improve the collaboration between stakeholders while offering flexibility to set the price at a point of lower uncertainty. On the other hand, technology innovations opened the way to work across boundaries in a remote way, which is known as virtual teams. The trend of virtual teams was increasing, yet, the experience from the past two years brought to light the importance of human relations while working remotely (Jenkins, 2021 in Riccio, 2021) especially for organizations in highly collaborative environments.

Collaboration in the pre-construction phases requires cross-disciplinary interactions to exchange information across organizations through a shared information and communication technology (Sepehr & Ibrahim, 2017). Collaboration in construction projects is complex even without adding the lack of human interaction faced by virtual teams. Awareness of factors such as communication, team-building, and trust increased in the last year since these were affected by virtuality. Trust influences team performance regardless of the work environment (virtual or not) (de Jong et al., 2016). Without the right strategy, virtuality might obstruct trust-building and communication for new teams or new team members. Hence, when researching, developing, and evaluating potential virtual teams, companies should take into account human and organizational aspects (Rezgui, 2007).

Research regarding collaboration should incorporate the human factor as a variable, that is including elements such as goal alignment, integration, project parties' relationships, or willingness for collaboration and cooperation. Research regarding virtual teams highlights benefits such as travel cost reductions, facilitation of coordination, communication, knowledge sharing, and improving organizational performance. Yet, their execution has been slow and with various levels of success (Sepehr & Ibrahim, 2017). This could be attributed to virtual teams' weaknesses and threats such as client acceptance, decreased monitoring, organizational barriers, participants' perceptions, and

cultural differences (Odubiyi & Oke, 2016).

Furthermore, virtual teams research has been performed when videoconferencing was not available to everyone (Lurey & Raisinghani, 2001); without separating between short and long term teams (Lurey & Raisinghani, 2001); when team members were not forced to work in this configuration (Lee-Kelley et al., 2004); in different market sectors (Lee-Kelley & Sankey, 2008; Daim et al., 2012); or the construction industry in other cultural environments (Rezgui, 2007; Hosseini & Chileshe, 2013).

Taking into account the shift in the construction industry towards relational contracts such as the bouwteam process, the complexity and peak of collaboration in the pre-construction phases, the need to incorporate the human factor as a variable by focusing on soft aspects of the industry, the technology innovations that allow working across boundaries, and the lack of research of virtual teams in short distance teams; this research focuses on studying the collaboration of virtual teams in the design phase (bouwteam phase) of bouwteam agreements. Therefore, this study will include soft and hard factors due to their importance for project performance.

1.3 Research objective

The research seeks to seize the opportunity to expand the traditional working scope into a virtual or hybrid one in a way that doesn't jeopardize the performance of projects but rather improves it. Since one key aspect necessary to reach project success in the construction industry is collaboration, the research will take this element into account. That is, the research will address the influence collaboration could have on virtual teams as a way to improve their application. The goal will be reached by analyzing the current state of virtual teams and collaboration, examining the current perception of practices, identifying the barriers, and recognizing ways in which this can improve based on participant perspectives and existing literature.

The research objective is to promote and enhance the implementation of virtual teams in the construction industry by analyzing current virtual team collaboration.

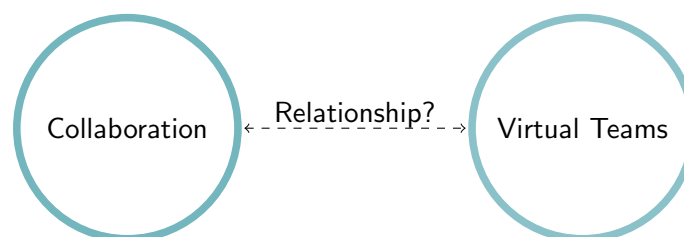


Figure 2: Collaboration vs Virtual teams

1.4 Research questions

In line with the problem statement in section 1.2 and the research objective in section 1.3, the main research question can be phrased as:

How focusing on collaboration improves virtual teams in the bouwteam phase?

Four sub-questions were formulated to help find an answer to the main research question. These sub-questions are shown in table 1 as well as the technique used to obtain their answer. In chapter three there is a more detailed discussion about the methodology and techniques used in the research.

Table 1: Research subquestions

What are the factors regulating collaboration and virtual teams?	Literature review + Semi-structured interviews
How is the current collaboration in bouwteams?	Case study + Semi-structured interviews
Which changes are required to overcome the challenges of virtual collaboration in the bouwteam phase?	Literature review + Cross-case analysis
Are the developed recommendations considered useful to improve virtual teams collaboration?	Expert validation

To solve the problem statement it is important to acquire the necessary knowledge to draw a suitable solution. First, it is important to define the elements that generate a positive or negative impact on the performance of virtual teams and collaboration (SQ1). Second, as the design phase is complex, it is important to gain information on the processes and the strategies currently applied in practice (SQ2). Building from the answers to the first two subquestions a set of recommendations can be drafted to improve the collaboration of virtual teams and ultimately improve their performance (SQ3). Finally, it is important to validate the designed guidelines to confirm their applicability in the design stage (SQ4).

1.5 Research scope

This section defines the boundaries of the research. The goal is to clarify the domain in which the research is going to take place and to identify the field in which the research will broaden the body of knowledge. The research questions will be answered within the scope boundaries mentioned in this section. This research is carried out in collaboration with PRO6 managers.

1.5.1 Included in the scope

The study will focus on dispersed teams collaborating virtually towards a shared goal, more specifically on dutch construction teams known as "bouwteams". Consequently, the unit of analysis of the study is project teams. Since one of the key aspects of the research is collaboration, the main focus of this study is on the design stage. During this phase, there is a large number of stakeholders involved, high interdependence of tasks, and high uncertainty towards the final output of the project. These aspects put forward an interesting playing field for research into managing projects through virtual teams. Therefore, this research will include the initiation of design to the completion of the price negotiation. The research will analyze the problem from three lenses: the

client, the contractor, and the consultant. Lastly, the research will focus on the hard and soft sides of projects. Complex projects require a balance between both to be managed efficiently.

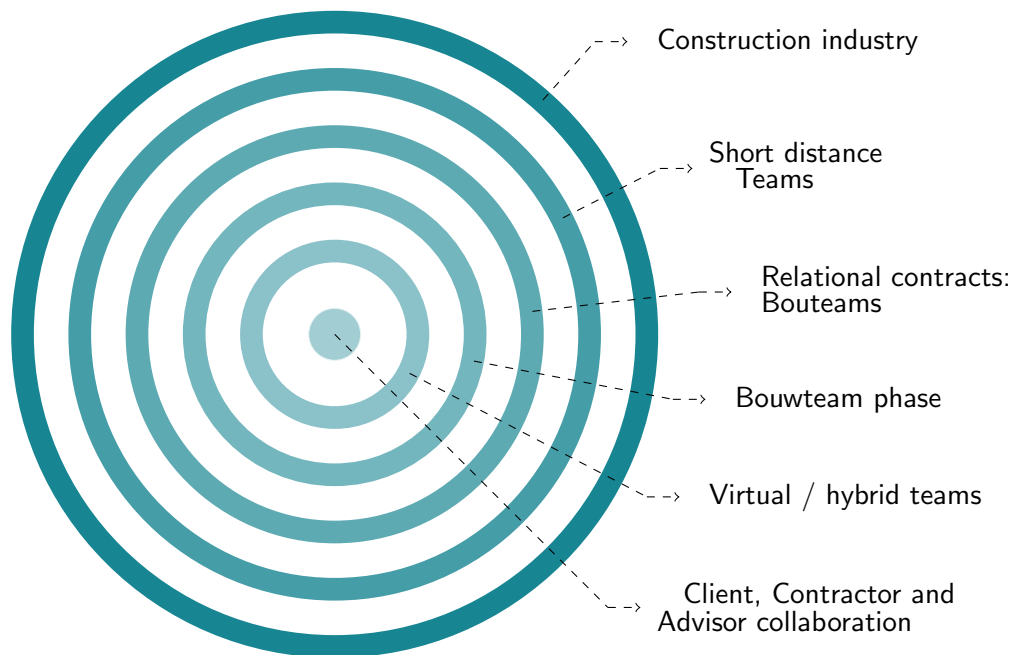


Figure 3: Research scope

1.5.2 Excluded in the scope

The focal point of the research is the bouwteam phase of projects, the role of virtual collaboration in other phases is not included in the scope of this research. Moreover, the research will not focus on a specific type of project e.g. real estate, oil and gas, infrastructure. Finally, since culture plays a part in the performance of collaboration, the study will only focus on teams collaborating in the Netherlands.

1.6 Research method

The research will be executed in four parts following the scheme in Figure 2. The exploration phase aims to do a appraisal of the existing literature in virtual teams and collaboration to identify current studies in the field, the results as well as the potential needs in the domain. This method is also known as the literature review. It allows exposing the current state of knowledge in the two main topics of this research: virtual teams and collaboration in relational contracts. The next step is to gather practitioners' perspective. As stated in section 1.5, the research is done in collaboration with PRO6 managers. In coordination with the company, four case studies were selected to collect data for phase two. The implementation of multi-case studies allows to I) get a better understanding of the problem and possible solutions, and II) cross-referencing the information, eliminating biased information, and obtaining a more reliable solution. In the research, semi-structured interviews are conducted to gather the team members' perspectives. The goal of the interviews is to get a practical perspective regarding the challenges, lessons learned, and

improvements required in the bouwteam phase when collaborating remotely. Third, by analyzing the data collected in the previous phases a solution can be found that answers the main research question. This phase aims to reduce the existing gap between theory and practice. Lastly, the results are validated to produce a trustworthy outcome. This is done through interviews with experts in the field once again coordinated with PRO6 managers. This approach aims to build sequentially upon each previous step. It also supports finding an answer to each sub question, and ultimately, the main research question. Further explanation of the research methodology is given in chapter three.

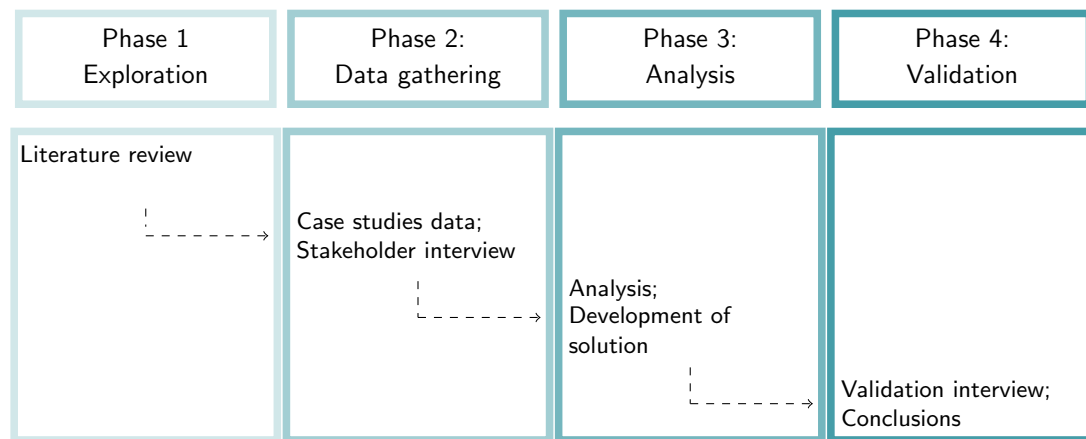


Figure 4: Research methodology

1.7 Research criteria

This research must meet the requirements described below. Therefore, it must be conducted in a manner in which the criteria are met throughout the investigation. In chapter seven a discussion will be done to assess whether the research meets these criteria.

1.7.1 Reliability

Reliability is the first criterion. Hernon & Schwartz (2009) explains the importance of reliability in research for both qualitative and quantitative; he further explains how it can be estimated for instance: internal consistency, pretest, test and retest. The first criteria refer to the compatibility in the information and concepts used in the research. The second concerns the review of the wording in questionnaires to ensure the meanings of the questions are clearly understood. The last, reflect the reproducibility of the results i.e. it measures up to which point similar results can be obtained by asking the same participants the questionnaire a second time (Hernon & Schwartz, 2009). To ensure the reliability of phases two and four, the interviews and expert validations will be recorded. According to Seidman (2006) recording the interviews allows the research to retain the original data, which provides various benefits e.g. accuracy, accountability, and confidence for the participants. First, it allows the researcher to access the original data to assess the precision of interpretation (accuracy). Second, it enables the researcher to demonstrate the grounds for the results (accountability). Lastly, it assures the participants that their input is going to be handled fairly and responsibly (Seidman, 2006).

1.7.2 Validity

Hernon & Schwartz (2009) argues that qualitative research must have credibility and transferable i.e. the research must be internally and externally valid. Internal validation consists of two parts; I) whether the research has the correct interpretation of the findings, and II) the extent to which the instruments used in the research accurately measure what they intend to measure. External validation refers to the level of generalization of the findings (Hernon & Schwartz, 2009). For this research, external validation implies that the findings should apply to the hybrid bouwteams who participated in this study, but also to the rest of the bouwteams working in the same manner. Therefore, the data collected should be as representative as possible to comply with this criterion.

1.7.3 Integrity

Klumpers (2018) argues that a cause for questionable reproducibility of researches is the lack of integrity. Therefore, that is the last criteria this research must meet. Klumpers (2018) also argues that performing the research in a professional, rigorous, and ethical way provides benefits such as an increase in the quality of research, and an increase in trust between scientists. To satisfy this requirement, the research will be performed professionally, the researcher must carry meetings with the committee to assess whether the study is being performed according to standards.

1.8 Report outline

Chapter one sheds light on the context and importance of the research. It highlights the problem on which the investigation is focused. It describes the study objective, questions, scope, method, and criteria. This chapter sets the basis of the research. Chapter two presents the existing knowledge regarding virtual teams and collaboration in relational contracts. It provides an analysis of the information and shows the theoretical background of the research. Chapter two includes all the relevant details of the study in terms of the analysis and design of the results. Chapter three clarifies the research methodology for phases two, three, and four, i.e., it contains the approach used to gather the information and make the analysis of it. The research uses case studies as a method of analysis and desk research combined with semi-structured interviews as the instruments to gather the data. Chapter four elaborates on the analysis of the data gathered from the case studies interviews while chapter five describes the cross-case analysis. The first third of chapter six shows the initial set of recommendations made, the second third describes the validation of said recommendations while the last part describes the final set of the recommendations to improve current practices in virtual teams. Chapter seven shows the discussion, limitations of the research and describes how virtual teams can be incorporated into the bouwteam process on short-distance teams. Figure 5, illustrates the report outline.

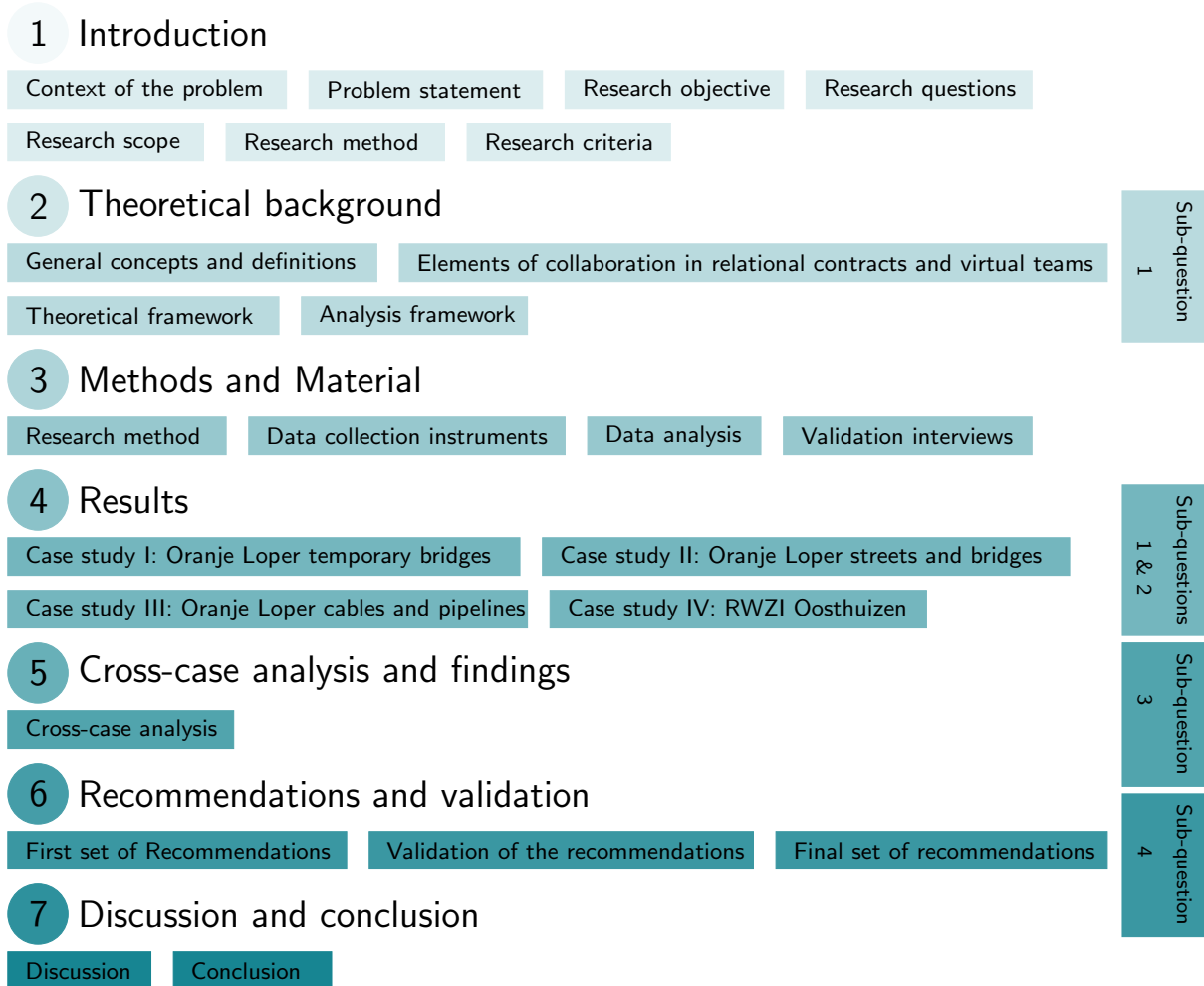


Figure 5: Research outline

2 Theoretical background

The goal of the research is to identify ways to improve the adoption of remote working in bouwteams without damaging the collaboration. Before discussing its application it is important to gain an understanding of the current knowledge available and unavailable regarding virtual teams and collaboration in bouwteams. The first step of this research is to perform an exploratory literature study consisting of two parts. Sections 2.1.1 to 2.1.4 define the key concepts of the research. Section 2.2.1 focuses on the agents influencing the collaboration between all the parties involved in a contract, more specifically those of a high collaborative nature such as early contractor involvement, alliances, and joint ventures. Although the subject of attention is the bouwteams, section 2.2.1 doesn't neglect knowledge gained from other types of contract that also requires high levels of collaboration. Section 2.2.2 focuses on virtual teams and the factors influencing their adoption and performance. This chapter aims to answer part of the first research sub-question.

What are the factors regulating collaboration and virtual teams?

2.1 General concepts and definitions

This section shows the definitions used in this research for the concepts of collaboration, bouwteams, virtual teams and short distance teams. It also provides background information about each term, the components that integrate them and their relevance for the construction industry.

2.1.1 Collaboration

The basis of the construction industry is project development. There are different actors with conflicting interests who play a part throughout the process. The interaction between these actors is deemed necessary to reach the final outcome of the project. Yet, in traditional methods, the quality of these interactions is considered poor. Traditional approaches tend to create win-lose situations, which in turn influence the behavior of the actors involved (Hertogh & Westerveld, 2010; Jelodar et al., 2016). It creates an ineffective, fragmented and adversarial environment characterized by the lack of trust which in turn affects project performance (Rezgui, 2007; Franz et al., 2017). Likewise, pre-construction phases are considered the foundation for the project and determine the outcome. During these phases, there is an interdependence of elements and uncertainty in goals and

methods which increases project complexity. Both project complexity and fragmentation, demand other project management approaches (Bosch-Rekvelde & Jalali Sohi, 2018). Literature shows a positive link between increasing the degree of collaboration and project success (Bond-Barnard et al., 2018; Suprpto, 2016).

Collaboration has been considered a promising solution to organizational and societal problems. It fosters constructive problem solving from different perspectives (Gray & Wood, 1991). This is done through interactions between actors within the same or different organizations. Collaboration within the same organization, i.e. between different teams or levels of hierarchy, is defined as intra-organizational (Oxford-reference, 2021b). Collaboration among different organizations, that is, between clients, contractors, and suppliers, is defined as inter-organizational (Oxford-reference, 2021a). The definition of collaboration varies across the literature. It has been described as I) merely a required interaction to complete a set of tasks (Sepehr & Ibrahim, 2017) II) a shared effort in which the exchange of information, ideas, or useful resources is needed to accomplish a common purpose (Jalali et al., 2021) and III) as a process on which not only shared effort to achieve a joint goal is important, but also the proper infrastructure and environment to support it (Mills, 1998).

Collaboration is often used as an umbrella term for relational contracts i.e. alliancing, joint ventures, and partnering (Jalali et al., 2021). Hughes et al. (2012) argue that the concept sometimes is used to describe any type of working together. The terms collaboration, cooperation, and coordination are sometimes implemented interchangeably in the literature (Jalali et al., 2021; McNamara, 2012). McNamara (2012) research sheds light on the nuances between each term through ten categories. Among these are design, the formality of the agreement, organization autonomy, information sharing, and decision making. According to McNamara (2012), decision-making in cooperation, coordination, and collaboration is independent, centralized, and participative respectively. Going through all the possible definitions, collaboration in this research will be defined as:

A process of intra and inter-organizational interactions where the appropriate conditions are needed to support the exchange of knowledge, information, and resources to achieve a common goal.

Although the definitions of collaboration vary to a certain degree, literature often shows there is a positive connection between its implementation and project performance (van de Hoef, 2020; Oraee et al., 2017). According to Bond-Barnard et al. (2018) team member relationships are important to enable collaboration. A stronger collaborative relationship between the stakeholders may facilitate the delivery of the project in time, budget, and quality (Loosemore & Lim, 2021; Sepehr & Ibrahim, 2017; M. & McGeorge, 2009). Therefore, the selected project strategy, such as type of contract or early involvement, defines the dynamics by shaping the stakeholders' attitudes towards the project (Aaltonen et al., 2015). Hertogh & Westerveld (2010) agree with this, they also argue that the alignment of the stakeholders' interests tends to dominate their behavior which in turn has an effect on the output or result of the project. Oliveira & Rabechini (2019) also emphasizes the importance of stakeholder management from the start of the project, they argue that early

management has a positive influence on trust-building which in turn influences collaboration.

Building a proper strategy and management from the beginning might set the path for project success or failure (George et al., 2008). Literature shows that the earlier the stakeholders are involved in the process the more likely it is to reach their expectations (Brazier et al., 2018). An approach that follows this notion is early contractor involvement (ECI). It seeks to increase the value of the project by engaging the contractor from the earliest stages of design (Song et al., 2009). By integrating the contractor's experience into the design, it could achieve benefits in terms of constructability, risks, optimization, construction methods, material assessment, and local practices (Wondimu et al., 2020). ECI also fosters a better relationship between all stakeholders which in turn is reflected even in the execution phase (Song et al., 2009). Different contracts follow this approach such as integrated project delivery, partnering, and alliances. These are also known as relational contracts since they promote a relationship based on mutual respect, good faith, open and active communication, and commitment to improvement between the actors (Moe et al., n.d.). In the Netherlands, the construction team (Bouwteam) and Interweaving are two contract forms that follow the ECI approach (van Wijck, 2018). Since the focal point of this research stated in section 1.5 is the bouwteam, the following section will shed more light on the definition, and composition.

2.1.2 Bouwteams

Early contractor involvement is fundamentally based on higher collaboration relationships between client and contractor in the preconstruction phases. In the Netherlands, a way to implement ECI is through the bouwteam approach. Bouwteams is defined by de Hoog (2020) as:

'The bouwteam is a temporary collaboration agreement during the design phase in which the participants - including at least client, contractor, and designer - cooperate towards a feasible design with an associated risk log and a building contract. To this end, each of the participants performs the tasks related to their experience and expertise while retaining their independence and responsibility.'

It is important to determine the starting point of this temporary collaboration agreement. Figure 6 shows the four main stages in the bouwteams; tender, design, price negotiation, and construction. It also depicts the involvement of each party throughout the process. Yet, de Hoog (2020) divides the design phase in two parts; the project start-up and the design itself emphasizing the importance of team building and the definition of a common goal at the start of the project (de Hoog, 2020). The start-up phase also allows organizations with different cultures to establish practices that facilitate their interaction (Seidman, 2006).

