

THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

The impact of social relations on interorganisational collaboration:  
an analysis of collaborative project delivery models in infrastructure projects

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## Abstract

The growth of projects has elicited much interest in the last decades, both in academia and amongst practitioners. The increasing scale and complexity has further brought attention to the particulars of interorganisational collaboration: as projects grow, the relevance and impact of interdependencies between participating organisations rise to the surface: no organisation is an island and so a project becomes an archipelago of interconnected networks.

Current literature on such models focuses on contract and procurement, both important aspects of project management. There is less data pertaining to project realisation and how these changes in interorganisational collaboration shape the project process.

A field where this change has been especially noticeable is the infrastructure construction industry, where collaborative project management models have been introduced to reduce adversity and improve project outcomes. These new models necessitate changes in the conventional ways of work within the field, such as collaboration between project actors early in the project process, as well as how the actors use the project network or engage in project-related activities, such as sharing resources or the reallocation of responsibilities.

In this work, I expand on the theory pertaining to project networks in the empirical setting of infrastructure projects applying a collaborative project management model, with the aim of examining the collaboration between interorganisational project actors in a collaborative project delivery model. The methods used in this thesis are based in the qualitative research tradition and emphasise interviewing and observation. During this work, 44 interviews were completed in two case projects and observation of both project's shared office space was carried out.

My results show the importance of social relations as enablers of the realisation of the expected benefits of collaborative models as well as indicate the changes necessary for the models to be effective.

**Keywords:** project management, major projects, collaboration, network, social relations

## List of appended papers

### Paper 1:

af Hällström, A., Bosch-Sijtsema, P. (2020): Collaborative governance models towards sustainable infrastructure projects: the case of resources

This paper was presented at the World Sustainable Built Environment Conference Beyond2020 in 2020. The paper was co-authored with Petra Bosch-Sijtsema. The research design was developed by both authors. Data collection was conducted by myself, while analysis and writing was conducted jointly by both authors.

### Paper 2:

af Hällström, A., Bosch-Sijtsema, P. (2020): Collaboration and relationships in Nordic infrastructure project networks

This paper was presented at the Conference of Association of Researchers in Construction Management (ARCOM) in 2020. The paper was co-authored with Petra Bosch-Sijtsema. The research design was developed by both authors. Data collection was conducted by myself, while analysis and writing was conducted jointly by both authors.

### Paper 3:

af Hällström, A., Bosch-Sijtsema, P., Poblete, L., Rempling R., Karlsson M. (accepted for publication with revisions): The role of social ties in collaborative project networks: a tale of two construction cases.

This paper is originally based on paper 2 with extensive reworking done after comments during the ARCOM conference. The paper was co-authored with Petra Bosch-Sijtsema, León Poblete, Rasmus Rempling and Mats Karlsson. The idea for the article was jointly developed by af Hällström, Bosch-Sijtsema and Poblete. The research design was developed by af Hällström and Bosch-Sijtsema, in collaboration with co-supervisors Rasmus Rempling and Mats Karlsson. Data collection was conducted by myself, while analysis and writing was conducted jointly by af Hällström and Bosch-Sijtsema.

## Other published papers

af Hällström, A., Bosch-Sijtsema, P. (2019): Early contractor involvement in the construction industry: A preliminary literature review. Association of Researchers in Construction Management, ARCOM 2019 - Proceedings of the 35th Annual Conference

## Acknowledgments

Is it all right to have a picture here instead of text?

I'm thinking of a comic strip.

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## Abbreviations

<i>CPDM</i>	Collaborative project delivery model
<i>SNA</i>	Social network analysis

# I. Introduction

## I.1. Background

Projects have grown larger and more complex during the last decades (Flyvbjerg, 2014; Lundin et al., 2015). Moreover, projects tend to involve more complex goals and tasks that change iteratively throughout the project process, than those the parent organisation deals with normally (Lundin et al., 2015; Sydow & Braun, 2018). This is compounded by the amount of organisations partaking in the project, as this involves negotiation among multiple organisations with their own goals, making projects requiring interorganisational collaboration especially complex (Gann & Salter, 2000; Jones & Lichtenstein, 2009; Lundin et al., 2015; Sydow & Braun, 2018).

Major projects, whose lifespan is counted in decades and budgets surpass 100 million dollars (Flyvbjerg, 2014), often involve multiple stakeholders and involve the coordination of different project participants (Flyvbjerg, 2014; Gann & Salter, 2000) and are thus particularly affected by challenges related to interorganisational collaboration. Moreover, the interorganisational relationships born in such projects often persist after the project is delivered (Hellgren & Stjernberg, 1995; Sydow & Braun, 2018). The interorganisational and relational dimensions are thus important dimensions to take into consideration when discussing projects, and especially major ones.

Projects are, moreover, a special kind of organisation, bound in time and with a defined goal. The increase in complexity, combined with the particular characteristics of projects as organisations require a novel approach, both in practical as well theoretical terms. The growth of projects (Flyvbjerg, 2014), coupled with the increasing share of them that span organisational boundaries (Lundin et al., 2015; Sydow & Braun, 2018) has led to the introduction of new management models in an effort to minimise uncertainty and risk to the client (Chen, Manley, Lewis, Helfer, & Widen, 2018; Hastie, Sutrisna, & Egbu, 2017; Lahdenperä, 2012; Scheepbouwer & Humphries, 2011), in combination with calls for further theoretical frameworks (S. Pryke, Badi, & Bygballe, 2017; Steen, DeFillippi, Sydow, Pryke, & Michelfelder, 2018).