“Remember teamwork begins by building trust. And the only way to do that is to overcome our need for invulnerability.” — Patrick Lencioni

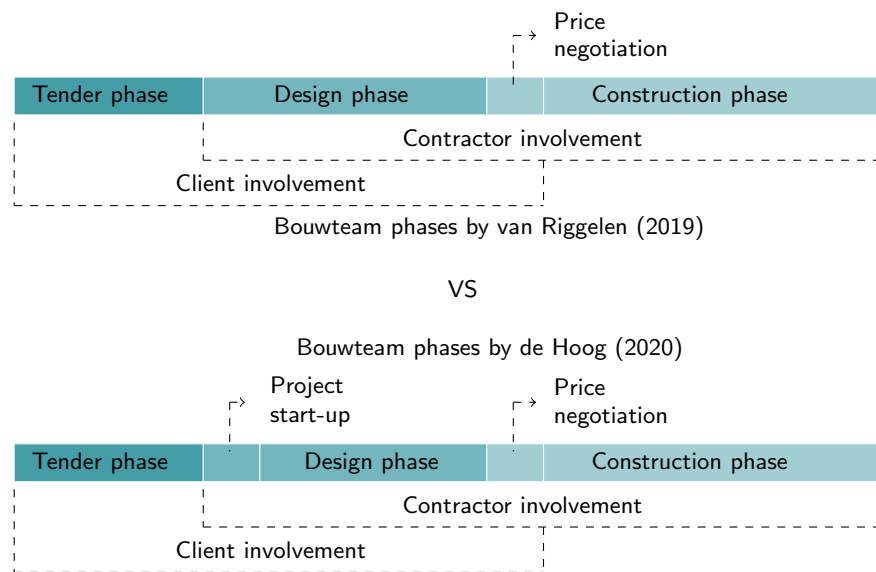


Figure 6: Bouwteam phases by van Riggelen (2019) and de Hoog (2020)

2.1.3 Virtual teams

As mentioned before, innovation in information and communication technologies coupled with globalization made it possible to work across boundaries. Companies have the opportunity to implement virtual teams through management and industry-specific tools such as Microsoft Teams, or BIM methodology. But virtual team adoption requires more than technology; the mix levels of success are a proof of that (Sepehr & Ibrahim, 2017). Companies need to prepare themselves with practices that allow them not only a smooth and successful transition to this environment but help them to remain competitive in the long run.

Although virtual teams have been around for more than 20 years; there is not an agreed definition throughout the literature. Some definitions found are I) limiting virtual teams in terms of collaboration through information and communication technologies (ICTs) (Sepehr & Ibrahim, 2017); II) incorporate geographical dispersion as another characteristic (Fruchter, 2014; Lurey & Raisinghani, 2001); III) adding temporal dispersion as the second dimension (Odubiyi & Oke, 2016; Dulebohn & Hoch, 2017); and IV) combine the previous definitions with cultural dispersion (either by language, organizational or professional) (Mors & Waguespack, 2021; Zakaria, 2017). Hosseini & Chileshe (2013) conclude that the variations in the definition are the result of a difference in hypothesis and approaches for the investigations; as a result, they call for further research to determine the conceptual interpretation of virtual teams. Bearing in mind the possible definitions, for the purpose of this research virtual teams will be referred to as:

Teams collaborating mainly through ICTs who are geographically and culturally dispersed.

Moreover, geographically dispersed teams, dispersed teams, and remote teams will be used as synonyms of virtual teams throughout this report.

"It is the long history of humankind (and animal kind, too) that those who learned to collaborate and improvise most effectively have prevailed." — Charles Darwin

2.1.4 Short distance teams

As stated in section 1.1 and 2.1.3, virtual teams have been implemented for years in different industries. Multinational companies have used it to stay competitive or to share information relevant to the development of the project. Others also implement it as a learning tool to improve their processes or strategies (Wiewiora et al., 2020). Yet, virtual teams have been explored mostly from the perspective of long-distance groups (Wiewiora et al., 2020). This research focuses on short-distance groups which are defined as:

Teams that are integrated by members located within the same country, state, or city who could travel daily to the office or construction site of the project.

2.2 Elements influencing collaboration in relational contracts and virtual teams

This section is divided into two parts; section 2.2.1 discusses the factors found in the literature related to collaboration in relational contracts while section 2.2.2 addresses the factors associated with virtual teams adoption. Literature shows there are three types of research regarding collaboration or virtual teams: I) studies focused on finding the factors that affect it, II) investigations in which these concepts are combined with others such as project success, satisfaction, or stakeholder management, and III) studies that focus on aspects known for their influence on either. The highlights of said researches will be discussed below.

2.2.1 Elements influencing collaboration in relational contracts

Collaboration has been considered an integral part to achieve project success (Patel et al., 2012; Suprpto, 2016; Sepehr & Ibrahim, 2017). Therefore, it is essential to identify the factors that have the potential to influence its performance and get acquainted with the most recent developments, ideas, and solutions in the field i.e. the state of the art in collaboration research. This section aims to describe such knowledge. This section will act as a foundation pillar for this study since it will contribute to the development of the research framework.

To date, there has been some research focused on developing collaborative frameworks. An example of this is Patel et al. (2012), they examined through literature and empirical work the factors affecting collaboration. Their research resulted in a comprehensive framework with seven main categories: context, support, tasks, interaction processes, teams, individuals, and overarching factors. Their research is thorough, yet it acts as a general source for three different industries: construction, aerospace, and automotive. In the construction industry, the use of relational contracts between clients and contractors produced different levels of success (Suprpto, 2016). This begs the question of what are the causes for this mixed performance? and what are possible solutions for it?. Suprpto (2016) concerned with this issue researched the conditions behind this behavior and ways to improve it. His research results yielded two sets of elements that moderate the project performance and relationship continuity; he named them antecedents and mediators. The antecedents include relational attitudes, team integration, joint working, commitment, capability and contract. The

mediators include teamwork and team trust. Moreover, Jelodar et al. (2016) and Ptschelinzew et al. (2020) concerned about the lack of collaboration and good relations in the construction industry, developed a conceptual framework of relationship quality. They describe the necessary attributes to foster good relations between the stakeholders such as trust, commitment, teamwork and strategy, among others. Lastly, Larsson & Larsson (2020) researched the means to encourage collaboration in sustainable projects. According to them, the intensity of the collaboration, the number and levels of people engaged play a role in collaboration performance. Most of the elements mentioned in the research of Suprpto (2016), Larsson & Larsson (2020), Jelodar et al. (2016) and Ptschelinzew et al. (2020) overlap with the framework of Patel et al. (2012) except for the category joint working and sub-element long-term orientation.

The degree of collaboration can be moderated by coordination in the project (Bond-Barnard et al., 2018). In coordinative interactions, leadership is considered a crucial element for establishing an example and encouraging commitment (McNamara, 2012). There are different types of leadership styles; yet, for joint ventures, the autonomy of the team has been positively linked to project efficiency and effectiveness (Bener & Glaister, 2010). This indicates that higher levels of autonomy in teams correspond to a higher degree of meeting the project expectations.

Likewise, the relationship between stakeholders has been highlighted for their importance in collaboration (Bond-Barnard et al., 2018). Stakeholder relationships can be managed through two different approaches called prescriptive and relational management. Both are important for project management since the first one allows the identification, classification and monitoring of the stakeholders while the second one seeks their involvement and engagement. Yet, relational management tends to foster trust by involving and engaging the stakeholders. According to Oliveira & Rabechini (2019) there are four types of trust: relational, intuitive, integrity, and competence. Yet, an intuitive trust formed by empathy and demonstration of interest in needs and expectations has a slightly higher weight over the others. Therefore, project managers need to foster trust by implementing relational management focusing on showing interest in the needs and expectations of the stakeholders.

A connection between contract completeness, cooperation, and project performance has also been found in the literature. There is a systematic relationship between these three concepts. Previous cooperation tends to create an adaptive and flexible environment towards risks. This assists the structuring of the contingency terms on formal agreements, resulting in a more complete contract. Contract completeness creates a stronger positive relationship that encourages future cooperation. Both cooperation and contract completeness influence project performance (Luo, 2002). Contract completeness is crucial to reduce risks, yet it does not restrict stakeholders' extra-role behavior ¹. Prior cooperation tends to have a positive influence on in-role and extra-role behavior (Wang et al., 2017).

Misconception between stakeholders, team integration, and cohesion are also mentioned

¹In-role behavior refers to the minimal effort necessary to comply with the role description. On the other hand, extra-role behavior refers to the extra efforts made from the participants to enhance the project (Wang et al., 2017)

as determinants of collaboration. Regarding misconception, some measures that are considered to counter it are: having prior collaboration, including early in the process the stakeholders and having an adequate conflict resolution plan (Ptschelinzew et al., 2020). Concerning team integration and group cohesion, they are also considered to have a positive impact on project performance. Early contractor involvement tends to promote higher levels of team integration. While the implementation of open-book contract terms and a selection based on qualifications foster group cohesion (Franz et al., 2017).

Team member perspectives tend to regulate their attitude which affects collaboration and ultimately project performance. de Hoog (2020) researched bouwteam members perspectives towards collaboration. The research result yielded three perspectives: relationship first, structure first and early involvement of the right people. All of them agree that mutual trust and a clear scope definition in the early phases are essential for bouwteams collaboration (de Hoog, 2020).

Collaboration is important for project success. Therefore, different collaborative contracts were implemented in the industry, yet their performance was varied. Concerned about this, researchers studied this phenomenon and linked different elements as determinants of collaboration. They have done it either directly developing a collaborative framework or indirectly to provide a ground for their research. Yet, most of the studies agree to a certain degree concerning the elements that impact it. Bearing this in mind, for this research, the factors considered to influence collaboration in relational contracts are depicted in figure 7.

"A successful team is a group of many hands and one mind." – Bill Bethel

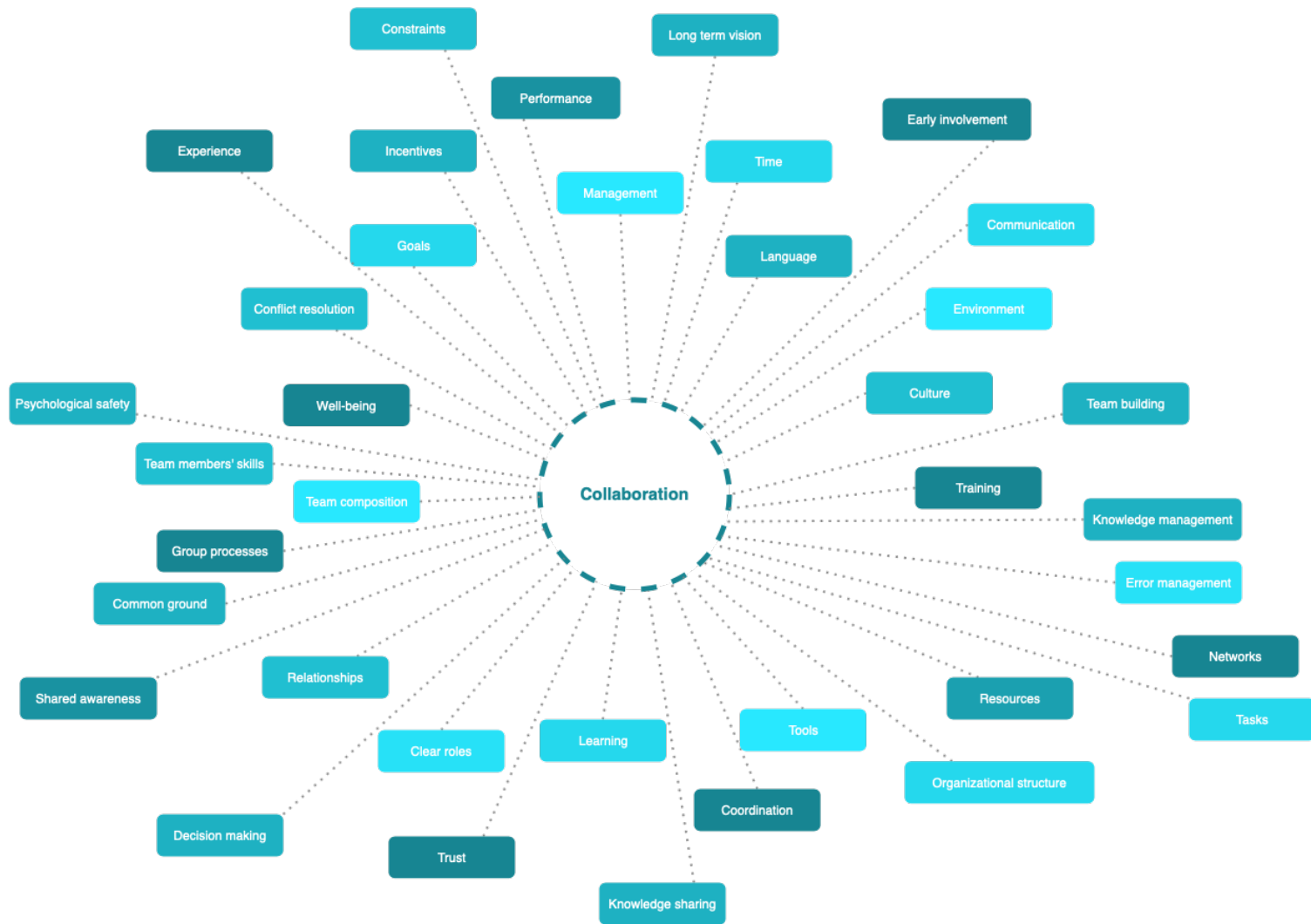


Figure 7: Factors influencing collaboration

2.2.2 Factors that facilitate virtual team adoption

As stated in section 1.5, the final goal is to implement virtual teams successfully in bouwteam projects. Therefore, it is crucial to gain a comprehensive overview of what has been done and what remains to be done. In other words, the state of art in virtual teams' performance and implementation. It is also important to gain an understanding of the factors that facilitate or impede its adoption. This section elaborates on such knowledge. Both, this section and section 2.2.1 will contribute to the development of the research framework.

Virtual team's performance and satisfaction have been assessed through three types of predictor variables: internal group dynamics, external support mechanisms, and design processes (Lurey & Raisinghani, 2001). The first variable refers to factors such as team member relations, team processes, internal leadership, among others. The second variable refers to executive leadership, tools, communication patterns, incentives, and training. A high correlation was found between effectiveness and satisfaction, which in turn, were mostly affected by team processes and team member relations. This would imply that relying purely on the most advanced technology does not guarantee effectiveness; rather, special attention must be put on internal group dynamics and external support mechanisms (Lurey & Raisinghani, 2001). Yet, senior management and team members tend to emphasize different factors. The former tends to give more importance to hard factors, such as processes, communication infrastructure, terms and conditions. The latter highlights the value of soft ones such as trust, commitment, motivation, communication, and recognition (Lee-Kelley et al., 2004).

Virtual teams have also been analyzed from their transition between Tuckman's stages of team development². Teams that have a quick transition from the forming to the norming stage have a better performance. To achieve this, teams need to set the norms from the start of the project (Lee-Kelley et al., 2004). Therefore, it is necessary to be aware of the issues that teams might face. Some of these are unclear roles and responsibilities, over-communication, cultural differences, trust, and training, among others. Tackling them will allow reaching project success (Lee-Kelley & Sankey, 2008). Yet, based on the analysis of Verburg et al. (2013), the correct implementation of virtual teams needs two conditions: I) communication/collaboration based on clear communication, rules and trust; and II) organizational support such as tools, infrastructure, policies, rewards.

For project managers working in collocated or dispersed teams, reputation and accomplishment are significant drivers. In the same line, trust, clear communication, technical and overall corporate support are important elements for task completion (Verburg et al., 2013). This last statement contradicts Lurey & Raisinghani (2001) results where they state that communication patterns don't have a substantial relation to performance or satisfaction.

Gilson et al. (2015), Dulebohn & Hoch (2017), and Jimenez et al. (2017) researched the

²In 1965 Tuckman in his article "Developmental Sequence in Small Groups" lists four linear stages unavoidable to reach effective group functioning known as "Tuckman's model of small group development". After almost a decade, in 1977 Tuckman and Jensen added one more stage to the model resulting in five stages: forming, storming, norming, performing, and adjourning (Bonebright 2010:114).

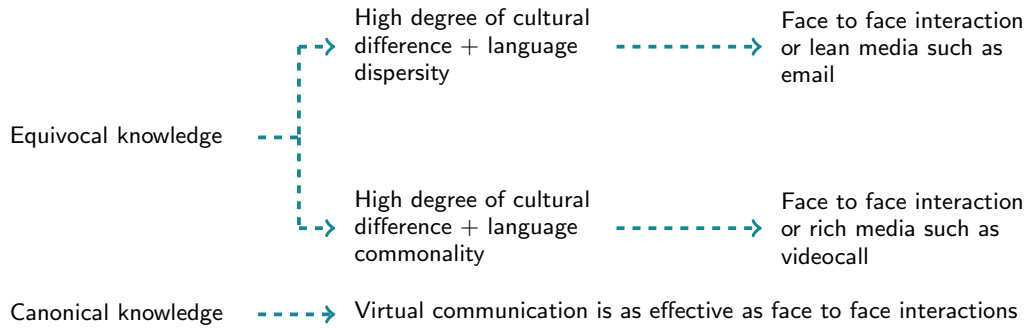


Figure 8: Type of media for knowledge sharing by Klitmøller & Lauring (2013) (Own figure)

state of art in virtual teams at the time and provide a list of future research in the field. During their analysis, they mention some factors deem important for dispersed teams and some of the challenges they face such as institutional differences, or group fragmentation. Ruiller et al. (2019) mentions perceived proximity as a challenge of virtual teams since it affects relationship quality which in turn influences project success. Shared identity and communication are highlighted for their influence to counter perceived proximity.

According to Mors & Waguespack (2021), researchers working in virtual teams tend to have faster success but struggle to recognize failure. That is, once resources have been invested in the research, teams find it difficult to recognize the moment when it is no longer feasible to continue with the investigation. Therefore, teams need to consider throughout the process whether it is feasible to keep working on the project to avoid wasting resources.

Learning flows also have an impact on virtual teams' performance since it allows the individual, the team, or the organization to improve. To facilitate them, teams and organizations need a culture of empowerment, promote or restrict ideas through power and politics, sessions of coaching and mentoring to share projects issues and experiences, and focus on deliverable and results (Wiewiora et al., 2020).

On the other hand, communication breakdown causes poor performance in cross-functional communications. This can be solved by having a stronger presence of company culture as it fosters effective communication (Daim et al., 2012). Media richness, cultural difference, and language commonality have an impact on knowledge sharing in virtual teams. To improve knowledge sharing, the solution must take into account the type of information that is being transferred i.e. whether it is canonical or equivocal information³. The scheme showed in figure 8 summarises a solution by Klitmøller & Lauring (2013).

The literature described above was carried out in a mixed industry, so this information can be implemented in a general way. The literature focused on the construction industry is described below. Rezgui (2007) modeled a system for virtual teams adoption focused on three types of

³Canonical knowledge refers to information that can be interpreted easily without confusion. Equivocal knowledge refers to complex information that may lead to misinterpretations.

roles. They conducted questionnaires, interviews, and evaluation forms to map, describe, develop and assess their model which focuses on promoting software application through a service provider. Hosseini & Chileshe (2013) researched the state of art in construction virtual teams at the time and provide a list of future research in the field. Hosseini et al. (2016) developed a framework where the factors affecting perceived virtuality ⁴ were categorized into two groups: predictors and moderators. Context disparity and degree of dispersion are considered the predictors while situational factors such as individuals' knowledge, skills and abilities (KSAs), handling relationships, and history of cooperation are considered the moderators. Odubiyi & Oke (2016) developed a SWOT ⁵ analysis of virtual teams in Nigeria. The analysis allowed them to give a set of recommendations for the adoption of dispersed teams in the industry such as the being flexible and open about virtual teams, or being understanding and accepting cultural differences among team members. Sepehr & Ibrahim (2017) analyzed the impact of virtual collaboration on project progress monitoring. They argue that the implementation of virtual collaboration increases effective time control, cost control, and quality control. They also provide a list of variables found in the literature on which they measured virtual collaboration. Jutraz & Zupancic (2018) analyzed the learning experiences gained by a group of students in dispersed teams participating in a collaborative design studio. They enlist the challenges faced by the students as well as the facilitators that allowed them to collaborate more easily. Hosseini et al. (2018) validated the conceptual framework proposed by Hosseini et al. (2016). Their results show that the factors task nature, degree of dispersion, and size of teams don't impact the perceived virtuality on teams.

Lastly, in the wake of the pandemic, journals and researchers got interested in dispersed teams and the issues organizations are facing due to social distancing. Kniffin (2020) enlists the emergent changes in work practices and issues organizations faced. Müller & Klein (2020) provide four streams of future research to increase organizational resilience through lessons learned of response strategies during the pandemic. Assaad & El-adaway (2021) provide a list of possible future research streams related to the pandemic. Lastly, Hosseini et al. (2020) highlights the threat of sick building syndrome faced by dispersed teams when they lack adequate space to work.

Bearing the information above in mind, three conclusions can be made. First, virtual team research has been around for more than 20 years, and most of the research has been carried out for mixed industries or others than the construction industry. Second, due to the recent experience with virtual teams in the construction industry, there is an opportunity to investigate further its application in the field. Third, throughout the literature, researchers have linked different elements as determinants of virtual teams, and most research coincides to some degree concerning the factors. Said elements are depicted in figure 9.

⁴Their concept of perceived virtuality resembles the definition of perceived proximity by Ruiller et al. (2019). Hosseini et al. (2016) research focuses on "hybrid teams" which is defined as those who work both face-to-face and through ICT's without regard to geographic location.

⁵SWOT is the acronym for "Strength, Weaknesses, Opportunities, and Threats". The SWOT analysis allows the identification of internal factors and external factors of projects. This type of analysis is implemented for strategic planning

“The way a team plays as a whole determines its success. You may have the greatest bunch of individual stars in the world, but if they don’t play together, the club won’t be worth a dime.” – Babe Ruth

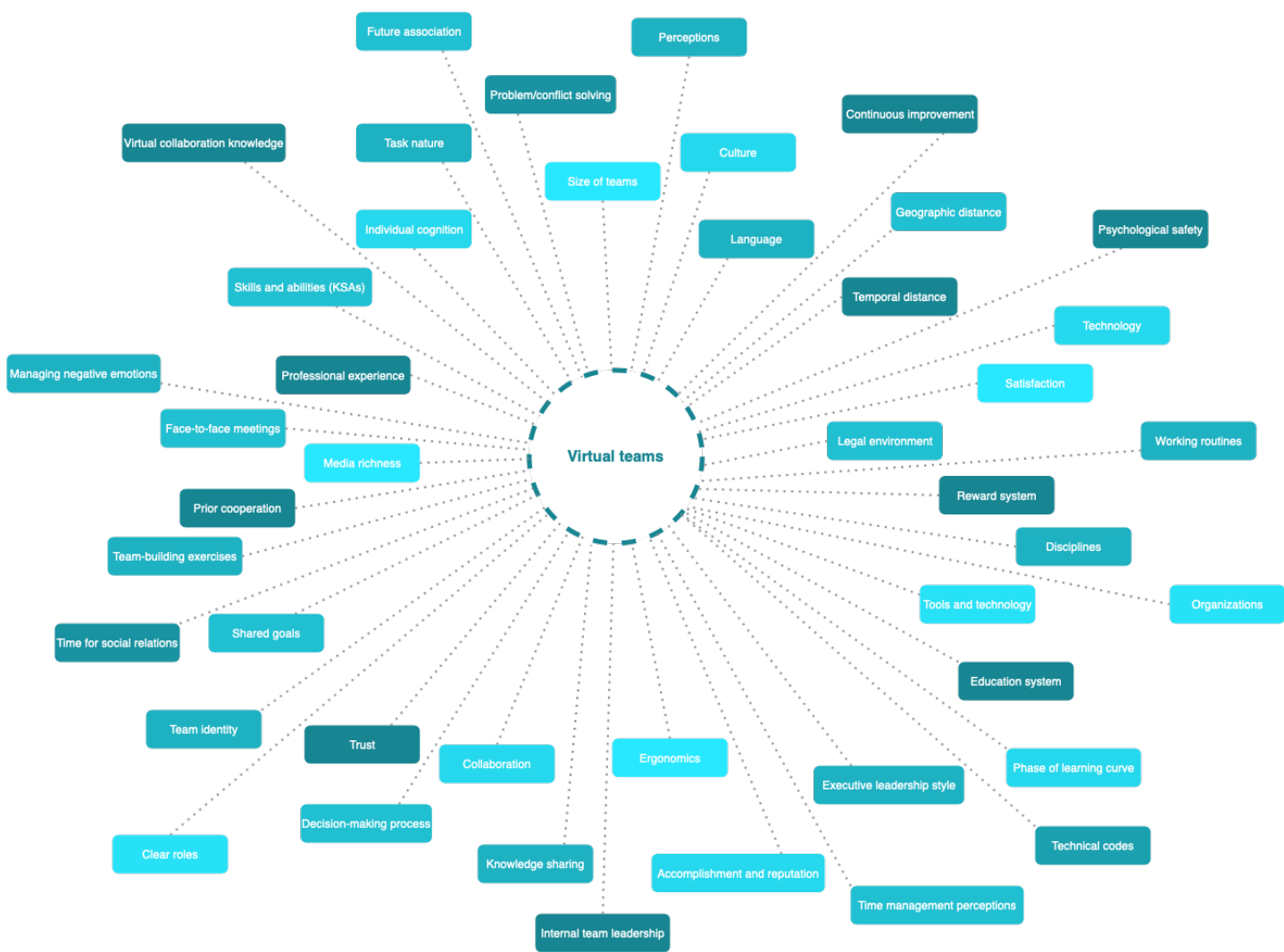


Figure 9: Factors influencing virtual teams

2.3 Research theoretical framework

In the past sections, the research key terms were defined and the factors influencing their performance were identified. In this section, a comparison between the findings of sections 2.2.1 and 2.2.2 is done to reflect on the factors that influence the application of virtual teams as well as collaboration which is considered a fundamental part of the bouwteam agreement. Figure 10 depicts the elements where both fields match as well as the factors where they dissent. Most of the elements affecting virtual teams are related to the ones influencing collaboration. There are some exceptions, for instance, team identity, media richness and psychological safety are highlighted in virtual teams literature for their influence on its performance. While collaboration in relational contracts stresses the involvement of stakeholders as early as possible in the process.

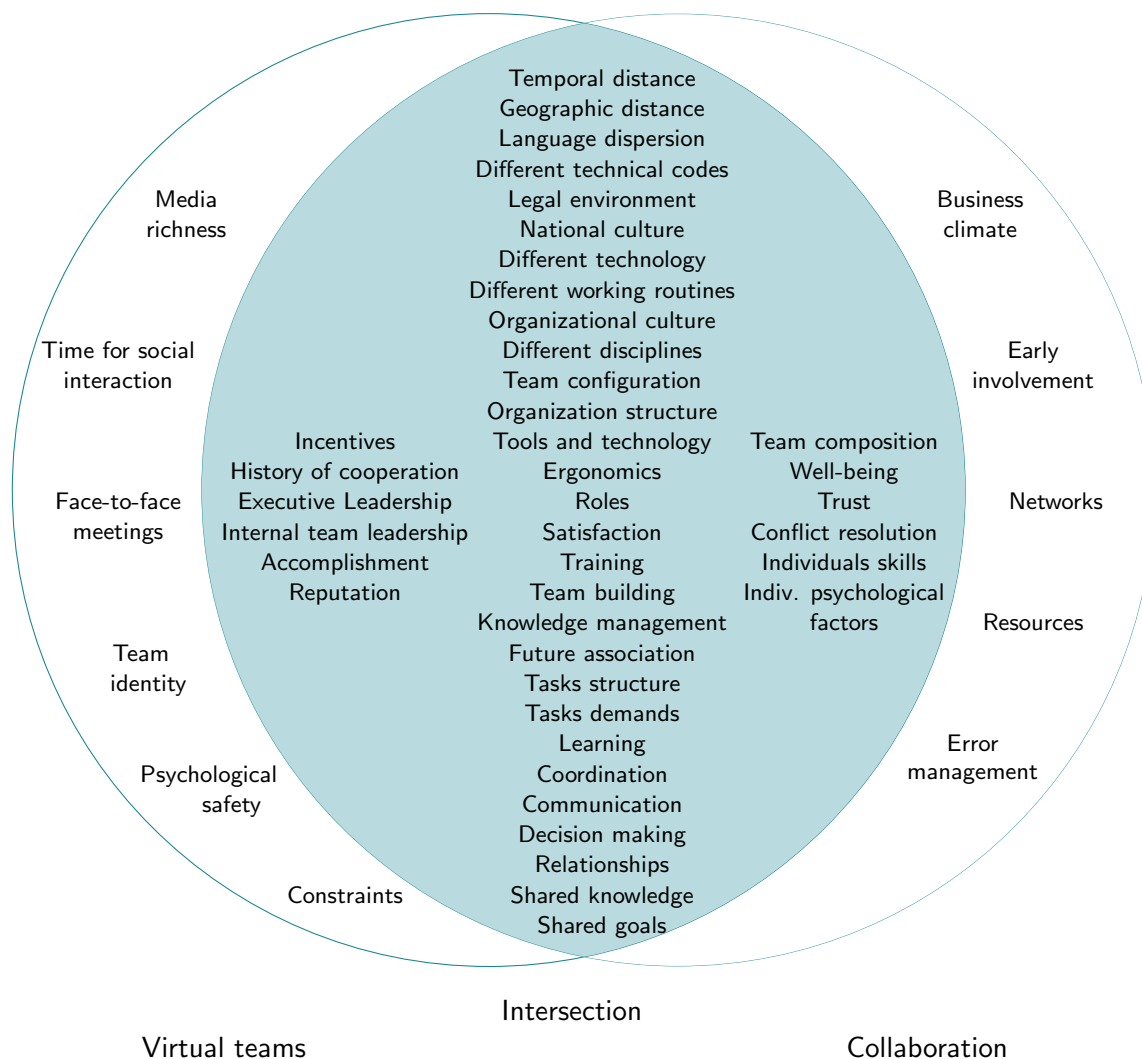


Figure 10: Comparison of collaboration and virtual teams factors

Considering that most of the elements that influence virtual teams are also determinants of good collaboration, it can be inferred that collaboration is an important part of a virtual team. Therefore, the performance of virtual teams can be improved through collaboration by focusing on

the aspects they have in common. This goes in line with Lurey & Raisinghani (2001) statement of relying purely on the most advanced technology is not enough.

Taking this information into account, a theoretical framework is assembled to provide a structure to the data gathered from the literature and from the case studies. Also, the same configuration is going to be used for the cross-case analysis of the research. The framework done by Patel et al. (2012) will be used as a baseline since it is considered the most thorough in the literature. Most of the elements contained in Patel et al. (2012) framework remained except for shared goals and performance, as they are considered duplicated in the frame. Minor changes were done, where some elements were translated to the virtual environment. Figure 11 depicts the outcome.

The first category in the framework is context, which is formed by three elements culture, ergonomics, and organizational chart. Culture is further subdivided into three levels national, organizational and professional. The national level includes elements such as temporal distance, geographic distance, language dispersion, the difference in technical codes, and the legal environment. The factors at the organizational level are the difference in technology and working routines. Culture and business climate were added to both levels since these factors may vary between nations and organizations. Different disciplines and team configurations are considered determinants of professional culture. Ergonomics refers to the working conditions and environments where individuals and teams work which is considered in the literature as an agent influencing the performance of people. Lastly, the organizational structure delimits the boundaries, power, and control within the company. Autonomous teams are associated with higher levels of productivity and satisfaction in traditional and virtual teams.

The second general category is support. It is formed by seven elements tools, networks, resources, training, team building, knowledge management, and error management. Tools refer to the technology, software, and apps used which may range in their richness to transfer information. Networks refer to the ability to connect with other professionals or experts to consult new information or techniques. The third element address the provision of the resources needed to perform individual and collective tasks. Forth, training allows individuals and teams to grow and gain new skills and knowledge which enables them to develop shared mental models. Team building exercises facilitate teams to build trust which reflects in their relationship, they also improve team morale, motivation,

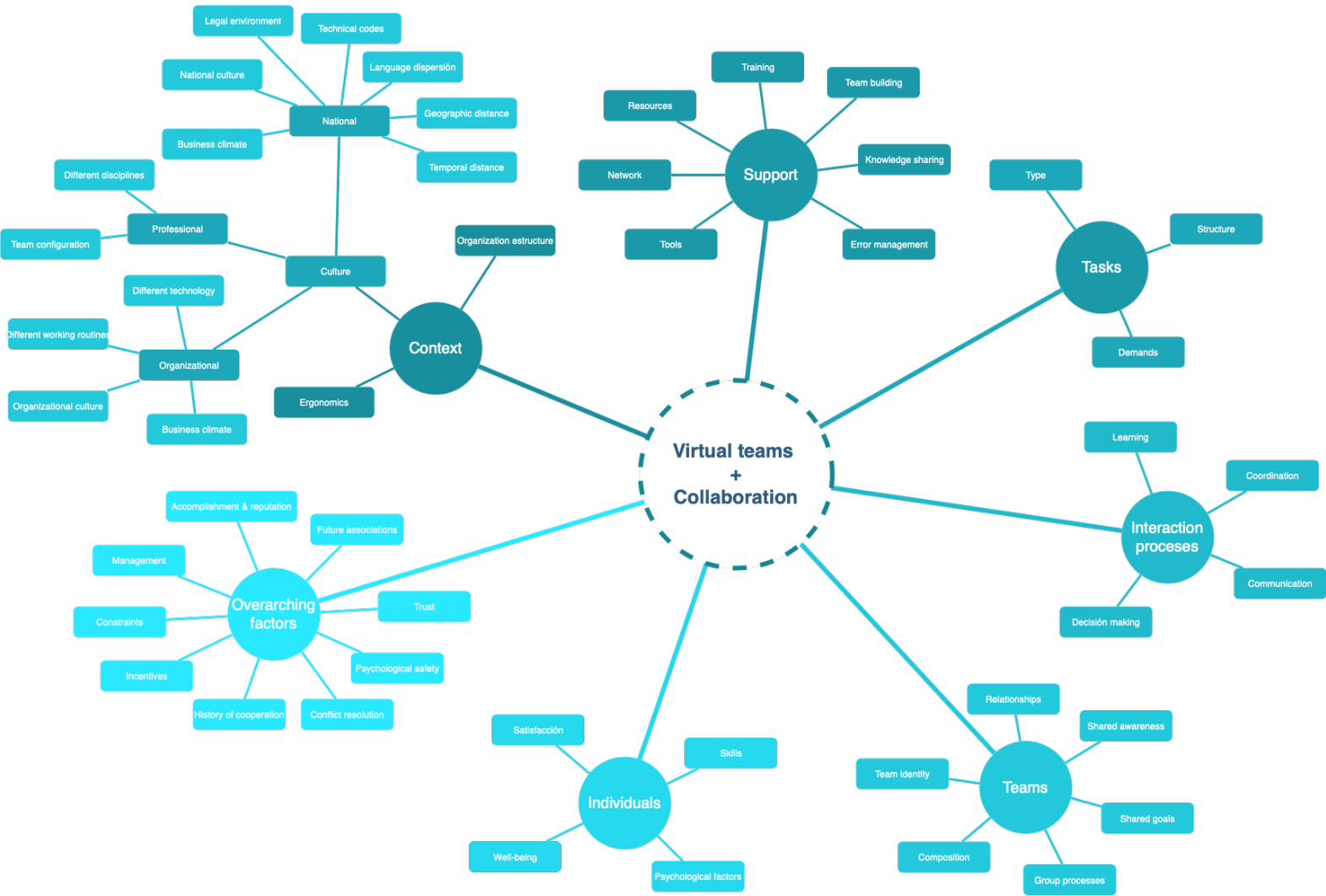


Figure 11: Research theoretical framework

cohesiveness, commitment, and address cultural barriers. Knowledge sharing refers to the environment and structure in place to allow the transmission of information needed to complete a task. Lastly, error management refers to a culture where team members report problems as they arise, and where the whole team focuses on solving the issues instead of looking for the culprits.

The next category is tasks and it is formed by three elements. The type of tasks either by their scope or cycle (routine or non-routine); the structure or flow on which the task is being performed; and the demands required to complete it in terms of effort, deadline, and so forth.

Interaction processes contain four elements. The first one, learning, refers to a culture of continuous improvement. According to Patel et al. (2012) through collaboration participants are exposed to formal and informal learning opportunities which allow them to have personal and professional growth. The second element, coordination refers to the joint planning to exchange information and responsibilities (McNamara, 2012). Communication is important since it is a support for teams to understand each other and transfer information (Patel et al., 2012). A proper communication protocol should contain the channels, frequency, contingency plan, and the respective people to contact for a certain issue. Lastly, decision-making refers to the extent to which team members will decide as individuals or as a group, the people that need to be involved in the process, the number of alternatives to explore, and deadlines.

The category of teams is formed by relationships shared awareness, shared goals, group processes, composition, and team identity. The quality of relationships has been highlighted throughout the literature. Teams where a quality relationship exists tend to be more productive. Therefore, it is important to establish good relations within the team. Shared awareness and goals allow team members to be on the same page enabling them to work more effectively. Group processes refer to the way in which teams interact. For virtual teams, it is important to assign time for social interaction and to hold face-to-face meetings at the start of the project. Team composition refers to the size, gender, age, experience, background, and so forth. Diverse teams tend to perform better at complex tasks (Patel et al., 2012). Team identity was deemed important to improve the sense of belonging in dispersed teams which in turn enhances team performance.

The sixth category is individuals. It is formed by skills, psychological factors, well-being, and satisfaction. The first one refers to the individual set of skills and knowledge in their area, which in turn is moderated by motivation (Patel et al., 2012). The psychological factors refer to the capacity of the individuals to govern their emotions. Lastly, well-being and satisfaction are also important since they influence directly the team member's effectiveness and performance.

The category of overarching factors contains nine factors: trust, psychological safety, conflict resolution, history of cooperation, incentives, constraints, management, accomplishment and reputation, and future associations. Teams with high levels of trust tend to engage in regular communication and have fun interactions (Daim et al., 2012). For virtual teams, psychological safety provides a safe space for team members to participate which in turn keeps them engaged and motivated in the project. Conflict resolution can arise from incompatibilities between individuals'

personalities, goals, values, opinions, or perspectives (Patel et al., 2012). Having in place a good protocol to tackle conflict as it arises allows to stop it from damaging the relations between team members. History of cooperation and incentives have a positive link with teams collaboration while constraints have the opposite either from an individual or a team level. Management refers to executive and internal team leadership. The role of the managers is crucial especially to generate an environment of trust (Daim et al., 2012). Accomplishment, reputation, and future association are mentioned as factors that may moderate positively the behavior of dispersed teams.

2.4 Conclusion chapter two

This chapter aimed to deepen the existing knowledge related to the problem definition. It also aimed to provide a foundation for the solution to how virtual teams can be stimulated by collaboration and how collaboration can be stimulated in a virtual environment. There is a relationship between these two concepts since they coincide with most of the elements influencing one or the other. That is when focusing on those common aspects both have the potential to influence each other positively or negatively, it will depend on the approach used when addressing them. Furthermore, conducting the literature review which led to this information would answer the following sub-question:

What are the factors regulating collaboration and virtual teams?

At first, the definition of collaboration, bouwteams, virtual teams, and short-distance teams was provided. Further, the attributes affecting the implementation of virtual teams and collaboration are identified and depicted in figures 7 and 9. Using said factors as the basis, the interrelatedness of collaboration with virtual teams was described. Further, the findings represented through these figures are combined and categorized to develop a theoretical model to represent a comprehensive relationship between collaboration with virtual teams. The said framework is illustrated in figure 11 and is formed by seven main categories: context, support, tasks, interaction processes, teams, individuals, and overarching factors. The framework is also implemented in the research as a structure to describe the data gathered from the case studies and to perform the cross-case analysis.

3 Methods and Material

This chapter of the report describes the methods and instruments implemented to find a solution that enhances the implementation of virtual teams in bouwteams. Section 3.1 defines the research method; section 3.2 shows the data collection instruments; section 3.2.3 depicts the data preparation and section 3.3 describes the data analysis

3.1 Research method

The present study is described as a qualitative study. The case study method was chosen since it facilitated an in-depth study of the particularities of processes within a real context. It allows the researcher to gain a deeper understanding of the problem, possible causes, and potential solutions. A multi-case study enables the cross-reference of information which in turn aid in eliminating biased and obtaining a more reliable result. Therefore, this investigation implements the multi-case study approach. The following sections describe the process of case studies selection and gathering instruments.

3.1.1 Case studies selection criteria

When implementing single or multiple case studies it is advised to select first the cases and subsequently the respondents (Bryman, 2012). Therefore, as a first step, the selection criteria for the case studies were established. The criteria should be aligned with the reliability standards discussed in section 1.7. That is, the researcher must avoid unrelated or incomparable cases which makes impossible the generalization of the findings. Consequently, the cases were chosen based on the type of contract, the phase when it took place the virtual collaboration, availability of information, and access to stakeholders. A second set of criteria, which focused on the scope of the research, was used for the selection of the cases. This is described below.

- The projects are required to be executed through a bouwteam process since the research focuses on the collaboration of this type of team.
- The project is required to be executed in the Netherlands due to the influence of culture in collaboration. Likewise, differences in normative and legislative factors also make it difficult to compare projects from different countries.

“To build a strong team, you must see someone else’s strength as a complement to your weakness and not a threat to your position or authority.” – Christine Caine

- Lastly, it is required that the bouwteam phase of the project was developed partly or fully through remote working.

Since multi-case studies allow analyzing the variations, best practices and generalizations; four case studies were chosen in coordination with the partnering company, PRO6 Managers. The first project “Oranje Loper” was divided into three parts due to the difference in teams and scope of work. Figure 12 show the names of the four case studies and next chapter provides a complete description of them.

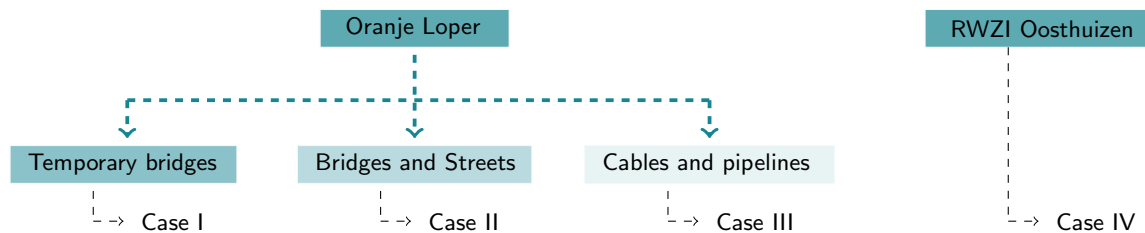


Figure 12: Research case studies

3.2 Data collection instruments

Two instruments are used to collect the data from the case studies: desk research and semi-structured interviews. First, through desk research, general information about the project is gathered from government, organizations and company websites to get an insight into the overall project. This enable deeper conversations with the interviewees as the researcher had a frame for reference. Second, semi-structured interviews are used to complement the desk research. The goal of the interviews is to get detailed information about the issues faced in the project while working remotely. The interviews will reveal whether the findings from the literature review match those present in practice or if other issues have not been scientifically documented. Section 3.2.1 and 3.2.2 describe the steps taken for each method.

3.2.1 Desk research

The focus of this step was to obtain information about the work to be done, the contractors involved, the complexity of the surroundings, and the time frame of the project. The information was gathered through the partnering company, by sharing with the researcher documents containing information about the scope of the project; and through digital platforms from the municipality of Amsterdam, the water authority (Hoogheemraadschap Hollands Noorderkwartier), and the contractors, which had general information available to the public.

3.2.2 Semi-structure interviews

To complement the literature review and the desk research, qualitative interviews are implemented. This type of interview is attractive for its flexibility since it allows the researcher to deviate from the topic and explore what the interviewee sees as relevant and important by asking new or follow-up questions that can vary the order or wording of the original questions. The aim

is to obtain rich, detailed answers in a manner that can be coded and processed quickly (Bryman, 2012). There are two types of interviews: unstructured and semi-structured. The semi-structured interview was deemed best suited for the research since it allows covering some specific topics while providing some flexibility to go off at tangents (Bryman, 2012).

The objective of the interviews was to identify the enablers and disablers found in practice while collaborating remotely in Bouwteams. The interviews also aimed to obtain the perspectives of the interviewees towards virtual teams. Hence, as a preparation for the interviews, a list of questions or topics was formulated as an interview guide. To allow for a thorough examination all interviews were recorded and fully transcribed. The interview was designed for a duration of 60 to 90 min. The researcher started with a description of the research objective and the goal of the interview as a reference for the interviewees. Then the questioning part of the interview was divided into three parts, it started with general questions about the interviewee and the project, the second part focused on the bouwteam phase, the interview ended with closing questions reflecting the perspective of the interviewee towards virtual teams. Appendix A shows the interview protocol.

3.2.3 Data preparation

As said before, an interview guide was established to cover specific topics. The guide was formulated following the findings from the theoretical background, that is taking into account the seven categories explained in section 2.3. The interview guide contained questions about team building, trust, training, communication patterns, information transfer, or the organizational structure within the project. The final questionnaire resulted from the two rounds of discussion with the first supervisor from the university and with the approval from the company supervisor.

Aforementioned, before the interviews, general information about the projects was studied to enable the researcher to have a frame of reference and to ask follow-up questions relevant to the case study. In doing so, a better understanding of the causes leading to certain enablers or disablers can be reached.

3.2.4 Gathering respondents

The selection of the interviewees is considered important since it can enable gathering relevant information about the topic. Therefore, the following criteria were set to select the respondents taking into account the scope and method of the research.

- The respondents needed to be part of the case study during the bouwteam phase.
- The respondents could be part of the client, contractor, or advisor side.
- The target group for the interviews is considered to be any project participant, from the project manager, contract manager, or technical manager to the project leader, designers, or engineers.

The goal of the selection procedure was to gain access to a wide range of relevant participants to obtain different perspectives and roles in the project. The selection of the interviewees

"I can do things you cannot. You can do things I cannot. Together we can do great things." Mother Teresa

was also based on the availability of the professionals and it was done in collaboration with the partnering company, PRO6 managers. Figure 13 shows the role of the interviewees.

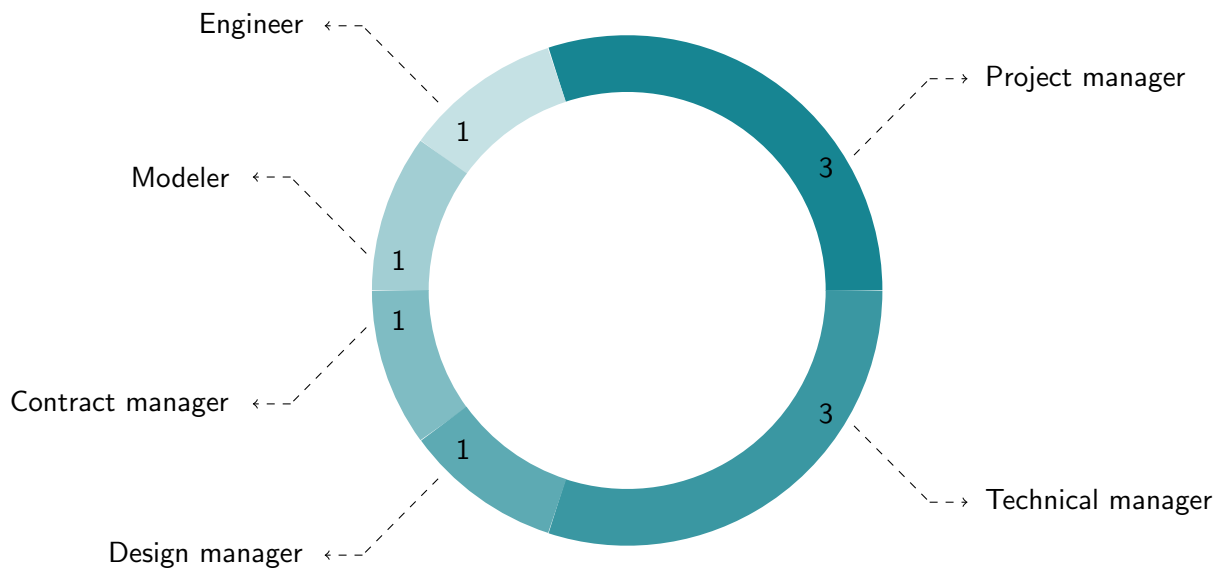


Figure 13: Respondents role in the project

The potential interviewees were contacted through three strategies. The first one was by direct contact through PRO6 managers. The company shared with the researcher some participants who were interested to cooperate in the research. The second strategy was snowball sampling. This technique allows the researcher to get access to other potential participants through the initial interviewees. This is done by asking the initial participants to propose other potential interviewees. The last strategy was to venture into contacting participants through LinkedIn.

3.3 Data analysis

The analysis of the data was done in parallel to the semi-structured interviews. The first step of the data analysis was to transcribe the recording of the interviews. This was done in two steps: the first one involved the software Atlas TI that provides an initial transcription of the interviews when recording the meeting; the second step was done through human analysis by comparing the initial transcript with the audiotape and correcting typing errors. The next step is to analyze the transcript once again through human interpretation. This method provides a higher probability of connecting the new data to the research framework described in section 2.3. The analysis on this step has three goals; I) identify the enablers and disablers factors faced in a remote setting II) connect the causes of the factors to the research framework categories and III) assess the robustness of the research framework to what is happening in practice. It is important to mention that some of the questions focus on the interviewees' perception of virtual collaboration. This might yield varying answers, however, this doesn't mean that these answers are wrong, hence they won't be set apart. A discussion of these answers is shown in chapter four and it was taken into account in the final recommendations of the research.

Once identified the factors deemed important per case study. The cross-case analysis begins. This step allowed the researcher to identify patterns in the data in terms of similitudes or differences between case studies and the literature. The information is organized following the theoretical framework discusses in section 2.3. The outcome of the research is to provide recommendations aiming to improve the application of virtual and hybrid teams through important aspects that conform them but also by focusing on collaboration.

3.4 Validation interviews

The last phase aims to gather the remarks from experts in the field regarding the recommendations produced. Both to determine their usefulness to reach the goal of the research and their application within the bouwteam context. A session with two experts was held to validate the proposed recommendations. The session lasted between 60 and 90 minutes, depending on the availability of the experts.

The session started with a short introduction regarding the research goal, a description of the results found in practice, and the criteria for designing the recommendations. Then, the recommendations were explained one by one, some contained different strategies within which were also explained in the session. Once the recommendations were described, the experts responded to a pop-up multiple-choice questioner containing the first question enlisted below and where the options ranged from totally agree and totally disagree. The multiple-choice questionnaire aimed to open the discussion among the experts and the researcher about the differences in results and the recommendations themselves. At the end of the session, the experts responded to questions two to four.

1. How much do you agree with the following recommendations?
2. Would you apply them in your project when collaborating remotely?
3. Do you find the recommendations useful during the bouwteam phase?
4. What would you improve in the current recommendations?

4 Case studies results

This chapter provides an overview of the case studies through desk research as well as the findings of the qualitative interviews. Section 4.1 discusses in detail the first three case study, the selected interviewees per case, and the retrieved data in terms of the enablers and disablers factors found per case, the advantages and disadvantages of virtual teams, and a reflection of the future of projects. Section 4.1.1 and 4.1.2 describes case study I Oranje Loper temporary bridges, section 4.1.3 and 4.1.4 is dedicated to the case study II Oranje Loper bridges and streets while section 4.1.5 and 4.1.6 discusses case study III Oranje Loper cables and pipelines. Lastly, section 4.2.1 and 4.2.2 provide the same information regarding case study IV RWZI Oosthuizen.

This chapter provides a partial answer to the first sub-question and a full answer to the second sub-question formulated as:

What are the factors regulating collaboration and virtual teams?

How is the current collaboration in bouwteams?

4.1 Case study I, II & III: Oranje Loper

The municipality of Amsterdam is investing in inner-city infrastructure by renovating nine road bridges important for accessibility from the Raadhuisstraat to the Jan Evertsenstraat. Most of these are more than 100 years old and partly at the end of their useful life. The municipality is also using this opportunity to redesign public spaces into greener ones, giving more importance to pedestrians, cyclists, and public transport. Their aim is to improve road safety, increase the reliability of public transport and the quality of public space which is necessary to keep the area liveable and accessible for the future (Amsterdam, n.d.-a).

The whole project is called Oranje Loper and the aim is to redesign the ground level and renewal nine bridges. The project includes the following streets: Nieuwezijds (Nieuwezijds Voorburgwal North and South), Raadhuisstraat-Rozengracht, De Clercqstraat and Jan Evertsenstraat. The bridges are located along these streets and they need an integral replacement with the exception



Figure 14: Scope of Oranje Loper from Amsterdam (n.d.-a)

of bridge 108 which is located in the street de Clercqstraat crossing the canal da Costagracht. This bridge needs a partial replacement since most of the supporting structure of this bridge was recently renewed. Figure 14 shows the full scope of the project (Amsterdam, n.d.-a).

Among the activities to execute are the installation of temporary bridges to allow accessibility to the site, the relocation of cables and pipelines to the temporary bridges, the actual bridge execution, the relocation of the tram track, and the monitor of deformations of existing buildings. Moreover, the design of the project is simple, yet the limited space, the need to remain free of pollution (air, sound, and visual), the risk to damage existing buildings, and the need to remain accessible to the local residents and businesses make the project complex (Amsterdam, n.d.-a).

Taking into account this complexity, the municipality decided to implement the bouwteam agreement as the contract for the project. By doing so it could exploit the benefits of this type of contract such as: including the experience of the contractor for improvements in constructability, planning and design. Three different bouwteams agreements are used in the project as shown in figure 15. Therefore, the whole scope of the project was divided into three parts. The cables and pipelines bouwteam is in charge of the underground works. The temporary bridges bouwteam is in charge of conditioning the surroundings to allow the placement of the temporary bridges and the placement itself. Lastly, the bridges and streets bouwteam is in charge of the remaining scope related to the preparation and design of the final bridges and streets. All the bouwteams are required to be flexible to changing tasks and have an adaptive capacity to respond to additional scope.

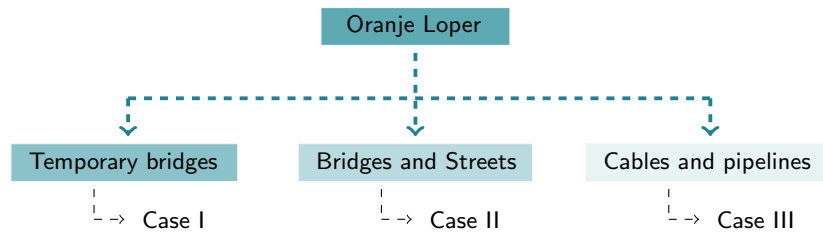


Figure 15: Oranje Loper bouwteams

4.1.1 Case introduction: Temporary bridges

As stated before, part of the construction procedure is to install auxiliary bridges to allow the transit between streets and temporarily lay the cables and pipelines. There will be one temporary bridge for every bridge except for the one located in de Clercqstraat and da Costagracht. The location of the bridges is as follows: four bridges on Raadhuisstraat, two bridges on Rozengracht, one bridge on De Clercqstraat and one bridge on Jan Evertsenstraat. The first four bridges on Raadhuisstraat are only for pedestrians due to the lack of space for bikes. The rest of the temporary bridges can be used by pedestrians and cyclists. Since the bridges are going to stay for some years its design is intended to integrate into the environment. Each temporary bridge will have 6 meters wide and metal side panels with artworks in the form of perforations. Once the bridges are replaced, the temporary bridges can be used in other parts of the city with minimal adjustments (MobilisTBI, n.d.; Amsterdam, n.d.-b)

The bouwteam is integrated by the municipality and two contractors: Mobilis TBI and Dura Vermeer. The works to be performed for the installation of the bridges could cause some foundation settling. Therefore, the bouwteam needs to evaluate the risk of this happening and assess whether there is a need to reinforce the existing structure to support the installation. Since this is an inner-city project, the bouwteam needs to plan fluvial and terrestrial routes to supply the materials and avoid the creation of traffic. The bouwteam also needs to keep in contact with the neighbors and businesses to discuss the activities and works to be done. Further information about the project can be seen in table 2.

Table 2: Oranje Loper temporary bridges facts:

Number of team members:	7-10 people involved
Added complexity:	They need to keep the surrounding up, the structure is old (wooden piles), they needed risk analysis to evaluate the impact of the construction in existing buildings.
Contractors:	Dura Vermeer & Mobilis TBI
Estimated cost:	€8 million
Start of the bouwteam phase:	Started online

4.1.2 Results: Temporary bridges

Representatives Interviewed:

"The strength of the team is each individual member. The strength of each member is the team." — Phil Jackson

- Interviewee A.1 is the technical manager from the client side and has 15 years of experience.
- Interviewee A.2 is the project manager from the contractor side and has 15 years of experience.

Enablers of collaboration:

As mentioned in table 2 the team was formed by different organizations where at least two people from each organization were assigned to the project which resulted in a small team. Most of the team members were living in the Netherlands nearby the office or the construction site and spoke the same language which facilitated the communication and collaboration among the team members. That is, having the same cultural background, the members tend to perceive or give more importance to the same aspects while members with different cultures could find other features more important. The same happens with the language, members not speaking in their mother tongue might obstruct the communication if they don't count with a clear accent, fluency, or vast vocabulary.

"I think one of the benefits of the bouwteam Oranje Loper is that everybody has the same cultural background, and everybody talks Dutch, which makes it easier" Int A.2

Since the interviewee had experience working on virtual teams abroad, he had a point of reference to compare the current case study with the rest of the project he/she has been part of.

"I've also worked with other countries or project teams from different cultural backgrounds which makes it 10 times more difficult because you don't understand the expressions or the intentions or the way people explain things" Int A.2

Collaboration played a significant part in the project. Therefore, a specialist was included to guide the members through discussions leading members to learn new methods to collaborate and have fruitful conversations. This coupled with a feedback session, where each member reflected on the collaboration in the project, acted as support mechanisms to improve the project processes and motivation of the team members.

"There is still coaching in the in a collaboration in the teams but it's pretty high over" Int A.1

"If you ask questions like How do you think is your production? What do you need? How do you think other people are? How do you think the collaboration is in the teams? to someone, then people start thinking am I doing alright? ... I guess It's good that the questions are asked." Int A.1

Additionally, one of the organizations had selection criteria and procedures for the new team members. Implementing this kind of measure allowed the team to choose the members with the best fit for the project, those with the background and mindset necessary for this highly collaborative context.

"We come up with an approval process where you had at least two meetings with several people from the different parties participating in the bouwteam to see if you would fit into the bouwteam. So we try to monitor at the gate that we get in the right people, then we have an on-boarding session every once in a while" Int A.2

Most of the meetings were done online due to the restrictions imposed by the government and organizations. The design team got the chance to meet each other twice throughout the project. Once the restrictions were less strict some meetings were done offline such as the head of staff or the project management meeting. Yet, this posed a challenge to coordinate, as the municipality's guidelines were stricter in face-to-face interactions than contractors or consultants.

"We've had a lot of meetings where we would do it online, which I think works if it's just about sharing information now when everything is a little bit more relaxed, we try to have at least certain meetings face to face" Int A.2

Furthermore, the meetings were considered efficient when a high degree of interaction is not required. Yet, they were also perceived as direct and impersonal. The former affected the flow of discussions as team members had to be punctual, otherwise, a delay of five minutes resulted in a loss of content. While the second affected the relationship between the members which are created and nurtured by small, informal interactions at the coffee table, between or within meetings or having fun together. Aware of this lack of interaction, the members called each other individually as a way to compensate and maintain the bond between them.

"The informal dance about how you're doing, what happened, and whatever, that small talk makes a big difference in the atmosphere in the meeting, in the productivity and the social interaction ... I'm more willing to accept something from someone who had a nice chat with, than someone who's just doing business." Int A.1

As mentioned before, a feedback session called keep-start-stop was organized to gather information regarding the processes and collaboration. Another approach implemented by the contractor was to set a one-on-one meeting with the members to review their performance and get their input regarding their satisfaction and needs.

"We try to monitor it every once in a while to see how people envision the way of working together or how they view we could improve or what we should stop or what we should do better ... I think will work to have the right people showing the right behavior and working together." Int A.2

"All my higher level we go through the people once in a while and then share or our reflection on how we believe they are performing not just from a performance point of view, but do they have the right mindset and do they feel well equipped and in a position to do the work" Int A.2

"It is the long history of humankind (and animal kind, too) that those who learned to collaborate and improvise most effectively have prevailed." — Charles Darwin

Disablers of collaboration:

The bouwteam agreement aims to set up a more integrated team where both the contractor and the client must develop individual assignments. It was acknowledged that the project complexity demanded said agreement, and integrating the knowledge of both sides could lead to project improvements in the supply chain logistics or by foreseen problems. Yet, not every team member agreed on it, some would prefer to keep working in a traditional contract where it requires less collaboration with the client. Furthermore, this type of contract implied a new challenge for one of the contractors as it was their first time involved at this point in the process.

"The contractors were involved from day one, which is a benefit for us because we can bring in the knowledge we have and our ideas, the negative or the downside part is that sometimes some of these phases are also unknown to us, so we also have to learn a little bit how to deal with these activities, which are normally done by the client themselves." Int A.2

"I think it is also normal because not everybody likes or prefers the way of working in a bouwteam ... there are also people who really like the old structure ... and there are also a lot of people just like doing the work without much interaction. " Int A.2

In the project, the team members scheduled consecutive meetings. These affected the collaboration within the team, as they demanded more energy from the team members. Back-to-back meetings also affected the project by not leaving room to work on individual tasks, delaying the progress. It also affected the degree of response between the members since these lacked time to provide a reply to every email received.

"Everybody was constantly back-to-back meetings ... and so you don't have time to process your findings, all the emails that were just piling up and you have to pick what's important and the rest was piling up" Int A.1

Enablers of virtual teams:

A stable internet connection as well as providing the right equipment and software to the team members are considered necessary to have a good collaboration in a virtual environment. There were some incidents where some team members were lagging during a meeting interrupting the flow of the conversation or where there were some audio and video issues due to a microphone and camera of low quality. These events generated distractions to the team members which affected the efficiency of the meetings.

"What helps is that you've got the correct hardware and a very stable good Internet connection ... the sound and the camera should be good enough to understand everybody who's in a room, otherwise it's impossible to do so." Int A.2

"The tools were quite good while we started going up working in the field. The people who are in the field didn't have a very good Internet connection, they didn't have the facilities to work on location." Int A.1

Tasks and meetings with low demand for interaction between the team members are better suited to be performed remotely. For instance, interviewee A.1 regarded certain progress meetings or risk sessions during the bouwteam phase as suitable since the participants need to share their findings or discuss their input without entering into an in-deep dialogue. Yet, there are certain periods of the design phase where require a high amount of interactions, which is recognized by the interviewees. They noted that during this part of the process the virtual discussions are usually less effective due to the interruption between members trying to give a point of view or solution.

"Risk sessions or sessions with a lot of people and maybe different stakeholders, you want to interview. I would do them with video conferencing because it's more effective to gather information to let people speak" Int A.1

"The informal and creative ideas that you have, it's easier to discuss with someone while it's on the same table than in video conferencing." Int A.1

Communication can provide verbal and non-verbal cues. Working in a remote setting tends to limit reading non-verbal cues, therefore, turning on the camera will allow team members access to more information regarding the communication. Yet, the interviewees noted that is not as efficient as offline meetings.

"People are saying just put on your camera because I can't see you, I want to see you. If that's the atmosphere in the meeting then it will be more effective." Int A.1

Offline meetings at the start of the project were recognized as an enabler of virtual teams by the interviewees in the project. This supports team relations by reducing the lack of familiarity between team members, improving the collaboration at the same time as the application of virtual teams. While the inclusion of social interactions in the structure of remote working allows team members to keep building relationships with each other, which in turn supports motivation and a good working atmosphere. Team motivation and a good atmosphere facilitate effective collaboration.

"I think if you have met somebody in real life and I have talked to him 10 times or five times or whatever, then it's easy to have 20 Internet meetings with the guy" Int A.2

"I think if you know each other from a live setting and you have a team with a high level of team development you can work perfectly digital." Int A.1

"I think what enables virtual teams is if you have organized this in such a way that there is still social interaction." Int A.2

Disablers of virtual teams

During the design phase, several decisions need to be made regarding the design, engineering, supply, and logistics, among others. These require a high degree of interactions and discussions. It was recognized that current platforms don't provide the facility to point precisely the location of the solution or the problems as in a collocated setting. Likewise, as mentioned in the enablers of collaboration, providing a stable internet connection and equipment can support the implementation of virtual teams while neglecting these factors can affect team members' collaboration and effectiveness due to connectivity problems or response from the equipment while running programs.

"Technical people want to see they want to draw, then want to discuss they want to look and feel and you won't get that in video conferencing" Int A.1

"The informal and creative ideas that you have, it's easier to discuss with someone while it's on the same table than in video conferencing." Int A.1

As mentioned before, most of the team members in the project dealt with back-to-back meetings. This type of arrangement demands a lot of energy from team members to process information and keep up with their activities, which affects their effectiveness while working in a virtual environment. Another issue faced in the project was an inadequate structure in the meetings which obstructs a proper transfer of information at the same time that prevents reaching the desired outcome.

"If you do a life session, you've got an outcome immediately and you have on a deliverable and everybody is synchronized and with an online meeting a lot of people are catching up their mails in between or doing other things and there are not 100% involved in the meeting because they have so many meetings and they need to have time to process and restore." Int A.1

Lack of body language is also considered a disabler of virtual teams since team members cannot react in a conversation according to the atmosphere in the meeting. Another disabler pertaining to the interaction processes category is the reduction of interaction between team members with different levels of experience. In a collocated setting older generations tend to pass on their knowledge to younger generations through interactions at the office, either in meetings or coffee talks. Since the project was done mostly online, these opportunities decreased for the younger generations which could lead to slower development. In the same line, for managers, not being able to visualize the interactions among the team members represent a reduction in access to information about how the team is doing as well as individual performances.

"Sometimes it's quite difficult to understand other people's expression if you talk to each other over a screen" Int A.2

"A successful team is a group of many hands and one mind." – Bill Bethel

"Because there's not only the back-to-back meetings, but it's also the informal and creative ideas that you have, it's easier to discuss with someone while it's on the same table than in video conferencing." Int A.1

"It's difficult from my screen to show the right behavior or because you don't see any interaction within a team ... I learned from how others do things or behave" Int A.2

"It is more difficult to notice issues earlier than you would normally do" Int A.2

Lastly, it was considered in the project that social interactions are fundamental either in a collocated setting or a remote one. Yet, being at the same office forces team members to interact with each other, while working remotely does not impose this interaction, rather it demands team members to interact with each other to obtain the information necessary for their activities.

"Behind the computer, you must put effort into interacting with people." Int A.2

Reflection on virtual teams.

In the project, both interviewees noticed the benefits of virtual teams such as reduction in travel time, efficiency in certain types of meetings, access to better equipment, or uninterrupted time to focus on individual tasks. Yet, when confronted to choose between working collocated, fully virtual, or in a hybrid way, both preferred to do it a hybrid since they can access the benefits of both worlds. This decision comes with its challenges since currently does not exist a right receipt for working in this setting. They reflect on the experience gained in the project:

What worked such as on-boarding sessions, interviews to select the team members, feedback sessions, and individual relations;

What needs to be looked out such as group relations, social interactions, and type of personalities to push team members to participate in the meeting; and

What needs to be avoided such as consecutive meetings and inadequate internet connection or goals for the meetings.

"I look at specific people like modelers, for instance, I think the hardware. And the setup they have in their houses is way better than what we can provide them in a flex office." Int A.2

"You recognize how fast the video conferencing became a common thing, we have sessions with 25 people fairly neatly organized, and everybody puts in something that wasn't possible before in a live setting with 25 people in" Int A.1

"So it's the difficulty is the flexibility you want to have for the efficiency you want to achieve and the social interaction you want to promote." Int A.2

“I think it can work, but I think you have to pay a lot of attention to, say informal communication to make sure that everybody can provide this input and to also keep in mind the different characters.” Int A.2

4.1.3 Case introduction: Bridges and streets

A bouwteam formed by the municipality of Amsterdam, Mobilis TBI and Dura Vermeer was created for the renovation of the bridges and the redesign of the streets. Among the responsibilities of the bouwteam regarding the bridges is the renovation of the constructive interior and foundations, while maintaining the monumental exterior design of the bridges. On the other hand, the responsibilities regarding the streets are the improvement of the layout of the streets and the increase of traffic safety at the intersections by providing more space for cyclists, pedestrians, the tram, and green areas. The streets to be redesigned are Raadhuisstraat - Rozengracht, De Clercqstraat - Jan Evertsenstraat and Nieuwezijds Voorburgwal. The bridges are located along these streets, four bridges on Raadhuisstraat, two bridges on Rozengracht, one bridge on De Clercqstraat and one bridge on Jan Evertsenstraat. Bridge “108” located over De Clercqstraat and Da Costagracht was already renovated in 2018. Therefore, the bouwteam is renovating only the foundation under the footpaths and bicycle paths. On this bridge, the team is also installing new natural stone and masonry (Amsterdam, n.d.-b). Table 3 shows additional information about the project.

Table 3: Oranje Loper bridges and streets facts:

Number of team members:	Started with 20-25 people involved, it grew to 130. The 130 was divided into sub-teams of 8-10 people.
Added complexity:	The large amount of stakeholders involved in the project in terms of team members, residents, and businesses. The need to keep low levels of pollution (noise, visual).
Contractors:	Dura Vermeer & Mobilis TBI
Estimated cost:	€100 million (document amst) (int: 230 million) which one?
Start of the bouwteam phase:	Started offline, then it had to move to an online environment

4.1.4 Results: Bridges and streets

Representatives Interviewed:

- Interviewee B.1 is the project manager from the advisor side and has 17 years of experience.
- Interviewee B.2 is the modeler from the contractor side and has 5 years of experience.
- Interviewee B.3 is the design manager from the contractor side and has 21 years of experience.

Enablers of collaboration:

The organizations worked together for two months to develop the project management plan which contained two documents the collaboration structural plan and the project culture plan. The aim of this is to integrate both organizations into a team where the traditional hierarchy doesn't apply. The goal of doing it jointly is to generate commitment between the parties regarding the agreements made.

"I can tell you how we want to work, but that's not the same if we together discuss it and make the plan" Int B.1

In the project, an information management system was used to concentrate all the information in one place. Although at times, the members used email to transfer information. In the information management system, all the team members had access except for sensitive information such as financial or human resources. The aim was to allow everyone to be informed about the progress of the project, the risks, mitigation measures, or all the information that might be needed to perform their tasks.

"I always implemented a document management system online so I don't want people sending each other documents by email, and it doesn't mean it doesn't happen but you know just one source for information" Int B.1

"If you want to work like this you should have all the information available for everybody in the team so I have a bad experience with separating clusters into information" Int B.1

Also, an expert in collaboration and feedback sessions were included as support mechanisms. The former aided train team members on how to tackle collaboration issues, while the latter provided a space to hear back from all the team members on how to improve the structure of collaboration.

"We had a collaboration specialist guiding us through exercises or discussions or with breakout rooms really like sessions for two to four hours to discuss whatever needs to be discussed on the collaboration" Int B.1

"We call it keep-start-stop sessions. It's lots of people, they write down, for example, what has been going well in that project and what has not been going well, so it's to discuss that." Int B.2

The design phase being a creative process requires discussions among team members to find the best option or solution for the project. When the design changes, the team members need to check whether the other aspects in the design conform with the new design. When dealing with changes it was recognized as more efficient to do it face-to-face through informal talks since it's easier to explain and have a relaxed discussion this way.

"I do miss that social interaction because sometimes design changes can get across faster when you're in a face to face meeting" Int B.2

"Cooperation is the thorough conviction that nobody can get there unless everybody gets there." – Virginia Burden

As part of the structure of collaboration, different types of meetings were organized such as project team, project management, management, high-level, and specialized team meetings. Each meeting has its own goal, either high-level to discuss decisions for the project, or management to discuss the next steps in the program. This provided clarity to the team members on the activities to be carried out, the solutions to be applied or sought in the coming days. Also, a day was blocked where there were no meetings. The goal of this was to work on individual tasks and make the necessary progress for the next meeting.

"We had the agreement that on Thursday we have a meeting-free day so there were no meetings scheduled but you would call up people or meet whatever you need to do but it's to keep the production of the team, otherwise other people will do only meetings and not work." Int B.1

As mentioned before, informal talking in between meetings or at the coffee table supports the discussion of design changes. But, it also supports a good collaboration between the team members since it enables them to have discussions and resolve questions about certain points of the meetings. It also allows them to have a chance to be personal and create/maintain bonds between them.

"If you have an offline meeting you could have like formal meeting and you have the informal part of that meeting before during and after." Int B.1

Moreover, to maintain the motivation of the team members, their satisfaction was assessed in the project through the feedback sessions. Besides this, the contractor fostered a culture of openness where the employers could voice their concerns or issues that disturb them. They also implemented one-on-one sessions with the workers to address this as well as their overall performance.

"Two to three times a year that we meet with our I wouldn't say direct supervisor but saying one representative of the BIM Department, and we talk about how things are going in the project, how things are going with their mental health, for example, how do you feel? Do you enjoy your work? Do you want to do something different? Things like this" Int B.2

One of the benefits of the bouwteam agreement is building mutual trust between the parties by creating an integrated team. Another form to create trust is through an open-book contract. In the project, the procurement was done in collaboration with all the parties which provides transparency to all the stakeholders regarding the real price and quality of the materials in the project. Doing the procurement together enables all the stakeholders to trust each other. Trust can also come from previous experience when it is a positive one. On the contrary, when the organizations have a negative history of cooperation this has to be handled and resolved to avoid dragging it into the new project.

"We don't work towards a fixed price contract is more like a target cost contract so we do a cost estimation together with the contractors... we will go into the construction phase and we

"The way a team plays as a whole determines its success. You may have the greatest bunch of individual stars in the world, but if they don't play together, the club won't be worth a dime." – Babe Ruth

will procure together with the contractor and that's really new, normally the contractor would do their own procurement with subcontracts but now as an employer, we step in that process and the process of making transparent for us what other prices." Int B.1

"When I enter into a new contract with an organization which has a bad experience with the city of Amsterdam that probably will reflect on what we do, but it doesn't necessarily mean how I'm stepping in the collaboration or cooperation the same is of course to the contractor side." Int B.1

Disablers of collaboration:

As mentioned before, the creation of silos of information within the team tends to affect the project. In terms of the performance of the team members and the integration of all the information. Granting access to all the information allows team members to reach the same level of awareness concerning the project. It also works as a way for team members to learn from other areas when they are curious which could lead to improvement in their performance.

Back-to-back meetings were also present in the project. This affects collaboration since the participants didn't have enough time to process the information they received or prepare for the next meeting. It also affected their performance in terms of time to work on their assignments.

"I think four meetings per day is good enough... I leave half an hour in between the meetings to work on my part and prepare for the new one" Int B.3

Enablers of virtual teams:

The organization concerned with the performance of the worker remotely, conducted surveys to assess the needs of the employees. This way the organization could provide the necessary equipment to generate adequate conditions to work remotely. Apart from the surveys, individual requests were also taken into consideration.

"If I need a chair, I need a desk, I need a screen, mouse, laptop, whatever like sent it over. I can go pick it up. It's not an issue." Int B.2

Currently, there are different tools or online platforms that support sharing documents among team members, such as SharePoint, Ms teams, Relatics, and BIM360. At the start of the project, the main channel was selected for this purpose. Along with the information management system, it was recognized that the implementation of different virtual tools is necessary to support work in a virtual environment. Another important aspect essential for an efficient meeting is having a stable internet connection. Without it, connectivity issues can distract meeting participants and interfere with the ongoing conversation.

"If I had nine hours to chop down a tree, I'd spend the first six sharpening my axe." — Abraham Lincoln

"If you want to work online you have to work online in such an environment and I don't think you can do it like for 70 or 80% like this and 10 or 20% not like this because you will lose the information or people will work on a certain version of the information" Int B.1

"The thing is when someone in the meeting doesn't have a stable internet connection is difficult to have a discussion about the design" Int B.3

The project started with 20-25 people and grew to 130. During this transition, the entire team was divided into sub-teams of 20 people to facilitate group management. Each group had a leader who guided the team members through the necessary changes or tasks in the project. At first, some members met face-to-face with their immediate co-workers. Organizing meetings offline allowed team members to meet and bond, reducing unfamiliarity and distance between them, facilitating collaboration throughout the project. Moreover, once the restrictions were lifted or less strict, offline meetings were arranged for the design and work preparations as it was recognized that for both teams small and quick interactions to resolve questions were critical to the progress of the project.

"I was in charge of around seventy people. I had to divide the whole team into sub-teams with a leader on each... in the sub-teams, there were around 10-25 people." Int B.3

"I actually just met most of my team in person. I met all project leaders, some direct colleagues at least once in person." Int B.2

"But we were not forced to go offline but when the opportunity came a few months ago to work offline we give priority to the design and works preparation teams to go on-site and work offline because we notice that those types of problem-solving, really need to have a discussion but also short discussion so people would work on something and then talk about it in five minutes." Int B.1

Also, it was noted that to encourage participation in the meetings, there must be a safe environment for team members to express their opinions without feeling judged, in addition to good management. That is, the manager must be aware of the type of people he/she are dealing with, introvert or extrovert, to handle them accordingly or check whether the people in the meeting are really required for the discussion.

"How you can facilitate people in making their points in a meeting, for example, are they feeling enough space to address problems" Int B.1

"As a project manager or partner checking involvement and commitment is something that is higher in your awareness in online meetings you will immediately notice when people start to disengage but if you are with 10 or 15 people in a room maybe you don't see it as fast." Int B.1

"We really encouraged the small interactions to happen for the design team and the works preparations teams." Int B.1

Disablers of virtual teams:

In the project, online meetings were perceived as more rigid and direct than offline. It affected the negotiation process in terms of the relaxation moments and informal negotiations during the coffee break. It also affected the creative process of the design phase which requires a high amount of interaction. It was more difficult to monitor the progress of the team members in terms of understanding the ideas discussed in the meetings and what was been asked out of them. In online meetings, the discussions were more difficult to manage since two or more people could react at the same time making discussions slower. Lastly, another issue faced was the integration of the project. Although it was recognized that the cause of this problem was not virtual teams but a combination of other factors such as short time or not taking into account the big picture, it was observed that virtual teams made the problem worse.

"The big issue for me with online is very direct so if you contribute to a discussion it's more specific, if you're negotiating on screen it can be more difficult because you don't have the time to say OK let's have a coffee break for 10 minutes and try to work something out over there" Int B.1

"After the meeting, you don't see the people working, their progress, you have to wait for a week and check the work, you cannot go directly to their desk or working station and ask about their progress to check if they understood the task or not" Int B.3

"The thing is, the design phase is a creative process, you need to talk about the options, and sometimes in an online meeting, two or three people react at the same time" Int B.3

"Another issue I saw is the integration of the model, in the end, we had four models one for the bridges, one for streets, work preparation, and design... but I don't attribute it to virtual teams, I think virtual teams increased the issue but it is not the cause" Int B.3

The satisfaction of the team members was also considered a factor that could act as a disabler for virtual teams. In the project, it was noted that older generations tend to be more reluctant to work in a virtual environment which could moderate their behavior making it harder for them and the other team members to collaborate in this environment.

"My project leader is probably somewhat older, so he is used to sitting with the person or with me for example, and talking about something. He likes their short lines, but I've noticed with the younger guys working on the project that they don't really care about this. They're like, yeah, I can just as easily share my screen and talk about the same thing if we're apart from each other so I would say for my project leader he has not liked it, he doesn't like that." Int B.2

Reflection on virtual teams.

Save in travel time, increase productivity depending on the type of task, and the facility to collaborate with external organizations were considered as benefits of virtual teams by the interviewees while the reduction in social interactions, reduction in monitoring the progress of the team members, and lack of body language as some drawbacks. Considering these factors, the interviewees preferred a hybrid setting for their future projects despite the fact that the interpretation of hybrid was different for two persons. Interviewees B.1 and B.3 argue that hybrid teams look more like hybrid meetings with external organizations rather than hybrid meetings internally.

Although the interviewees preferred a hybrid setting, there are some concerns about the implementation. It is recognized that not all the workers or participants would prefer this setting, which could affect their performance, project collaboration, and the implementation of said environment. Also, another concern is how this setting will impact tracking the progress of the team members between meetings. Reflecting on the knowledge gained in the project the following statements can be made:

What worked such as the joint creation of project culture, open-book contract, feedback sessions, sub-dividing the whole team into groups of 10-25 people, sharing the screen with the model when discussing the design, and sharing all the information with the team;

What needs to be looked out such as group relations, social interactions, individual commitment, individual satisfaction, and tracking progress; and

What needs to be avoided as consecutive meetings or unclear goals for the meetings.

"Normally, you had the site engineering and designers and work preparations they were all on-site because the project director wants his full force of the team under one roof, I think we stepped away from that you don't need everybody under the same roof to be effective."
B.1

"I think we will get better doing it online just getting better at it but also appreciate offline time." B.1

"I've noticed that in online meetings for some people it's very easy to just shut up and if they shut up for 10 minutes they shut down and if they shut down they don't give you the information you need because they think I'll mention it so problems will get hidden." Int B.1

"I like working from home, I feel like I have a bit more time in the day to catch up on personal activities. However, when it comes to the project side of things, sometimes you do feel the need to sit with the person next to you and maybe talk over about a drawing or a model or some design changes that have come." Int B.2

"I think hybrid, but for such things as progress meetings, for the design process itself I would stick to collocated." Int B.3

4.1.5 Case introduction: Cables and pipelines

The municipality of Amsterdam selected Heijmans and Van Gelder to form the bouwteam in charge of the cables and pipelines. The scope of the project included the relocation of the different services (gas, electricity, water, telephony and the internet) from the bridges located from Raadhuisstraat to Mercatorplein to the temporary bridges. The goal is to make the bridges function free so they can be reinforced. The bouwteam will place the cables and pipelines back once the bridges are reinforced. The relocation included the collaboration with 15 different network operators owners of the cables and pipelines laying in the bridges and the inner-city of Amsterdam. Therefore, the bouwteam needed to coordinate with the other two teams, "temporary bridges" and "bridges and streets", and also the operators which increased the complexity of the project. Another requirement they needed to comply with is to limit the nuisance for the residents and businesses this includes the minimal generation of pollution in the surroundings and the management of the traffic (Gelder, n.d.).

As part of the reduction of the number of cables, the bouwteam needed to identify the active wires transfer them to a new cable, and disconnect the ones that are no longer in use. Then the new cables are connected to other cables that follow a different path outside the site, this provides space for the bouwteam to work on removing the cables in the bridges and relocate them in the temporary bridges. This work is done for every bridge except the one located in Da Costagracht since the works to be done are around the existing cables and pipelines. After the bridges are renewed, the bouwteam will relocate back the cables and pipelines (Amsterdam, n.d.-c). Table 4 provides more information about the project.

Table 4: Oranje Loper cables and pipelines facts:

Number of team members:	20 people involved
Added complexity:	They had to work with the service providers (owners) to re-design and coordinate the placement of the cables. They also had to comply with seasonal requirements such as allowing a certain amount of water during winter. They had limited time to build the team and to bond since they started in March and needed to start digging in June
Contractors:	Heijmans & Van Gelder
Estimated cost:	€7 million
Start of the bouwteam phase:	Started online

4.1.6 Results: Cables and pipelines

Representatives Interviewed:

- Interviewee C.1 is the project manager from the advisor side and has 15 years of experience.
- Interviewee C.2 is the technical manager from the client side and has 24 years of experience.

"There is no such thing as a self-made man. You will reach your goals only with the help of others." – George Shinn

Enablers of collaboration:

Since the project schedule was tight, the organizations talked about the project culture in parallel to the tasks to be done. As part of this process, a core team was assembled, which was integrated by members from all the organizations, to tackle the decision-making for the project.

"We kind of started working together and talking about how we want to work together. And I think, it worked really well and we had good persons for that and then we all wanted to share what went good, but also what we came across that didn't go so well. We had an open mind in that." Int C.1

In the project, there were different types of meetings such as high-level, progress, and management meetings which provided clarity to the team members regarding the goals, decisions to be made, or issues to be resolved. There were quarterly feedback sessions called keep-start-stop that offered an opportunity to improve the project processes as well as an opportunity to assess the satisfaction of the team members since it was recognized that individual satisfaction played a part in the performance and collaboration.

"We had two hours every week a core meeting with the bouwteam it was online with the core team and also two hours that was just the project managers and me and we were talking about financial things, working together, more of the trusts things, and the things that really had to be accomplished, but it was a small group" Int C.1

Social interactions were also considered crucial for the project. Through these, the team members can create good relations with each other, relax and have fun. It was recognized that issues could be resolved through informal talks speeding the process and decreasing the need for meetings.

"I think that just one benefit of working together is that the small things such as asking someone something or for building the relationship or for the project." Int C.1

*"We are laughing and we are joking with each other in a meeting, sometimes it's serious and then someone makes a joke out of it so I think that helps, just not to only be focused all the time. **So I think that the power of our team: some humor.**" Int C.1*

"We had two times a week short meeting to discuss other things than work." Int C.2

Trust was another factor crucial for the collaboration among the organizations and the team members. At the start of the project, when the whole team was forming, the main concern was financial. The reason for this was the nature of the work, as it was underground, so it was not possible to visualize the extent of it. The managers tackled it by scheduling regular meetings among the organizations to discuss these concerns which support building trust over time.

"And we had to build some trust, but, the main trust was financial and of course, we need to have trust that the price is OK." Int C.1

"For added trust and looking at each other in the eyes when there's really something it's better to meet each other offline. But we also did a conversation online and it was OK. We did online meetings talking about more difficult things or trusts, or things that weren't going well and it was OK, you can do it all online." Int C.1

Lastly, one of the interviewees worked previously in one of the organizations which helped him/her in the collaboration of the new project. That is, previous experience enabled him/her to understand the way the organization and the team members work.

"But I knew the people so we get used to each other before. So we work together in the earlier stage but then on the same side. And now we're on the opposite sides. So that was for me not a problem." Int C.2

Disablers of collaboration

Another element that was taken into account was the structure and engagement in the meetings. It was noted that consecutive meetings tend to affect the performance of the team members as some participants were not 100% focused on the discussion but rather immersed in other tasks. Consecutive meetings also limited their time to work on their assignments.

"What you hear from other people is that they are working and meeting from 8:30 until 5:00 and they were only meeting. So when do they have their job done?" Int C.1

"Some are working between the meetings or in the meeting themselves." Int C.2

Enablers of virtual teams:

As part of their responsibility, the organizations approached the team members directly to make sure that they had the right equipment and space to develop their work efficiently. This was coupled with the selection of a set of tools that is the best fit for the project and are user-friendly, which supported the virtual collaboration. Once the tools are selected, the organizations provided training to avoid decreasing the performance of the members by learning how to use the tools on the job.

"Every employer has to give the tools to their people, chairs, screens, and all that sort of stuff to work at a good normal way in the last one and half years." Int C.2

"To build a strong team, you must see someone else's strength as a complement to your weakness and not a threat to your position or authority." – Christine Caine

When working remotely, it is important to have a good structure in the meetings. Within the project, there were two types of structure: meetings to transfer information "one-way" or a meeting for discussions "two-way". The number of participants dictated the type of meeting. Also, social interactions play a bigger part when working remotely than in a normal setting. The managers aware of this, structured the meetings including social interactions to support team relations and collaboration. This was combined with face-to-face meetings when needed. At the start of the project, the core team met in person occasionally to work on building trust and resolving sensitive issues. It was recognized that getting to know each other made it easier to collaborate remotely or to accept suggestions during discussions.

"The meetings are with a maximum of 8-10. Because otherwise, you don't have a meeting, then you give some information and you can't discuss because it's too big." Int C.2

"Meetings it's only straight and business and business and work and work, and I think it's important to also have those moments online and we don't create it with a quiz or something, we just make jokes in a meeting and someone is either talking funny things about each other so, because of that, it's less of an effort to be in a meeting for me." Int C.1

"So the meeting of status, action and also of course with some technical things it's good online. But when you really want to understand the contract, the work that has to be done, the complexity of the surroundings we combine that with some offline meetings" Int C.1

"People are now thinking that you have to work all day. Because normally if you come in at 11:00 o'clock and you get a coffee and you talk to someone and it's also some part of your work to approach someone and say how are you, what is in your head about this or how's your work or your private, you just do it. But online people say, oh, I don't have time for it because I have to work, so I think that's inefficient in a day because they are only working online." Int C.1

"When you're working hybrid then you work at home, you don't have the short meetings, so everything that I want to ask there is the meeting before, and that's why you have a lot of meetings, over and over again the whole day so that's why I sit at least seven hours in a meeting on zoom." Int C.2

Every project needs to build trust among team members, yet in a virtual environment the importance of it increases. Trust coupled with the creation of a safe environment enables team members to open up and share solutions, their progress, complaints, or doubts. Without them the virtual collaboration and virtual team performance decrease.

"The most important thing for us was trust and for some part liking each other." Int C.1

Disablers of virtual teams:

"A team is not a group of people who work together but it a team is a group of people who trust each other." – Simon Sinek

As mentioned before, the organizations must train team members to use the project tools. Otherwise, the advantages of said tools can not be seized, the efficiency or performance of the members will decrease since they will invest time in learning how to use said tools.

"I think we have the tools but it's learning on the job so you don't know how to use it in a good way." Int C.2

Also, the lack of body language of virtual teams impacted the approach used by the managers to monitor the project and the meetings. They relied on body language to measure the tension, level of understanding, and commitment in meetings or negotiations. Another aspect that made it more challenging to manage the project was a large number of participants in the meetings. To cope with these issues, the participants kept their cameras on during the meetings and arranged smaller meetings to discuss certain issues with the corresponding members.

"But I think you won't have the same result in understanding, because we did at first more online but when you are offline, you can more easily say something informal or express when you're having doubts about it with some kind of emotion, I think it feels you can bring it better offline because then you can immediately react" Int C.1

"I think it's hard in meetings, it's hard to read the people on the other side. Normally you can judge the people how they react and that's difficult for teams. Because you only see the head and not the arms and not the hands so you don't see the reaction on your comments or other things. And I'm used to read the people in the meetings so how they can react so you can change your subject or style of reading" Int C.2

Consecutive meetings were also considered as a disabler of virtual teams since it can affect the performance of the team members and collaboration which in turn influence the implementation of virtual teams. Social interaction is considered an enabler of collaboration and virtual teams. Yet, when this aspect is neglected in the project it can transform into a disabler of both.

"But online we want to regulate everything and we want to make it nice and just sit together and talk. Because that's what you do offline as well, so I think that's important. It is also important that people have work time, and that's sometimes also offline an issue that they've meetings all day." Int C.1

Reflection on virtual teams.

The interviewees noticed the advantages and disadvantages of working remotely. As for the disadvantages, it was mentioned that not knowing someone in person makes it harder to work with, it is harder to build relations online and team members have to work together to find each other. Also, there is a lack of coffee talk to resolve minor issues/questions, a lack of body language, and a need to improve current tools. Lastly, it was mentioned that it is harder to imagine whether something is going to fit in the design or not. On the other hand, working remotely reduce travel

"I can do things you cannot. You can do things I cannot. Together we can do great things." Mother Teresa

time, and it provides an efficient way to manage meetings regarding status, actions, and minor technical issues.

Both interviewees prefer a hybrid way of working since it can provide the advantages of both worlds. Yet, the interviewees noted the need for some improvements such as the tools which could be enhanced and tailored for the construction industry. One of the interviewees also mentioned that when implementing virtual teams or hybrid during a negotiation, the closing phase which is the last 10% of the process is recommended to do in-person to guide the parties into an agreement or avoid misunderstandings. Below there is a reflection of the knowledge gained in the project.

What worked such as face-to-face meetings at the start, feedback sessions, sub-dividing the meetings, turning the camera on, and having fun together;

What needs to be looked out such as group relations, social interactions, individual satisfaction; and

What needs to be avoided as consecutive meetings or lack of training.

"I think at the end when you're looking at a future where there's a combination of offline and online." Int C.1

"I think when you want to work more online, then some tooling can be improved because, for instance, there is a meeting where there are two or three persons online and the others are together and I think that's difficult. You can better have all people online because when you're in a room with 6 or 2 online, I think we still have to make it more effective." Int C.1

"I think that we don't have the experience in the tooling that are really well implemented yet." Int C.1

"I think it can be in hybrid way, because we have different offices, so I think it must be in hybrid way, but I think also we used to meet life with each other and then you have the best discussion and in the design you need to see the drawing you need to discuss over and over the design." Int C.2

"I think the apps and the digital techniques are better and better to work in a future on hybrid form, so I think it's going to be better." Int C.2

4.2 Case study III: RWZI Oosthuizen

Hoogheemraadschap Hollands Noorderkwartier is the water authority for the northern part of the province. It is responsible for ensuring the land doesn't get flooded, the roads are safe, and there is sufficiently fresh and clean water. The authority anticipating the increase in rainwater influx due to climate change and the population growth is renovating the wastewater treatment plant located at Beetsdijkje in Oosthuizen. The facility functions properly, yet some of the parts are

outdated. The aim is to update them into a more sustainable system while increasing the capacity to support the demands of the future (Eliquo, n.d.).

4.2.1 Case introduction

The current treatment plant functions with a conventional system formed by an aeration tank and secondary settling tanks. The new facility will work under the Nereda purification system due to its benefits such as durability (50% less energy), flexibility (easily expandable), and requiring less surface area. The Nereda system is going to be built next to the old one, the sludge buffer and container will be moved to a temporary location to make room for the new installation. The plant will maintain the old influent pipe, that is, through pressure pipes from Beets and Oosthuizen. In case of emergency, it is planned that the wastewater could be treated in a conventional way with the old system. The effluent is discharged via the existing effluent pipeline but the outflow system is being renovated. The renewal includes also the demolish of most parts of the current plant (aeration circuit and temporary buildings) and the installation of the new system Nereda. The last consists of the installation of sand and screen storage containers, two Nereda tanks, storage and dosing flocculant, sludge thickener, and sludge buffers. Figure 16 shows the location of the old facility and the area delimited in yellow represents the location of the new facility (Hollands-Noorderkwartier, n.d.).



Figure 16: Scope of RWZI Oosthuizen

The wastewater treatment plant is located in the Oosthuizen business park which focuses on service provision and agriculture-related activity. There is a residential house southeast of the plant. Both businesses and residents are aware of the project. Furthermore, there are two points of access to the plant, the first one is through the road N247 via the Beetsdijk, the second one is

through the Ambachtsweg via the business park. The closure of the roads is not necessary. Lastly, the location of the plant is adjacent to the Boezemkade, a regional flood defense. Therefore, flood risk management needs to be carried out throughout the construction. Taking this information into account, the project is considered of a less complex nature (Hollands-Noorderkwartier, n.d.). Further information about the project is depicted in table 5.

Table 5: ORWZI Oosthuizen facts:

Number of team members:	20 people involved
Added complexity:	The need for a flood risk management.
Contractors:	Eliquo
Estimated cost:	€ million
Start of the bouwteam phase:	Started online.

4.2.2 Results: RWZI Oosthuizen

Representatives Interviewed:

- Interviewee D.1 is the project manager from the advisor side and has 12 years of experience.
- Interviewee D.2 is the technical manager from the contractor side and has 25 years of experience.
- Interviewee D.3 is the engineer from the contractor side and has 14 years of experience.

Enablers of collaboration:

At the start of the project, the organizations gathered to structure the collaboration in terms of scope, responsibilities, and roles, which helped to set the way of cooperation and avoid problems due to organizational differences.

"Normally you start with something like a project start-up, just gathering with all the people involved in the project to get to know each other, to talk about the processes we have to go through, how you want to cooperate with each other and those kinds of things... with the virtual team we did exactly the same, but we did it online." Int D.1

Also, a systems engineering of the project was done, that is the requirements were identified and integrated into one document to describe the prerequisites of the project. Through it, the team members will be able to know the requirements and the need to coordinate with other members to reach the project outcome.

"The system engineering efforts, which needs to be done during the start of the project funny enough help to know each other better." Int D.2

The meetings were divided into high-level, progress, technical, and contracts meetings. Int D.1 mentioned that there were a few differences between working online and offline, for instance,

the type of meetings and frequency was considered the same. Moreover, it was recognized the need to leave a day without meetings to allow the members to work on their tasks.

"You start with the regular rhythm of your project management meetings, your technical meetings, your contracts meetings... of course, you have to adapt the way you are communicating, how many people you want involved in a meeting, there's a difference in that, but in general you can say that it's not completely different." Int D.1

To promote team bonding different activities were done such as small social interactions at the start of the meetings which also helped to create a relaxed environment, setting a day per week to work jointly online with the camera on and microphone off simulating a day at the office, or calling individually to check the well-being of the members.

"We had one day on Tuesdays when we work together. It was all online, but that's was the day when everybody was available for the project." Int D.1

"I did that mostly with our with my team so I just spoke to everybody by teams or phone or whatever." Int D.1

Individual satisfaction was addressed through feedback sessions where the team members needed to respond to a series of questions regarding the collaboration and ways improvements to it. Team members' satisfaction is considered important to keep their commitment and engagement to the project.

"We also measured actually how happy everybody was in the project, with their role, with the cooperation between contractor and client, how easily people could find each other online or by phone; so we measured that, and the results were from the beginning to the end pretty good." Int D.1

"And that helped to find out what is below the water and you could say if there is an iceberg. Most of the things people don't say can come out if you have proper project evaluations. More about a soft side of the cooperation. And we use these methods more frequently than normally." Int D.2

"It's not really that you were one team, but someone can, you can discuss it, what's your problem or what you think about how we are working right now and I think, that was positive." Int D.3

Lastly, for the managers, it was important to create a safe environment where all team members felt safe to share their opinions without feeling judge. This is important since it allows the managers to gather the information they need about the project or to identify problems, monitor the well-being of team members, or gather solutions.

"Coming together is a beginning, staying together is progress, and working together is success." — Henry Ford

"But we had a social safe environment, I think where people well could talk and say whatever they want... we achieve this spending time to talk about chit chats... For me, it was a way to not only focus on the work but also on everybody's well-being and what they were up" Int D.1

Disablers of collaboration:

The project was not considered complex in terms of the engineering or surroundings. Yet, it was a new experience for the client in terms of the tools and the bouwteam agreement which required adjustments in the organizations. The client was not used to performing certain types of tasks, which harmed the collaboration and the progress of the project since all the parties needed to work together to create the design of the waste-water plant.

"The second thing was the customer was not used to act in the building team and yeah to be very strict on the what do we do and what does the customer do is much more difficult when you're talking to a screen, sitting in a room it's more easy to discuss this." Int D.2

Enablers of virtual teams:

For the project, it was considered necessary and professional to make sure every team member is working with the right equipment, camera, microphone, and even the space to work. Ensuring this will improve the virtual experience and will enable team members to have a better performance.

"It's just a simple thing, get a good camera and a good headset. We had a lot of things with that when people switch their comms off, that's fine, but it also is not fine because they are not part of the meeting. They do it because someone is building or have some working going on around his environment and we only heard hammers and machines on the background." Int D.3

In the same line, it was recognized that selecting the right set of tools and knowing how to use them support the collaboration in a virtual environment. For instance, a stable internet connection, Ms Teams, Mentimeter, or BIM360. The whole team should agree on the selected tools and prepare to grant access to the required team members.

"A good Internet connection. It starts with that because if there are people that don't have a good Internet connection, you're not able to communicate at all, it's very annoying when that is the most problematic part of communication." Int D.1

"I had to switch, make some exports to him and then he exported it back to me and then I had to add my model together and that was not very handy, that could be better." Int D.3

"The strength of the team is each individual member. The strength of each member is the team." — Phil Jackson

"I think that is something many companies have to learn, how to share your models and make them build them up so someone else can do something with it and not just you, but can also engineer from it." Int D.3

"In that kind of meetings, I had my 3D model opened and I moved to the component where we talked about that was very handy." Int D.3

In a virtual environment, it is important to have a good structure for each meeting. Having a clear and feasible goal as well as a desirable outcome enables the team members to have the required information to continue working on their tasks. Also, the team members needed to leave their cameras on during the meetings to monitor their engagement or whether it was time for a break. Implementing a guideline for the information management system provides clarity to the team members on where the information is. Also, it was recognized in the project that the people involved in a meeting needed to be selected critically since it is more likely that people not giving input lose focus during the meeting.

"Also time-wise, so this meeting is 2 hours. We have to pick these points and don't make a long list because you already know we are not going to get through to the end of the list." Int D.3

"You can usually make a teams meeting and it works and you don't know have to drive so I think it's can be very effective, but make your meeting or set your meeting goals and then it's effective." Int D.3

"We became aware that you should be very selective on who to invite and what's the reason you invite people. Because otherwise, you noticed that people don't say anything in a meeting or they say themselves that they are not really attached to what we are talking about." Int D.1

"As a project manager for the project, I was in the lead in many meetings and for me, it was very nice to see all the faces and know If people were still involved or if they were doing other things. So it helped me also to see whether we needed a break or ask somebody a question that was apparently doing something else just to get everybody well involved." Int D.1

The bouwteaam agreement requires good and high collaboration between the parties, that's the reason the project included small informal interactions throughout the project to support the creation of bonds. This was done either by talking about something different than work at the start of the meetings or calling to check on other team members. It was also recognized that the importance of relations increases in a virtual environment.

"Spend time on teams to not talk about the project, but about other things, to have a chat like you do when you were going for a coffee at the coffee machine." Int D.2

"Remember teamwork begins by building trust. And the only way to do that is to overcome our need for invulnerability." — Patrick Lencioni

"Not only talk about the goal of the meeting, what you're going to do during the meeting, and get to that topic directly, but also talk about well, as I mentioned, all other things that happen in life." Int D.1

Lastly, in virtual teams, the manager is required to create an environment in which every team member feels safe to share their portion of information about the project. Otherwise, there is a risk for problems to stay hidden.

Disablers of virtual teams:

As mentioned before, the selection and access to the project tools influence the application and performance of virtual teams. At times, the poor internet connection of some members or implementing the wrong tools made the design process inefficient. For instance, members working on similar platforms to grant access to the same information for the rest of the team.

Overcrowding the meetings led to a decrease in participation which affects the performance of the team. Consecutive meetings represented another issue in the project. It was recognized that the meetings should be shorter to maintain the team members' engagement. Meetings of 4 hours long or even the whole day are not effective without the right structure, that is having breaks along the way and involving the members in the meeting. Throughout the project, it reached a point on which the calendar of the team was full of meetings. This is ineffective since the members need time to work on their tasks to have some progress in the project.

"Your agenda is completely dominated by teams meetings. And the relaxation moments you normally have if you're sitting in a room or if you're traveling to a meeting. You don't have that when you are very busy with a lot of teams meetings." Int D.2

"What I do see is that customers are still struggling with their IT infrastructure." Int D.2

"We have strict folder arrangement... but when you are looking at other companies who are not doing that in a collaborative project, then you have a lot of problems with someone who is putting his file in a folder we don't know and we have to search and search and give a call." Int D.3

"The Wi-Fi doesn't work properly or whatever. No, I'm not satisfied about that. People use the wrong microphone, it's still not optimal. It can be much more improved." Int D.2

As mentioned before, small meetings with clear goals are recommended for a virtual environment. However, in the project there were meetings with the opposite, that is unclear goals and overcrowded, which affected the efficiency of the discussion and meeting itself. In the same line, a lack of body language presented in a virtual environment affected the ability of the managers and members to moderate the discussions.

Reflection on virtual teams.

"It is the long history of humankind (and animal kind, too) that those who learned to collaborate and improvise most effectively have prevailed." — Charles Darwin

Decrease in travel time, facility of coordination, and collaboration with external organizations are considered benefits of virtual teams while a decrease in effectiveness on certain types of meetings, differences in IT levels among the organizations, and the increase in difficulty to coach external organizations were considered disadvantages of virtual teams. Taking this information into account, the interviewees considered a hybrid team the best option for future projects. Reflecting on the results from the project the following statements can be made:

What worked such as setting one day to work together online, feedback sessions, sub-dividing the meetings, turning the camera on, having fun, and creating a safe environment;

What needs to be looked out such as group relations, social interactions, individual satisfaction, and guidelines for the information management system; and

What needs to be avoided as consecutive meetings or big differences in technology infrastructure,

"I would prefer to hybrid way. Hybrid I mean that you don't meet, I'm talking about the relation with the customer. So not internally, internally that always prefers to have face to face." Int D.2

"I think hybrid is definitely better... especially when you don't have the kind of technical meetings, it's just about a project or process you can do fine without the physical now you can do it in teams." Int D.3

"The office has a lot of advantages but also disadvantages when you have a long task or just want one task, like drawing something and you know is 2 days work, you better be home. In the office is very nice to speak to everyone but it's also interrupting your work. So I think, now there are advantages for working at home and working at the office. I think a mix is fine depending on which kind of work you have, in my case it should work fine 50/50." Int D.3

"It went like how we should have normally done that we discussed based on our cost estimates and everything that was used to produce the cost estimates and we had the same discussions as we normally should have had and I don't think it was harder or more difficult, no." Int D.1

4.3 Conclusion chapter four

This chapter aimed to get an overview and understanding of how virtual teams are implemented and collaborating within current short-distance Dutch Bouwteam projects. This information needs to be gathered to get a better understanding of the environment for the development of the recommendations. Also, this chapter provides an answer to the subquestions: "What are the factors regulating collaboration and virtual teams?" and "How is the current collaboration in the bouwteams?". The information for this quest has been found through the use of four case study. The main findings from each case can be found in table 6.

In chapter 2, a partial answer focused on theory was given to the first sub-question. Table 6 provides the practical side of the answer, within it can be seen the match between the factors and the elements of the framework in section 2.3, as well as, those new to the literature.

As for the second sub-question, during the case study, it was found that every organization forming the project have their policies regarding virtual teams and the way to collaborate, that is their strictness regarding face-to-face meetings or openness to implementing virtual teams in the future. For instance, in case study one it was mentioned that the client limited face-to-face meetings due to their regulations regarding COVID while the rest of the organizations were more flexible. Also, the interviewees of all the four case study were open to collaborating in a hybrid way, yet ones in managerial positions preferred a collocated setting within the organization.

Moreover, most of the strategies implemented in each case are similar, but there are some exceptions. For case study one both the contractor organization and within the project, a set of interviews were arranged to select the team members. Also, the members of case study one relied on individual efforts to build relations with the other members. For collaboration, case study two used an open-book contract which is known to increase the trust between the organizations contrary to case study three on which a set of in-person meetings needed to be arranged to work on financial

Table 6: Case study results

Categories		Collaboration	Virtual teams	CS 1	CS 2	CS 3	CS 4	Lit
Context	Same cultural background	✓		✓				✓
	Creating a culture for the project	✓			✓		✓	✓
	<i>Providing the correct equipment *</i>		✓	✓	✓	✓	✓	✓
Support	Incorporating and expert in collaboration	✓		✓	✓			✓
	Develop systems engineering at the start of the project	✓					✓	
	Having selection criteria and procedures for team members	✓		✓				✓
	Including an information management system	✓			✓			✓
	Guidelines for information management system	✓			✓			✓
	<i>Access to all the information of the project *</i>	✓		✓	✓			✓
	<i>Lack of experience in highly collaborative contracts **</i>	✓					✓	
	<i>Good internet connection *</i>		✓	✓			✓	✓
	Implementing the right set of tools		✓		✓	✓	✓	✓
	<i>Training **</i>		✓			✓	✓	✓
Tasks	Discussing the changes to the design on informal talks.	✓			✓			
	<i>Creating silos of information **</i>	✓		✓				
	Tasks with low demand of interaction.		✓	✓				✓
Interaction processes	Weekly progress meetings	✓		✓	✓	✓	✓	✓
	Keep-start-stop sessions.	✓		✓	✓	✓	✓	✓
	One day without meetings.	✓			✓		✓	
	Turning on the camera during the meetings.		✓	✓				✓
	<i>Having a good structure in a meeting *</i>		✓	✓	✓	✓	✓	
	Having fun.		✓	✓		✓		✓
	<i>Consecutive meetings **</i>		✓	✓		✓	✓	
Teams	<i>Lack of body language **</i>		✓	✓		✓	✓	✓
	Face-to-face meetings at the start of the project		✓	✓	✓	✓		✓
	<i>Include and promote social interactions *</i>	✓	✓	✓✓	✓✓	✓✓	✓✓	✓
Individuals	<i>Personal preference for a traditional project delivery **</i>	✓		✓				✓
	Team members' satisfaction.	✓	✓	- ✓	✓✓	- ✓	✓✓	✓
	<i>Personal preference for a traditional collocated setting **</i>		✓		✓			
Overarching factors	Do the procurement together.	✓			✓			✓
	Resolve previous issues before the start of the project.	✓			✓			✓
	Trust between all the stakeholders.	✓				✓		✓
	Having a safe environment		✓		✓	✓	✓	✓

Notes: * Elements that are considered both enablers and disablers depending on how they are managed.
 ** Elements considered disablers.

trust. Case study four used system engineering to gather the requirements of the project and as a team bonding activity, it also held a virtual office day where all the members were connected working together. Case study one, two, and three held face-to-face meetings at different points in the process, contrary to case study four, which was done fully online.

Another noticeable aspect throughout all the projects is the presence of a need for social interactions between the team members and organizations within the project. Currently, virtual teams don't provide the level of social interactions the team could have when working together at an office. Which can be interpreted as an opportunity for improvement in the implementation of virtual teams. Also, a knowledge gap between the team members on how to manage the project tools was recognized. This knowledge gap could be the result of the difference in the received training between the organizations or the lack of familiarity with said tools. Chapter five provides a deeper analysis of the results through comparison among the four case study and literature.

5 Cross case analysis

This chapter uses the findings from chapter 4 to develop a cross-case analysis where a comparison is done to identify the commonalities and differences between the cases and the literature described in chapter 2. This information is found in section 5.1. Once the data is analyzed, the findings of this chapter will be used to develop the set of recommendations described in the following chapter.

5.1 Cross Case analysis

At the end of Chapter two in section 2.3, a theoretical framework is proposed which contains the most relevant factors influencing collaboration and virtual teams across the literature. The framework contains seven categories deemed important for both concepts. Then a series of empirical interviews from four different case studies were done to gather the lessons learned when working remotely in the form of factors that acted as enablers or disablers. Chapter four describes the interviewees and the findings per case study which are enlisted in table 6. Within the table, the factors are classified in two ways; through their influence and through the categories of the theoretical framework.

Among the similarities regarding collaboration found across the case studies is the recognition of four factors: satisfaction, social interactions (informal talking), feedback sessions (keep-start-stop), and different types of meetings. Both literature and the case studies show that these factors act as enablers of collaboration due to their positive influence on team processes and relations. Moreover, a factor that was considered both enabler and disabler of collaboration was the degree of access team members have to information. The availability of information act as support when developing tasks, while creating silos of information could affect the integration of different parts of the project.

On the other hand, there were some elements related to virtual teams present in all four case studies which are providing the correct equipment, having a good structure in a meeting, and promotion of social interactions. The findings from the case studies show that these factors can act as enablers or disablers of virtual teams. Across the literature, these factors have been mentioned,

yet, the promotion of social interactions was mentioned as critical in a virtual environment by Lurey & Raisinghani (2001) which goes along with the findings from the case studies.

Case studies one, three, and four are considered similar in terms of the number of people involved in the project, yet across these three cases, two disabling factors were presented: lack of body language and consecutive meetings. Across the literature, the lack of body language has been frequently mentioned, yet, consecutive meetings have been mentioned only in two of the articles studied for this research (Lee-Kelley & Sankey, 2008; Daim et al., 2012). The following sub-sections provide a deeper cross-case analysis per category.

5.1.1 Context

Culture refers to the characteristics and knowledge of a certain group of people, that is language, social habits, behaviors, and so on. Literature shows that collaboration tends to be easier in teams with the same cultural background either national, organizational, or professional (Patel et al., 2012). This goes in line with the findings in the case study one recognized by one of the interviewees. In his/her personal experience with international and national projects, speaking the same language and implementing similar working routines made it easier to collaborate since the members didn't have to deal with accents or differences in the information needed to provide context to a problem or solution.

As seen in the studied cases, most of the projects played with this aspect similarly. Due to the different organizational culture, technology, and even business climate, the team opted to hold a meeting at the start of the project to address jointly the culture for the project. They discussed, agreed, and develop guidelines regarding the integration of each organization into the scope, the core values of the team, and the behavior of each organization, and ultimately team members will have to show throughout the project. These guidelines defined the rules of the game for collaboration in the bouwteam by providing a clear framework to reduce uncertainty and limit conflict between project participants. This compromise also allowed the whole team to build trust among each other. This goes in line with the literature where de Hoog (2020) mentioned that at the start of the project the members of the bouwteam can hold a start-up meeting to address their expectations and strong or weak points of the project.

On the other hand, for virtual teams, it was recognized both in the literature and the case studies that the organizations need to ensure that their workers operate in an appropriate work environment. A suitable work environment contributes to efficiency and competitiveness, and it is also an important health factor. For case study four, the background noise from one of the team members interfered with the conversation in the meetings. Since the project was formed by a short distance team, the organization arranged a place either at the office or site for the team members with similar circumstances. Moreover, for the members working from home, they provided the necessary furniture to work remotely. The organizations followed a program where the workers filled in a format stating their needs if there is one or asking directly.

5.1.2 Support

Tools are important for virtual teams and collaboration since team members can rely on these to work on their individual and joint tasks. Yet, the literature also mentioned the importance of ensuring the interoperability among the technology used in the project (Hosseini et al., 2016). The salience of paying attention to the selection of tools and the accessibility of the team members to them was highlighted by the interviewees of case studies two, three, and four. The internet connection also plays a part in the application of virtual teams. As mentioned by two informants, the team encounter connectivity problems from some team members which obstruct the communication during the meeting. This impacted negatively on the transmission of the message in the meeting but also in its efficiency. Another aspect raised in two of the case studies was the level of experience implementing certain types of tools. Without the right knowledge, the members cannot seize the full potential of the technology they are using. These results coincide with the thinking of some researchers where they emphasize the importance of training not only to provide the participants with the knowledge but also as a way to build trust in team members' relationships (Jelodar et al., 2016).

In both case study one and two, although it wasn't considered a necessity but rather an element nice to have, it was mentioned that for every project it should be assessed the need of incorporating an expert in collaboration. Among the reasons for this it was mentioned that it was essential for the members to have a guide through tough conversations that could lead to conflict by coaching them to voice effectively their arguments and build a consensus among the members. This goes in line with the literature, Jelodar et al. (2016) mentioned that it is important to look after the relationship quality during complex events such as conflict or disputes. Another issue raised by the interviewees was the lack of experience in highly collaborative contracts. One of the organizations forming the bouwteam required additional coaching to venture for the first time into this form of collaboration. This challenge required time for the organization to assimilate the new requirements and responsibilities asked of them which affected team collaboration.

Also associated with this category was an issue present in the fourth case study related to the lack of guidelines to align the building of folders in the project. Given the lack of policies or procedures to upload or locate information in the selected data management system, a level of chaos was presented in the project. This affects not only the quality of collaboration and communication but also the efficiency and performance of the team. The members feel the need to spend time looking for information or obtaining it through a different platform. As mentioned by some of the informants, clarity in the location of the information among the team members is key, as this could later impact their motivation and engagement in the project. Another aspect related to information was the level of access the participants had to it. As recognized by the interviewees of case studies one and two, creating silos of information tends to lead to negative outcomes in the project such as duplication of effort or incompatibility among different parts of the project.

An aspect found across the literature and in one of the case studies is the inclusion of the right people in the project. One of the organizations involved in case study one was aware of

"The way a team plays as a whole determines its success. You may have the greatest bunch of individual stars in the world, but if they don't play together, the club won't be worth a dime." – Babe Ruth

the negative repercussions this could provide to the project. Therefore, they developed a round of interviews to assess the compatibility of the new members with the rest of the team. This is in line with the literature, as it shows that it is important to evaluate the effectiveness of collaboration between team members as this could have repercussions on project performance (Patel et al., 2012). Another technique for team building is the development of system engineering at the start of the project, as done in case study four. The team members jointly developed said system which granted them information about the project requirements as well as the people in charge of each aspect; this activity supported team cohesion and trust-building. This last factor was not found across the literature as an exercise to build trust and cohesion.

5.1.3 Tasks

As stated before, the design phase is considered a creative process by the respondents of case study two. The interviewees recognized that the discussion of design changes is facilitated by informal interactions either to review the changes done or to discuss other possible solutions in a relaxed environment. This factor relates to collaboration while the next one is considered for virtual teams. The respondents from case study one mentioned that the implementation of virtual teams can be effective for activities with low demand of interaction. Debates in virtual meetings are considered inadequate due to the slow pace of the conversation when different actors intend to voice their opinion or concern about the issue being addressed.

5.1.4 Interaction processes

As can be seen from table 6, this category is the second one with the most factors mentioned by the interviewees. Interaction processes are a multidimensional category where a mixture of dimensions interplay to achieve efficient collaboration among the team members. Among the factors related purely to collaboration are the integration of different meetings and blocking at least one day of production while a factor related to virtual teams is the over-communication in the project, these go hand in hand. Separating the meetings, according to the discipline or issues to address, requires only the key players to be involved while demanding less time to reach a consensus among them since the agenda of the meetings will be only a small set of issues. Involving only the critical players in the meeting will also rule out unnecessary members in the threads of communication. Yet to avoid communication issues due to ambiguity, the structure of the meeting needs to be planned stating the goal and desired outcome. As only the key members will be involved in the meeting, the rest of the team will be able to center their efforts on their tasks which is indispensable to progress in the project. As recognized by the interviewees from case study two and four, it is essential to leave at least one day free of meetings for the team members to center on their jobs.

As research suggests, taking into account the satisfaction of team members regarding the collaboration helps to moderate their behaviors (Patel et al., 2012). In resonance with this statement and the factor explained above was the next strategy executed by all the case studies. The implementation of a keep-start-stop session allows the managers to gather information about the way the project has been performing in terms of collaboration. The session enables team members to voice their opinions, concerns, and suggestions to improve this aspect of the project.

Another issue mentioned in three of the projects and across the literature is the lack of body language which affects communication in a virtual environment. Literature suggests projects to incorporate media that grant access to higher communication cues to the team members such as video-conferences. Media richness has been proposed to cope with this and as a solution to transfer canonical and equivocal knowledge depending on the cultural difference and language commonality (Klitmøller & Luring, 2013), which in this case both are similar between the team members. Yet, the recommendations from the literature deviate from the data gathered from the case studies. Klitmøller & Luring (2013) mentioned that for equivocal or canonical knowledge the knowledge can be shared either by face-to-face interactions or virtual communication, whereas the findings from the case studies show complex or equivocal information is preferred to transfer through that face-to-face interactions.

5.1.5 Teams

Literature and the findings of the case studies show that the nature of the relationship between the team members will have consequences on the bouwteam performance. This category defines the quality of collaboration according to the quality of team members' interactions.

In the studied projects, the lack of space and time allocated to social interactions was considered an issue for both collaboration and virtual teams. Collaboration is considered enhanced when the team members' relations are good since it can reduce communication and coordination demands (Patel et al., 2012). While this aspect comes naturally in a collocated setting where team members can find each other at the office and have small interactions throughout the working day. In a virtual environment, the opposite happens. The physical distance echoes the perception of team members' closeness. As recognized by the interviewees, virtual collaboration was considered mostly business. A strategy to form an effective team, the organizations, and the project should have a structure where time is allocated not only to focus on technical issues but also to build relations among the team members which will also provide them a sense of belonging to the project.

Literature suggests some degree of face-to-face contact in virtual teams (Lee-Kelley & Sankey, 2008). Some researchers mentioned that this type of meeting should happen at the start, intermediate stage, and at the end of the project (Lee-Kelley et al., 2004). In resonance with this statement, case studies one, two and three implemented this strategy not only at the beginning but also when necessary. Establishing collocated meetings served as a vehicle for building trust among the organizations and team members but also to address complex decision-making issues. While face-to-face interactions are valuable for trust and building relations, other strategies could be integrating rich media such as video-conferences (Lee-Kelley & Sankey, 2008).

5.1.6 Individuals

As can be seen from table 6, this category was identified not only across the case studies but also for both collaboration and virtual teams. The literature considers team satisfaction as relevant in the performance of collaborative working (Patel et al., 2012) which can vary in time (Jelodar et al., 2016). Participant satisfaction has been identified as a factor affecting the relationship

quality in the project (Jelodar et al., 2016). This goes in line with the findings of the case studies. The interviewees mentioned that satisfaction is important to maintain good relations which is important for collaboration, but also to maintain their commitment throughout the project. Yet, in a virtual environment, team satisfaction and motivation are also considered critical (Rezgui, 2007) since it could, in turn, affect the effectiveness of the team (Hosseini et al., 2018). Team member satisfaction is seen as a multidimensional concept that can be positively influenced by exhibiting learning behaviors, having a goal commitment, adequate technological capabilities, adequate conflict management, and effective leadership (Gilson et al., 2015).

Also, personal preference towards a traditional collaboration or offline collaboration was recognized as an issue by the interviewees of case studies one and two. As recognized by the interviewees, the dissatisfaction of team members due to their lack of fit into the context of the project tends to affect the collaboration and the performance of the team. Therefore, as a strategy to combat the disinclination to work in either a highly collaborative or virtual environment, resorting to selection criteria that comply with the qualifications has been well accepted. This strategy was implemented by case study one where the organization set interviews to verify the compatibility of the potential team members with the project and the rest of the team. Case study one also hold on-boarding sessions where the new members were trained to comply with the culture set at the start of the project.

5.1.7 Overarching factors

Trust, history of cooperation, conflict resolution, and psychological safety, are some elements considered in this category across the literature and the case studies of this research. The first one, trust, allows a better collaboration by supporting open communication and shared understanding (Bener & Glaister, 2010). Trust is not a condition granted once the contractors are selected and the project is about to start. It starts building from the tender phase, yet, team members must keep working on it throughout the project. According to Bond-Barnard et al. (2018) trust is a key ingredient to project success since it influences collaboration. Research shows that including an open-book contract has a positive influence on team cohesion since it provides transparency which helps build trust. This statement resonates with case study two where the organizations procure jointly the works in the project.

History of cooperation can have a positive effect on collaboration by enabling team members to predict the needs or behaviors of each other. It can also play a part in the social interactions and future associations between team members (Patel et al., 2012). Yet, these effects are influenced by the level of successful collaboration achieved. If the collaboration was negative, then the team members need to resolve past issues before venturing into the new project. Otherwise, this would lead to conflict between participants resulting in a decrease in the quality of collaboration.

Besides the need to resolve previous issues between the organizations or the team members, a safe environment must exist throughout the project. Literature shows that open discussions occur in an environment where the team members feel free to voice their opinions without fearing criticism

or rejection (Daim et al., 2012). As mentioned by some of the interviewees, in collocated projects psychological safety is important, yet in a virtual environment, it is key to influence the participation of the team members.

5.1.8 Reflection on virtual teams

Across the case studies, the interviewees recognized the advantages that can be gained through the application of virtual teams. For instance, it is more efficient the collaboration of certain types of meetings in this environment. Yet, most agreed on the need to maintain human interactions during the bouwteam phase, either to improve the integration of the team or to monitor design changes. All of the interviewees mentioned that short-distance teams can benefit from both worlds since they can meet or, as seen in the past years, work remotely. Therefore, across the case studies is considered a hybrid form the future of bouwteam projects. Yet, there is a disparity among the interviewees regarding the conditions for said form, 30% of the interviewees mentioned that a hybrid setting should be implemented inter-organizational while internally the collocated configuration should prevail. Contrary to this, the rest of the interviewees would implement hybrid teams both inter and intra-organizational.

5.2 Conclusion chapter five

To conclude this chapter an answer is given to the third sub-question:

Which changes are required to overcome the challenges of virtual collaboration in the bouwteam phase?

As part of the research methodology, the findings from this chapter were found through a set of interviews from four different case studies. The interviewees were asked to reflect on their experience regarding the current setup, the barriers witnessed, or lessons learned while working remotely which resulted in a set of enabling and disabling factors. These factors were placed under the categories previously identified in the theoretical framework of section 2.3. Table 6 contains the factors found in practice that led to the validation of the theoretical framework proposed. The table also sheds light on the relevance of each factor according to its presence in the case studies and the literature.

Within table 6 it is captured the answer to this sub-question. The factors that show potential to stimulate virtual teams and collaboration as well as the factors to vigil are shown. There are some strategies applied in different case studies which are not included in the rest such as a virtual office day, or open-book contract that can influence positively the application of virtual teams which are further used in the development of the recommendations.

6 Recommendations

This chapter follows the third and fourth phases of the research method, where a set of recommendations are developed for current and future bouwteams working in a virtual environment. Section 6.1 describes the initial set of recommendations based on the findings from the cross-case analysis. Then section 6.2 validates the recommendations through an expert session as well as the feedback gathered for their improvement. The final design is shown in section 6.3.

This chapter provides an answer to the fourth sub-question formulated as:

Could virtual collaboration be improved by the developed recommendations, and what is their application to the organization?

6.1 Initial set of recommendations

In the previous chapters, four case studies were analyzed individually and then compared with each other to distinguish the enabler and disabler factors of collaboration and virtual teams deemed important for each project. A set of recommendations in the form of the most important aspects to consider in a virtual environment will be proposed in this chapter. As for the strategy for the design of the recommendations, the following criteria were set: I) factors that were mentioned by at least two interviewees, II) factors that were mentioned by at least one interviewee and literature, and III) factors that were most frequently mentioned in the literature. These recommendations aim to enhance the implementation of virtual teams as well as the collaboration in a virtual environment. The author believes that by including these recommendations in practice, both elements will be stimulated in the project.

There are ten recommendations within the initial set these are project culture, addressing previous collaboration, team member selection, equipment and tools selection, feedback session, the structure of collaboration, the structure of hybrid meetings, good structure of meetings, the structure of remote work, guidelines for a document management system. The full description of the recommendations can be found in Appendix B.

6.2 Validation of the recommendations

As part of the last phase of the research methodology, this chapter validates the applicability and usefulness of the proposed recommendations with two professionals in project management and contract management. This section provides an answer to the fourth research sub-question.

Section 6.2.1 displays the discussion of the recommendation through the questions shown in section 3.4. Section 6.2.2 describes the conclusion and results from the recommendations and proposed strategies for implementation.

The methodology followed was a one-hour feedback session held through MS Teams. At the start, the researcher explained briefly the goal of the investigation, the case studies, and the goal of the session. Then, the dynamic was the following: the researcher described each recommendation one at a time; once the experts got the full context and description, a window popped up in their screens with the following question: How much do you agree with the following recommendation?; the experts then selected the answer that best fit which ranges from totally agree to totally disagree. This question was answered individually, the aim was to avoid bias in their answer and to avoid group thinking. After that, the answers were discussed and the experts offered feedback for improvement. At the end of the session, the experts responded to the following questions:

Would you apply them in your project when collaborating remotely?

Do you find the recommendations useful during the bouwteam phase?

What would you improve in the current recommendations?

Representatives experts:

- Expert 1 is a project manager from the advisor side and has 36 years of experience.
- Expert 2 is a contract manager from the advisor side and has 10 years of experience.

6.2.1 Discussion on validation

How much do you agree with the following recommendation?

As mentioned before, to avoid group thinking, the experts answered a pop-up questionnaire regarding their perspective towards the recommendation explained at the time before any discussion related to it begin. The answers from the experts to the pop-up questionnaire ranged from totally agree to neither agree nor disagree⁶. The results show a positive response to 8 out of the 10 recommendations. For recommendations six and nine, one of the experts was neutral on the aspects related to it. In his/her view organizing social virtual events support building relations and team

⁶The answers to recommendations one, two, three, and ten were 50% totally agree and 50% agree; recommendation four, seven, and eight was 100% agree; recommendation five 100% totally agree; recommendation six and nine 50% agree and 50% neither agree nor disagree.

integration, yet it doesn't replace human interactions, therefore, face-to-face meetings should also take place to work on these aspects and improve team cohesion. This suggestion is possible to include since part of the focus of the research is on short-distance teams, that is for this type of teams face-to-face interactions can be arranged easily.

Do you find the recommendations useful during the bouwteam phase?

The experts agreed that the recommendations are applicable and valuable for collaboration and virtual teams in bouwteam projects. One of the experts also mentioned the recommendations could even be used by any type of project, not only for bouwteam agreements, as the aspects mentioned also appear on them. Also, according to one respondent, these guidelines mark the way how to collaborate in a healthy way by identifying the aspects that damage the performance of the team members and those deemed necessary for collaboration and virtual teams. It was also mentioned, the recommendations can bring awareness of the importance of these issues to the team members and open the discussion on how to organize themselves to reach a successful collaboration in a virtual environment.

What would you improve the current recommendations?

Among the general suggestions, expert two noticed the relation of the recommendation to the culture or the structure side of the project. Therefore, he/she pointed out the possibility to arrange the recommendations into these two aspects, culture or structure. Another connection noticed by this expert was the similarity or relation some of the recommendations could have among them. The expert suggested merging or categorizing recommendation four with ten while recommendations six, seven, eight, and nine should be merged/categorized into one.

Recommendation one

Both experts agreed on the relevance and support that provide creating a culture of the project. Addressing this aspect jointly stimulates the stakeholders to be open about their concerns and promotes commitment to comply with the agreements made. This principle is already present in practice as can be seen in the case studies, but the elements integrating it varies, for instance, the inclusion of an expert in collaboration is only present in two cases. Therefore, expert two suggested defining the aspects mentioned within into nice-to-have and must-have. This categorization will allow the project manager and members to prioritize the elements and include the essential ones in the project. The expert added that the said suggestion could also apply to the rest of the recommendations that contain different elements.

Recommendation two

As mentioned before, prior collaboration can have a positive or negative influence on team collaboration and performance. The experts agreed with the recommendation to address the positive but especially the negative at the beginning of the project. Yet expert one added that dysfunctional

conflict could arise at the start but also throughout the project. Therefore, it is also necessary to include in this recommendation the discussion of a dispute resolution management plan. The said plan should also be developed at the start of the project to act as a guide to recognize conflicts and resolve them as soon as possible which is beneficial to the performance of the project.

Recommendation three

Both literature and the results from the case studies show that the inclusion of selection criteria for the team members is important for collaboration and virtual teams. Choosing poorly the members in the project could act as a barrier for collaboration (Patel et al., 2012). This goes in line with the perspective of the experts since both agreed on the need to include a selection process in the project. Although one comment was brought forward by expert one, that is the availability of the team members which plays a part in the selection criteria. Sometimes the best fit for the context of the project is not available which results in the team working with the remaining professionals.

Recommendation four

The selection of tools and provision of adequate equipment is necessary to ensure the correct performance of the team. Both act as support to the team members in their interactions and when performing their tasks. Both experts agree that these play a part in the performance of the team. Moreover, within this recommendation, it was mentioned the need to grant access to all the project information to the team members as the results from the case studies and literature show. Yet, expert one disagrees partly with this statement, in his/her perspective the access to the information should depend on the need for approval required from team members. That is temporary documents or discussions should be accessed only by a selected group of people. Once the document is finished and approved then the number of people with access could increase. Therefore, this notion should be taken into account when selecting the project tools and software.

Recommendation seven

As mentioned in the findings from the cross-case studies, there is an increased interest in hybrid meetings which is addressed in the present recommendation. The experts recognized the issues mentioned such as interruptions to the discussion slowing the flow of the conversation, or distractions due to inadequate communication equipment. Yet, both experts agreed that it is not necessary to ensure that every member wears a headset rather they should make sure they have adequate equipment with a good quality microphone, camera, and speaker. Expert one added that a meeting facilitator could be appointed to steer the discussion and indicate when is the turn for each member to participate, said facilitator will provide structure to the meeting.

Recommendation eight

The experts agreed on the points presented within this recommendation. Yet, expert one mentioned that the degree of involvement in the meeting, that is the number of meetings they need to attend, depends on the role and responsibilities of the members. Managerial positions are required to be present in a higher amount of meetings contrary to lower-level members. Which should be taken into account when blocking the number of days without meetings. He/she added that those in managerial positions should leave at least two days without meetings while the rest should increase.

6.2.2 Conclusion on validation

The experts highlighted the potential the recommendations have as a guideline in the implementation of a healthy way to collaborate virtually on short distance teams and agreed that the recommendations were clear and easy to follow which confirmed the feasibility and application to the bouwteam projects. Although the experts agree on the application of said recommendations, they provided points for improvement and suggestions regarding aspects to incorporate which are discussed below.

- General.- Merging/categorizing recommendations four and ten, while recommendations six, seven, eight, and nine should be mixed into one. Arrange the recommendations into two areas: cultural and structural.
- R1.- Categorize the elements into nice-to-have and must-have.
- R2.- Include conflict resolution into the recommendation.
- R3.- Take into account that the selection criteria should apply to the remaining pool of available professionals.
- R4.- Documents in progress should only be accessed by those working on them. Access once the documents are approved could be accessed by the rest of the team depending on the content of the information.
- R7.- Include a meeting facilitator. Instead of using headset ensuring the right specifications for the equipment.
- R8.- Take into account the role of the team members when blocking the days without meetings, minimum two days.

6.3 Final set of recommendations

In this section, the proposed recommendations for the improvement of virtual teams and collaboration in a virtual environment were validated by a group of experts with the goal to determine its applicability and usefulness. Through the discussions of the experts, the fourth research sub-question can be answered.

Are the developed recommendations considered useful to improve virtual teams collaboration?

As agreed by the experts, the proposed recommendations are considered to be useful and feasible to be applied in short-distance bouwteam projects. Added to that, it was thought the recommendations could also be used by other types of projects where virtual teams are being implemented. Furthermore, as part of the suggestions and points for improvement, some adaptations were made to the final recommendations which can be seen in figure 17 and were arranged in the form of a framework which is shown in figure 18. The figure shows three phases that represent the cycle of a project, the tender, project start-up, and design phase. Although it is acknowledged that the tender phase is outside the scope of the research, two recommendations were included due to the impact they have during the bouwteam phase.

6.3.1 Tender phase

The first phase contains two recommendations the selections criteria for the organizations and the conflict resolution of past collaboration. The first one relates to recommendation three explained in section 6. During the discussion, it was mentioned that selection criteria should be also included for the selection of the organizations. For instance, the level of IT infrastructure, access to different types of software, and openness to work in a virtual environment are important to include within the criteria. The incorporation of organizations that are flexible to changing tasks but also that they have an open-mind culture and are willing to collaborate in a virtual environment can have a positive impact on the implementation of virtual teams. Having access to different collaborative platforms will support the performance of the project. Although it is acknowledged

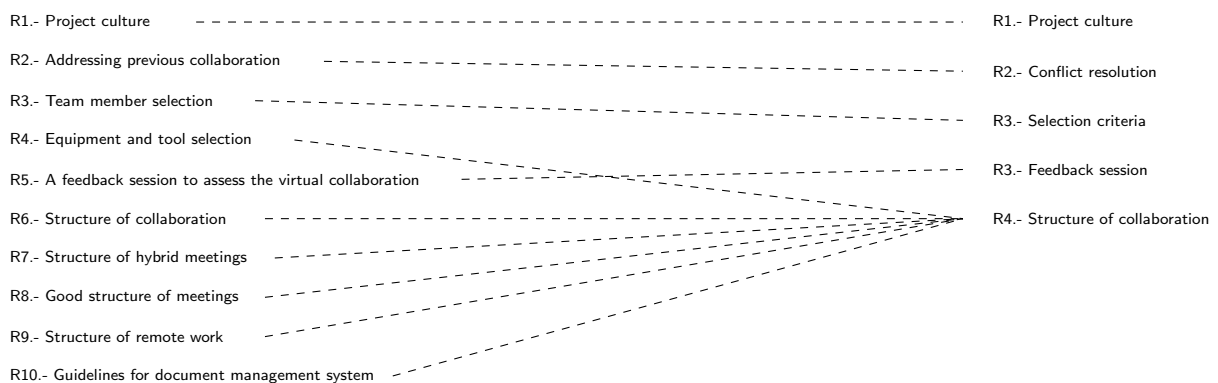


Figure 17: Rearrangement of recommendations

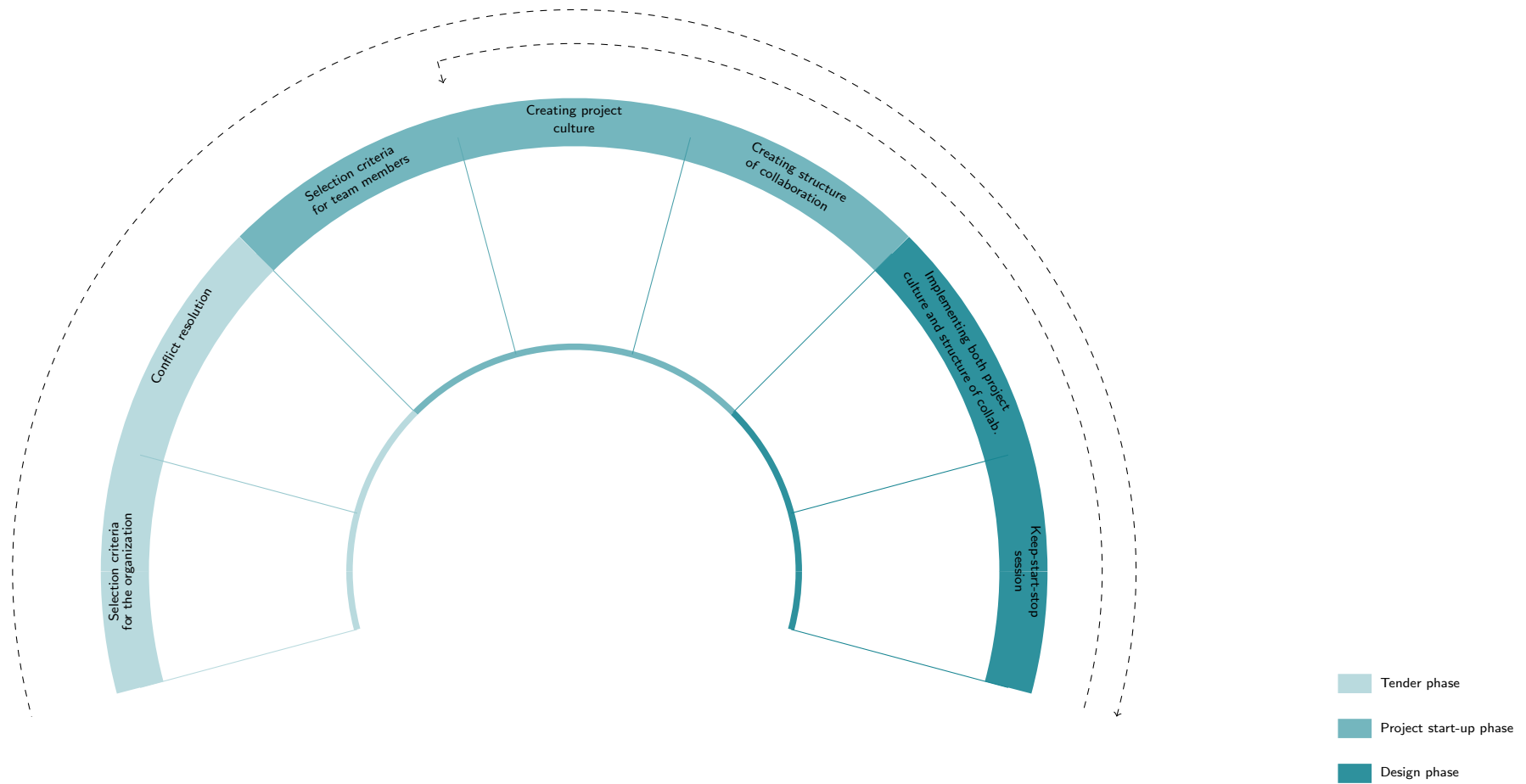


Figure 18: Roadmap to a healthy virtual collaboration

that this element from part of the tender procedure instead of the bouwteam phase of projects, it is included due to the impact that could have on the project if the partner is not the best fit.

As for the second recommendation within this phase, as recognized in the literature and cross-case analysis, the history of cooperation can either be positive or negative. In the case of the latter, the parties involved should discuss the negative experience as a way to avoid dragging past conflicts into the new project and prevent them from becoming dysfunctional.

6.3.2 Project start-up phase

The second phase happens at the project start-up. It contains three sets of recommendations: inclusion of selection criteria for team members, the creation of project culture, and the development of a structure of collaboration. For the first, although the researcher acknowledges the comments of the experts where they mention that the availability of the professionals on occasions prevents the inclusion of the individual that best fit the project; it is still advisable to set in place selection criteria to choose the team members from the pool of people available. Aspects such as individual KSA's, experience, autonomy, motivation, communication skills, and teamwork should be taken into account when selecting the members. The first two aspects are important for project performance while the last four to virtual teams. As the team members are required to work remotely, they need to have a level of autonomy to make assertive decisions without high supervision, they are also required to have a high level of motivation and commitment to the project and the organization, this way the members will be stimulated to achieve the project objective. Moreover, although communication skills are necessary on any project, their value increases for a highly collaborative environment such as bouwteam and virtual teams. Therefore, the potential members should be able to maintain clear, concise, and concrete communication with the rest of the team to share throughout the project their progress, ideas, problems, or possible solutions. Lastly, they are required to be capable of joint efforts with the rest of the team and support collective initiatives to reach the project goal.

The second recommendation within this phase refers to the creation of a culture for the project. As literature and the case studies show, each organization has its own identity which is formed by different practices and behaviors. These differences tend to create conflict in terms of asymmetries between management practices. Therefore, the organizations should discuss jointly the alignment of said practices as well as their level of involvement and responsibilities to develop the culture of the project. That is, the way it is expected from each partner and team member to behave towards each other. As mentioned before, debating these aspects jointly will create commitment towards the agreements made while also creating trust among the members.

Among the aspects to take into account, that is the must-haves, are mutual trust between the organizations and members; the creation of a safe environment where both can communicate either solutions or problems; no-blame-culture⁷ with a conflict resolution plan; a clear definition

⁷This research doesn't delve into the details of this aspect, yet Lloyd-walker et al. (2014) describe a no-blame culture as "an environment that supports identifying and addressing issues without fear of repercussions" p.234

of roles and relationships which bring transparency to the responsibilities and makes sure every organization/member knows what is expected from them; and the creation of a core team to steer the project. This last aspect was present in the case studies and worked to integrate the different organizations into one team, it also acted as a board to discuss concerns about the project and make tough decisions related to it. The commitment of organizations to provide their workers with the appropriate tools, whether in the form of equipment or access to certain platforms, is also considered essential. On the other hand, incorporating an expert in collaboration or in virtual teams, a dispute avoidance board, and an open-book contract, the development of a system engineering at the start of the project as a team-bonding activity, the implementation of a system of buddies or onboarding session to integrate the new members to the project are considered elements nice-to-have but not necessarily indispensable that contribute to the creation of the project culture and the application of virtual/hybrid teams. It should be noted that despite the dispute avoidance board being considered nice to have, the conflict resolution plan should be present and drafted jointly by the organizations at the start of the project.

Lastly, as the results from the literature, the case studies, and the expert session showed, at the start of the project, the organizations and the managers should discuss not only the culture but also the structure of the collaboration. Both discussions should be done in parallel. Among the aspects to take into account in the structure of collaboration are the selection of the collaborative and engineering platforms such as MS Teams, Zoom, Google teams, Relatics, BIM360, among others, the selection of the right equipment, the structure of the meetings either virtual or hybrid and the inclusion of social interactions which from the results are described as important in this environment.

The selection of the right equipment and tools

For the collaboration and the application of virtual/hybrid teams, it is important to choose early on the software on which they are going to be working on the project. These will guide the selection of the equipment, which must meet the minimum requirements to carry out the necessary tasks⁸. It is also important to ensure interoperability between platforms to avoid problems that could affect workflow and collaboration throughout the project. In the case of specific training, organizations should offer it to reduce learning times that can impact team member performance and collaboration. In the same line, as described in case study two, when working in a virtual environment it should be done with as many virtual tools as possible. Therefore an information management system with guidelines regarding the structure of the information should be included in the project. Within these guidelines it should be stated the accessibility the team members have to the information, that is whether the documents are approved and whether the information is sensitive or not.

Structure of meetings

⁸For instance, modelers and engineers might need additional screens or a PC with greater power than a contract manager or a project manager

For both hybrid and virtual meetings, the development of a clear and feasible goal as well as a desired outcome for the meeting is a must. When assessing the feasibility of the goal, a list of topics to be discussed during the meeting should be obtained, taking into account the allocation of a small period at the beginning of the session to address urgent issues. Moreover, when structuring the schedule of either progress or specialized meetings, the managers and team members should take into account the role of the participants to determine the number of meetings they need to attend. That is managerial positions should be involved in a higher number of meetings contrary to the rest. Below, there is a further specification about the requirements for each type of meeting.

Hybrid meetings

The organization should enable a soundproof space in the office for hybrid conferences where they have 180 to 360-degree cameras, a projector or screen large enough to share the conference, speakers, and good-quality microphones to ensure efficient communication for the collocated group as well as the remote one. As mentioned in the expert session, the inclusion of a meeting facilitator is also needed for this type of meeting. The facilitator should steer the conversation according to the meeting agenda, he/she should also avoid the creation of sub-groups within the session unless it was structured this way. Moreover, the number of participants will depend on the type of information being transferred or the amount of interaction required. For equivocal information and high interaction, the meetings should be up to 15 people. For low interaction and canonical information, the number is not limited, yet it should be noted that there should be a clear goal for the meeting and a structure that supports the number of participants.

Virtual meetings

Similar to the hybrid meetings, in a fully virtual environment, the organizations and the members should ensure they have the right equipment to collaborate, from the screen, camera, microphone, and speakers. The meetings should be thoroughly planned following the goal and agenda as previously described. Each meeting should end with a register of agreements made or minutes as a way to follow up with the meetings and the progress of the project. To enable the managers and members access to non-verbal communication, all the participants should leave their cameras on during the session. As in hybrid meetings, the number of participants is going to be determined by the information transferred and the amount of interaction required with up to 15 participants for equivocal information and a high amount of interaction. Moreover, there should be 30 minutes in between each meeting to process the information and prepare for the new session. It is advised that the duration of the meetings is not more than two hours, if so breaks should be placed to maintain the engagement of the participants.

In virtual meetings is also required to include a facilitator that steers the discussion. The facilitator could be from the manager or leader in charge of the participants to the participants themselves in case they have to present their progress. In the case of the manager or leaders, they should be aware of the type of personalities they are dealing with. Therefore, the organization or

for the whole project a test to determine the participants' personality could be applied and develop customized guidelines to deal with the different personalities.

When collaborating full-time virtually, then it should be considered the inclusion of face-to-face interactions at the start of the project to support team bonding and team integration. Another form to promote this is by doing a virtual working day emulating a day at the office where all the participants of the project join online to work together with the microphone off and camera on. Emulating physical interaction through sharing screens or break-out rooms is a good alternative to collocated meetings. The results from the case studies show the need and desire to include social interactions among the whole team to decrease the perceived distance. These could be achieved through collocated meetings or virtual ones where different social activities are organized such as drinking games, or virtual yoga as described in section 7.2.2 recommendation nine.

6.3.3 Design phase

After the project start-up follows the design phase, where the team members need to develop their tasks and interact with each other while respecting the project culture and structure of collaboration. Also, a recommendation part of the design phase is the organization of quarterly feedback sessions to assess the processes and collaboration done so far as a way to identify ways to improve it. This recommendation act as a loop where the data extracted can be used to adjust the project culture and the structure of collaboration. In the framework is also highlighted two responsibilities the individuals have during this phase. The first one which is part of their job is the creation of relations with the rest of the team. As the team is working jointly, it is expected from them to rely on each other to share information, therefore, they should be aware that a bad relationship with other members might impact their performance. The second one is the responsibility to inform possible problems instead of hiding them and letting them grow. It is acknowledged that the managers have a responsibility to push the members to bond with each other or to speak up, but also the individuals have a responsibility to act accordingly.

7 Conclusion and discussion

This chapter presents the discussion and conclusions about the research by answering the main research question and sub-questions and interpreting the results. The chapter is divided into two parts section 7.1 shows the discussion of the research while section 7.2 the conclusion.

7.1 Discussion

Section 7.1.1 describes whether the research was carried out with reliability, validity and integrity. Section 7.1.2 shows how this research builds on existing literature. Section 7.1.3 describes the limitations of the research. Section 7.1.4 sheds light on possible topics for future research.

7.1.1 Verifying research criteria

In section 1.7 a set of research criteria was presented on which the research needed to comply with. In the next section, it will be discussed whether it was met.

Reliability

As mentioned before, reliable research can be evaluated through internal consistency, pretest, test, and retest. The first one refers to data consistency throughout the study, that is, the compatibility between the concepts and the information used. In the research, the definition of the key concepts and framework provided clarity on what each one entails, allowing the researcher to match the new data accordingly. For the second, the interview questionnaires were reviewed with the supervisors to inspect the way in which the questions were being structured, with the aim of making them as precise and clear as possible. Also, in case of doubt during the interview, the researcher further explained the question and provided examples reflected in other industries to avoid influencing the answer of the interviewee. To ensure the reliability of the data collected, the researcher recorded the interviews, which allowed her to accurately assess the data and evaluate their interpretation. Lastly, the method used in the research was a multi-case study which enables the comparison of the information collected from each case to assess the similarity of the results. This verifies the precision and clarity of the questionnaires which lead to similar results between the cases. Taking this information into account, it can be stated that the research complies with this criterion.

Validity

This criterion can be evaluated in two parts, internally and externally. Internal validation refers to the correct interpretation of the findings and the degree to which the instruments used accurately measure what they intend to measure. For the first, as discussed above, the researcher recorded the interviews to refer to the data collected and assess whether the interpretation of the information is done accurately. Also, within the report, quotes from the interviews are presented in chapter four as a way to support the interpretation of the data. For the second, the research method was interviewing professionals about their experience while working remotely, their perspective

regarding virtual teams, and the future of projects. Looking at the results of the reflection of virtual teams in section 5.1.8, there were some discrepancies between the interpretation of hybrid teams for the future of the industry. Some of the interviewees interpreted that a hybrid team had to be intra-organizational while others regarded it as intra and inter-organizational. This differentiation in meaning damages the internal validity because it cannot be said with 100% confidence that all the interviewees completely agree on what hybrid teams are.

External validation refers to the level of generalization of the results. As mentioned before, the implementation of multi-case studies allowed the researcher to obtain information from different projects and compare them to assess their similarities and differences. In doing so, the degree of generalization was also evaluated. Most of the factors identified in the analysis are consistent across the case studies. However, there are some exceptions, these are attributed to the different strategies implemented per project. For example, the inclusion of a collaborative expert was present in only two case studies, while the implementation of an open book contract was enforced in one case. As the factors presented in isolated case studies were also mentioned in the literature, the external validation is not considered harmed by their lack of presence in the rest of the case studies. Furthermore, different roles involved in the design process were included in the research as a representative set of the construction sector within the bouwteam phase. Taking this information into account, the research is considered to have external validation.

Integrity

As mentioned before, the researcher held regular meetings with the research supervisor to make sure the research was executed with integrity. Moreover, as part of the graduation process, meetings with the whole committee were conducted to review the quality of the progress done and the quality of the research in terms of validity and reliability which in turn supports the integrity of the research.

7.1.2 How does this research build on existing literature?

This section will elucidate on how the already known knowledge is enhanced by this research. With respect to collaboration, this research takes into account the shift in the industry towards collaborative agreements and how these teams require more interaction, trust, and integration. It is acknowledged that there is research regarding integrated teams working collocated. Yet, research regarding teams working in both highly collaborative agreements and remotely was not found.

This research also expands the horizon for short-distance teams to work in a new configuration after the COVID crisis. Hence, when new projects intend to venture into a virtual or a hybrid form, there is an initial road map on how to implement them properly. Moreover, from another perspective, among the streams of research related to the COVID crisis mentioned at the end of section 1.1, the results from the research added knowledge on the implications of working remotely on teams size, team-work, and team building.

Moreover, an overwhelming amount of research emphasize the impact virtual teams could have on collaboration while this research looks on the other direction, that is how collaboration could impact virtual teams. Therefore, this research takes into account this notion and expands the current knowledge in this area.

7.1.3 Limitations of the research

Similar to other graduation theses and articles, this research faced some limitations which could influence the outcome of the study. Therefore, when interpreting the findings from this study is necessary to take into account the following:

One of the major limitations of the research is the number of participants included in two of the case studies. The researcher had access to only two interviewees due to the availability of the respondents. Although the information gathered is considered reliable due to the consistency of the data, the results could have potentially been different if more participants had been included in the research.

The results of the research could not be applied and tested in an actual project due to time constraints. Therefore, the impact and the extent of the benefits were not measured and analyzed. Nonetheless, to maintain the quality of the method and the findings, a validation session was carried out with experts in bouwteam projects to receive feedback regarding optimizations and the applicability of the results.

The research took into account the organizational and managerial elements related to the application of virtual teams in bouwteam agreements, the technology and hard aspects of a project are included in a general way. This is considered a limitation, and a suggestion for further research. There is a need to address the usability and interoperability of the platforms and instruments used in projects for managerial and design purposes.

The research considered the perspective of the interviewees regarding the practices without delving into practice base theory. In a similar way, different aspects related to the recommendations such as no-blame culture, steps to delimit a clear responsibility or communication are included in a general way. These are considered a limitation and can be examined in future research.

The case studies used in the research correspond to infrastructure projects. The first three cases are considered complex due to the surroundings, yet their design is considered straightforward. Case study four is considered simple in both surroundings and design. Therefore, the inclusion of a case study with a complex design could lead to different results since it could highlight different aspects than the ones considered in this study.

Another limitation of the research relates to the chosen scope. The study focused only on the bouwteam phase or design phase of bouwteam agreements. It is believed that the research results could yield in another direction in other phases of the project. For instance, during the construction

phase, the application of virtual/hybrid teams might harm the performance of the project since the key players are required to be on site. This could lead to the recommendation of implementing to a lesser extent using this configuration during the said phase.

Regarding the methodology used, the multi-case study came with its set of drawbacks. This method is considered subjective and time-consuming, which can also incur in biased. Although the level of generalization increases when implementing multiple studies, the researcher had to put special attention on analyzing the data objectively to avoid influencing the results due to personal preferences. Yet, there is a possibility that the inclusion of more cases in different sectors of the industry could generate slightly different results.

7.1.4 Recommendations for future research

Concerning the relation between collaboration and virtual teams. This research compares these two concepts and concludes that there is a link between them. As mentioned in section 7.1.2 the line of research has been done in one direction that is how virtual teams influence collaboration, yet, it could be further explored the influence collaboration could have on virtual teams.

Another opportunity for further research is the implementation of the recommendations and the framework proposed in this research. As mentioned in the limitations, due to time constraints these were not applied in practical scenarios. Carrying out action-based and quantitative research of strategies proposed could lead to their substantiation and even could yield improvements to the framework or benefits that have not been identified or become apparent yet.

For the interviews, mainly the perspective between the main contractor, client, and advisor was taken into account. Thus, the factors and recommendations made respond to the aspects that are noticeable to them. Expanding the research to sub-contractors could provide further information about the elements to look at from their perspective.

Moreover, technology plays a part in both collaboration and virtual teams. As noted by interviewee B.2 the interaction with technology doesn't pose a challenge for younger generations as they are digital natives. On the contrary, older generations could be more hesitant in engaging in virtual teams or online tasks since they need to adapt to them. Therefore, further research could be done regarding the impact it could bring to the collaboration performance of virtual teams.

Also, as mentioned in the limitations of the research, more research could be carried out to identify the different virtual platforms available for management or design, as well as to evaluate the interoperability of said instruments and their applicability in the construction sector. Either to assist in the discussions during the meetings, monitor the progress of the project, quantify the costing of the project or control the quality of the design.

Regarding the COVID crisis, formal research could be done reflecting the change in perspectives from the construction industry towards the implementation of virtual teams, as can

be seen in section 5.1.8 before the crisis, the standard was to set face-to-face meetings to address issues related to the project, while now the norm is to do virtual meetings and address in face-to-face meetings only complex problems.

7.2 Conclusion

The objective of the research was to expand the traditional working configuration of a collocated setting in the construction industry into a virtual or hybrid one without harming the performance of projects. As collaboration was deemed essential for construction projects, which is reflected in the use of relational contracts, this concept was also taken into account when looking at a solution that could improve the application of virtual teams. This was done through the analysis of literature and four case studies at the company, PRO6 managers, to have a theoretical as well as an empirical basis on which the analysis would be performed. The main research question was established as How to improve virtual teams in the bouwteam phase by also focusing on collaboration? where four sub-questions were established to answer it. Below, the answer to each question is given.

Sub-question 1: What are the factors regulating collaboration and virtual teams?

Literature shows that there are several aspects that can influence both collaboration and the application of virtual teams. These aspects ranged from external factors of the project such as organization culture, business climate, or geographic distance to internal factors such as decision-making procedures, shared goals, or resources. These factors can be seen in figure 7 for collaboration and figure 9 for virtual teams. After conducting the literature review, a theoretical framework was built containing the aspects deemed important for both concepts. Figure 11 presents the said framework which contains seven categories: context, support, tasks, interaction processes, teams, individuals, and overarching factors; section 2.3 provides a brief definition of the categories contained within.

As identified from the literature, the presence of these aspects can have a direct repercussion on both collaboration and virtual teams. This was observed in the case studies where some aspects were regarded as disablers as these were overlooked in the project, for instance, training or consecutive meetings. Table 6 shows the findings from the case studies and made a comparison with the literature. Most of the factors mentioned in practice can relate back to the ones already identified in the literature. Yet, the findings from the practical side are considered as explicit knowledge of the literature. The table is categorized in two ways, the first one following the theoretical framework while the second one describing the factors as enablers, disablers or both. For instance, providing the correct equipment is considered both an enabler and disabler since having the right tools support the members to work properly while a lack of these could harm their performance and their collaboration.

Sub-question 2: How is the current collaboration in bouwteams?

As mentioned before, the organizations had to work remotely on their projects due to the COVID crisis. During the interviews of the case studies, the different approaches taken by the organizations became apparent. The client was more strict regarding face-to-face meetings and was perceived as more open to implementing virtual teams in the future. Contrary to the advisors and contractors who were more flexible towards physical meetings. Moreover, it was found that most of the strategies implemented in each case were similar, for instance, all the case studies implemented feedback sessions, addressed team members' satisfaction, and provided the correct equipment for the members. But, there were some exceptions as some aspects were not present in all the case studies such as the implementation of an open-book contract, the inclusion of an expert in collaboration, the establishment of a selection procedure to choose the participants of the project, the use of system engineering as a team bonding activity, or scheduling virtual office day. Chapter four provides an extensive description of the aspects found and the current state of collaboration in bouwteams.

Sub-question 3: Which changes are required to overcome the challenges of virtual collaboration in the bouwteam phase?

Based on the findings from the literature and practice, a set of recommendations was designed which after their validation led to a framework composed of three stages. The said framework can be appreciated in figure 17. This framework intends to indicate the points of attention to look at for the correct establishment of a short-distance virtual team in bouwteam agreements during the design phase. Considering that there is a great number of factors influencing both collaboration and virtual teams, the design of the recommendations and, ultimately, the framework was set around the aspects found in the case studies which were deemed important by the participants. Below the key aspects of the said framework are enlisted.

- Tender phase
 - Selection criteria for the organizations.
 - * Level of IT infrastructure;
 - * Access to different type of software, platforms;
 - * Openness to work in a virtual environment
 - Conflict resolution from previous collaborations.
- Project-start-up phase
 - Selection criteria for team members.
 - * Individual KSA's
 - * Experience
 - * Autonomy
 - * Motivation
 - * Communication skills

- * Teamwork
- Creation of a project culture
 - * Expectations of the project
 - * Core values for the project
 - * Definition of the behaviors towards each other
 - * No-blame culture
- Development of the structure of collaboration taking into account:
 - * Selection of the software, platforms for the project
 - * The structure of virtual and hybrid meetings
 - * Inclusion of social interactions
- Design-phase
 - Implementation of both project culture and structure of collaboration
 - Feedback sessions

Sub-question 4: Are the developed recommendations considered useful to improve virtual teams collaboration?

After designing the recommendations, these were validated by two experts in one session. Overall, the experts expressed that the recommendations could be used by bouwteam projects working in a virtual environment during the design phase. They also expressed that it could even apply to any type of project as the aspects tackled in the recommendations are similar regardless of the project. Additionally, the proposed recommendation received positive comments as they were considered relevant points to be addressed in order to obtain a healthy form of collaboration in a virtual environment. In turn, the experts provided suggestions for improvements regarding the structure, the expansion of conflict resolution prior to the project to include intra-team conflict, and the level of detail of some recommendations. Taking into account the mentioned comments to the recommendations, a framework was developed which is shown in figure 18 while section 6.3 present the description of the final outcome.

In conclusion, this research presents a stepping stone regarding the expansion for short-distance teams to work in a virtual environment. As shown in the results, there is a positive stance of the participants towards a hybrid form of collaboration for the future. Therefore, the presented recommendations and framework can be implemented when managing projects in this configuration. This research also contributes to filling the gap regarding the relationship between collaboration and virtual teams. As mentioned before, from the analysis, it can be noted that there is a two-way relationship between both concepts. Yet, normally it is considered that collaboration could go without virtual teams while virtual teams without collaboration could result in communication issues, lack of knowledge sharing, and lack of integration of the project and the team.

An interesting point to highlight is the change in the standard regarding the scheduling of meetings. That is, before the COVID crisis, the organizations set physical meetings to address issues in the project, while currently, routine and less complex issues are handled virtually. It is also interesting to highlight the role of social interactions as it is normally regarded as irrelevant for virtual teams, yet, the results from the literature and case studies show the contrary, if anything this element increases its importance in a virtual environment.

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Appendix A

Interview protocol

Thank you for participating in the interview. My name is Tzitly Gomez. I am currently working on my graduation project for the master's in Construction Management and Engineering at TU Delft. I started my graduation assignment in collaboration with PRO6 Managers and TU Delft in June 2021. This research focuses on virtual collaboration in Bouwteam projects. The goal is to examine current practices to identify ways in which remote work can be implemented in the industry. I will mention below the interview's purpose, conditions, confidentiality and structure.

Purpose of the interview

The interviews are planned to get a practical perspective on the barriers encountered while collaborating remotely in Bouwteams. Therefore, semi-structured interviews will be conducted with Bouwteam participants for a practice-based perspective of virtual collaboration and how it can be implemented in the industry in a way that doesn't jeopardize the performance of projects but rather improves it.

Target group

Since the research focuses on the bouwteam and their performance as a team in a virtual environment, the target group for the interviews is any project participant, from the project, contract, and technical managers to the project leader or engineers.

Conditions

The analysis of the research is based on the interview. Therefore, the interview will be recorded to guarantee the reliability of the data. The recording will be deleted at the end of the research. By participating in this interview, the interviewee agrees that the answers will be used for the research and that the interview will be recorded.

Interview confidentiality

The interviewees will not be referred by name in the report. The answers will be anonymous.

Interview structure

In my research, collaboration in a Construction Team is regarded as a process. It starts in the tender phase, where the possible starting points are agreed upon. It develops further in the design phase and concludes with the award of the execution contract. The questions in this questionnaire, therefore, relate to the design phase, and the price negotiations. The interview will start with general questions about the interviewee and the project, then questions focused on the bouwteam phase will be asked, the interview will conclude with wrap-up questions.

Semi-structure interview questions:

Background:

How many years of relevant work experience do you have?

General questions:

1. Do you have previous experience with remote working?
2. Do you have previous experience with online meetings or online collaboration tools? (Through Zoom, MS Teams, Slack)
3. Can you give a brief description of the project?
4. What is your role in the project?
5. How many people is involved in the project?
6. Did you have previous experience working with the people involved in the project?
7. If so, what was the impact of this previous collaboration in the new project team? Was it positive or negative? (Easier to work together, acquaintance with processes)

Interview questions for projects working remotely in Bouwteam phase:

8. What activities were traditionally done during this stage? (Before corona)(Team building: get to know each other, goal alignment, role definition, organization structure)
9. How did these activities change for remote working? (How did remote working affect goal alignment, trust, defining roles and the organization structure, etc.)
10. What did your team do to improve team bonding? (escape rooms, trivia night, Friday drinks, wine testing)
11. Did you have trainings at the start of the project? if so, how was it carried out (media, length, periodicity) and what was the impact of remote working on it? Was it positive or negative?
12. How was the communication within the team (means/how, periodicity, roles, when, what)?
13. Were there any support mechanisms to improve remote collaboration? (team satisfaction surveys, feeling of team accomplishment, respect for personal life/time, technology if needed, team members acclimatization/adjustment of workspace, reward system, monitoring teams negative emotions [isolation and disconnection]).
14. In which phase was the transition to remote working and how was your experience of the transition process?
15. What barriers did you observed?
16. What was the consequence of these barriers?

Additional interview questions for team members involved in the project design

17. How was the transfer of information needs and data exchange traditionally carried out? (Before corona)
18. How did this change for remote working?
19. What kind of challenges did your team faced?
(misinterpretation, decreasing efficiency)
20. How did you and your team overcome the challenges?

Additional interview questions for team members involved in the price negotiation

21. How does remote working interfere with the price negotiations?
22. Is it possible to negotiate the price virtually or in a hybrid way; or does this activity have to be carried out face to face?

Conclusion:

23. What are the enablers for working remotely in bouwteams?
24. Do you think the sector is prepared on all fronts for implementing virtual teams? If not, What is missing?
25. On which phase of bouwteams does remote working has the highest impact and why? Is it negative or positive?
26. In case of a negative impact, do you think a hybrid form of collaboration will aid?
27. In your opinion, which phase has the maximum potential to implement remote working and which has the least?
28. Is there any remark you would like to add to this interview?
29. If you had to chose between going back to collocated, fully virtual or a hybrid way wich one would you choose? In which percentages?

Appendix B

Initial set of recommendations

7.2.1 General recommendations

1. Project culture.

Among the case studies and literature, a common factor considered key during the initiation of a project is the development of a project culture in the form of a project management plan. As indicated in the case studies, this plan encompasses how every organization will fit into the project, the core values, and the structure of the collaboration. This plan should be elaborated through **joint discussions and agreements** to increase the commitment from every party to the plan. Developing the management plan together provides the foundation of **mutual trust** for collaboration throughout the project. Trust has also been considered important by both the case studies and literature. Talking and getting to know each other is the simplest approach to building trust. This could be done through meetings and discussions addressing the concerns each party has concerning the project. Another approach to creating a culture of mutual trust that has been mentioned in literature and case study two is doing the procurement together, both client and contractor. This provides transparency on the costs, the quality of the materials, and the labor. Yet, it is understandable that the application of this last approach will depend on the strategy developed for the project and the desired involvement from the client.

Another important aspect to take into account when setting the culture of the project is to commit to **creating a safe environment** where all the team members feel secure to share their comments, suggestions, questions, and even problems without feeling judged. Creating a safe environment provides benefits for the team such as supporting building trust among team members, seizing every opportunity for improvement by letting the members participate in the discussion, and recognizing problems on time. **Incorporating an expert in collaboration** to guide the discussions can help the team not only to have a good collaboration but also to build this safe environment.

2. Addressing previous collaboration.

It has also been stated in literature and case studies that previous collaboration with one of the parties can benefit the collaboration or harm it if not addressed properly. Therefore, at the start of the tender or when selecting the team members for the project, it is necessary to **resolve previous quarrels** to avoid them from affecting the new collaboration about to embark. On the other hand, in the case of a positive experience, the parties could take the strategies that worked and apply them to the new project.

3. Team member selection.

Every project requires different types of resources for optimal performance, one of them is individuals with the appropriate skills, knowledge, and experience. Literature shows that setting **selection criteria** or procedures increase the chances to get access to the right people for the project. Case study one implemented a series of interviews to assess the compatibility of each potential team member with the project and the rest of the team. The team member selection is more important in a virtual environment since involving the wrong people with a preference for a traditional collaboration has been detected as a disabler. People with an affinity for a traditional collaboration might not be satisfied with the project resulting in a decrease in the quality of their collaboration and performance affecting the collaborative dynamics of the entire team.

4. Equipment and Tool selection

The responsibility of the organizations to provide adequate equipment was recognized by the literature and the case studies. Team members should count on the right equipment to develop effectively their tasks. Another aspect important to take into account in the projects is the selection of the tools that fit the best in the context and needs of the project. Yet once again the organizations and the heads of the project should organize training for all the team members so they are able to seize the benefits of said tools.

5. A feedback session to assess the virtual collaboration.

Every single case study and literature agrees on organizing meetings every two, three, or four months to evaluate the team processes and team members' satisfaction. Through this evaluation and feedback, the team can improve their processes and improve the satisfaction of the team members which in turn will impact positively the virtual collaboration.

6. Structure of collaboration.

Interviewees B.2 and D.2 mentioned that the frequency of interactions between team members and types of meetings in the project is the same both collocated and remote. That is implementing high-level meetings, progress meetings, or management meetings are necessary for projects being carried out both collocated and remote. The only difference is the environment in which this is taking place. Yet, every interviewee mentioned the following issues when collaborating remotely: the meetings felt more rigid, direct, and with a lack of social interactions. Most mentioned that they faced back-to-back meetings which drained their energy some mentioned that they keep facing the same problem to date. Therefore, when working remotely, the team should take into account these comments and incorporate the actions needed to counter them. For instance, making small talk at the start of the meetings, scheduling only four or five hours of meetings per day.

7. Structure of hybrid meetings

Some of the issues raised during the interviews about working remotely or working in a hybrid way are the processes in a meeting. For instance, one of the concerns is the difficulty to communicate in a virtual environment, a situation that might arise is when two or more participants in the meeting want to voice their opinion at the same time. The team must structure the meeting in a way that supports team members sharing their opinion, a solution could be asking team members to **raise their hand** when they want to provide some input. Another situation is where the members that are located in the same office disregard the ones that join the meeting remotely. The whole team must commit to **avoiding** this kind of situation where the meeting is **divided into subgroups** unless it is part of the meeting structure. Lastly, audio problems can arise when there is a lack of appropriate equipment. Therefore, when arranging a hybrid meeting, the team needs to make sure that **every member uses a headset** to ensure every participant can hear the whole discussion.

7.2.2 Company-specific recommendations

8. Good structure of meetings

It is normal to implement different types of meetings in practice such as high-level, progress, or management meetings. Yet the results from the case studies suggest that these could be improved by including the following criteria:

- Having a clear and feasible goal as well as a desired outcome for the meeting. In practice it is common to have a list of topics to address during the meetings, the managers need to make sure that this list is feasible to address during the designated time for the meeting.
- Involving the key stakeholders without overcrowding the meeting (in a virtual environment the desirable amount is 8 members, but it is possible to do it for up to 15 people). The managers need to be on the lookout for members included in a meeting for more than an hour without contributing any information and assess whether they need to be included for the following meetings or include them at certain times of the meeting.
- Allow a short time at the start to address urgent topics without taking the entire meeting to resolve the issue, in that case, a different meeting must be scheduled.
- Leaving at least 30 min in between meetings for team members to process the information and also prepare for the new meeting.
- Scheduling no more than 5 hours of meetings per day.
- Leaving at least one day without meetings.

9. Structure of remote work

The literature and case studies show that one enabler of working remotely is to have **face-to-face meetings at the start of the project**. This allows team members to get to know each other and to create bonds more easily. Another factor in common is the importance of **managers as leaders** of the project **to encourage informal interactions** between team members, for instance, by asking at the start of the meetings how is every member that day. Another common denominator

through all the interviewees of the case studies is the feeling of lack of inclusion of social interaction when collaborating remotely. Therefore, social interactions such as project barbeques, informal talks before and in between meetings or at the coffee stand are considered missed opportunities in virtual collaboration. Some of the actions implemented in the projects that worked well are the following:

- Organizing virtual events where the whole team has a chance to interact such as trying new types of beer together, virtual yoga or workout classes, escape rooms, or pub quizzes. Yet, the interviewees mentioned that escape rooms or pub quizzes do not provide enough space for interaction or getting to know other team members.
- Another approach that worked in case study four was setting a day where all the team members (including people for the client and contractor) were connected working together simulating a day at the office but online.
- For new hires it is important to provide on-boarding buddies or sessions, and arrange lunches or sessions to introduce them to the rest of the team.

10. Guidelines for document management system

When implementing a document management system in the project, it should mention in the project management plan developed at the beginning of the project a set of guidelines that indicate how the information will be shared. These guidelines should be shared among the organizations forming the bouwteam and all the project team members. Implementing this will make the process of finding the most up-to-date information more efficient. Furthermore, it will provide clarity for team members on how to arrange the folders in the platform without investing time in designing a structure.