One of the suggested academic approaches include a network-based perspective on projects (S. Pryke et al., 2017; Steen et al., 2018) as a network view can help conceptualise the temporality of projects and “enables a better understanding of projects as organizational forms” (Steen et al., 2018, p. 14).

Network theory focuses on actors, who are connected by ties: “[t]he pattern of ties in a network yields a particular structure, and nodes occupy positions within this structure” and “it is the researcher— by choosing a set of nodes and a type of tie— that defines a network” (Borgatti & Halgin, 2011, p. 1169). Thus, the definition of both actors, ties and the network itself depend on how the network is demarcated.

Recent arguments have been raised for a multi-level approach to project network theorizing, as there are multiple levels at which project networks interact with their environment and a strong focus on the individual actor leaves the context of their interactions aside (Sydow & Braun, 2018). Sydow and Braun (2018) mention project, organisation, network and field as separate levels to consider. The patterns of these levels are shaped by slightly different ties, which impact their structure. In this work, I am looking at two of the levels mentioned by Sydow and Braun (2018): the project organisation and the individuals participating in the project.

In the setting of projects, the project network becomes an object of analysis. There are two main ways of looking at the project network, as discussed in further detail by e.g. DeFillippi and Sydow (2016): as (1) the network formed around the individual project through interorganisational relationships; or (2) as the network created by the relationships created between organisations partaking in a series of projects. Although both projects and



interorganisational relationships are embedded within a larger organisational and institutional environment (DeFillippi & Sydow, 2016; Sydow & Braun, 2018), the relationships in a single project can broaden our understanding of how interorganisational relationships affect the project as well as of the patterns of interaction in a specific setting (Hellgren & Stjernberg, 1995), and make it easier to identify possible causes and effects. I will follow the idea of the network created around an individual project, as discussed by e.g. Hellgren and Stjernberg (1995), Adami and Verschoore (2018) and Pryke (2018) and use the term “project network” to denote the network shaped by a single project as this view can help us understand project dynamics and how project organisations are created.

This perspective can be further developed in the empirical setting of infrastructure construction. An increase of both research focusing on interorganisational collaboration (cf. Chen et al., 2018; Lahdenperä, 2012; Derek H. T. Walker & Lloyd-Walker, 2014) as well as studies looking specifically at certain management models such as such as alliancing (cf. A. M. Hietajärvi & Aaltonen, 2018; Derek Henry Thomas Walker, Harley, & Mills, 2015), early contractor involvement (cf. Eadie & Graham, 2014; Laryea & Watermeyer, 2016; Derek H T Walker & Lloyd-walker, 2012) and partnering (cf. Gadde & Dubois, 2010; Hansen-Addy & Nunoo, 2014) have highlighted a growing trend of collaborative approaches to project management in construction research. Furthermore, infrastructure construction shows several of the characteristics discussed in the beginning: projects have grown larger and more complex (Flyvbjerg, 2014) and there is a call for new management models (Bygballe & Swärd, 2019) and perspectives on construction projects, especially from a network perspective (S. Pryke et al., 2017).

The construction sector has traditionally been regarded as adversarial (Hansen-Addy & Nunoo, 2014), prone to conflict and costly disputes (Rahman & Kumaraswamy, 2004) and a lack of cooperation (Franz, Leicht, Molenaar, & Messner, 2016). Larger projects have exacerbated these problems (van Fenema, Rietjens, & van Baalen, 2016) and large infrastructure projects are seldom finished on time or within budget (Flyvbjerg, 2011, 2014). One solution to solve these problems has been the introduction of *collaborative project delivery models* (CPDM) which focus on collaboration between project participants rather than hierarchical relationships (Bygballe, Jahre, & Swärd, 2010; Bygballe & Swärd, 2019; Chen et al., 2018; T. Eriksson, 2015; Derek H. T. Walker & Lloyd-Walker, 2014).

Collaboration, in the context of complex project management, is used in varying ways and with apparently differing connotations. Several authors mention both collaboration and cooperation, but without making a significant divergence between the terms, while others use the terms collaboration, cooperation and coordination interchangeably. In this work, ‘collaboration’ is defined as “[a] process in which entities share information, resources, and responsibilities to jointly plan, implement, and evaluate a program of activities to achieve a common goal” (Camarihna-Matos & Afsarmanesh, 2011, p. 311). I focus primarily on collaboration.

Collaborative project delivery models (CPDMs) are characterised by differing degrees of “[e]arly involvement of key parties, transparent financials, shared risk and reward, joint decision making, and a collaborative multi-party agreement” (Lahdenperä, 2012, p. 57). The sharing of resources and risks as well as joint decision-making establish CPDMs as relational management models (Tadayon, 2018). Thus, the anticipated success of CPDM-based projects relies on the relationships that either enable or constrain the level of sharing activities and involvement of actors the chosen CPDM is based on.

Adapting a project network focus, with the multi-level approach described by Sydow and Braun (2018), a project network in a CPDM consists of actors (the participating organisations and individuals) and the ties connecting them. These ties can be formal or informal (Papadonikolaki, Verbraeck, & Wamelink, 2017; H. Wang, Lu, Söderlund, & Chen, 2018) as well as states or

events (Borgatti & Halgin, 2011). Wang et al (2018), building on work by Jones and Lichtenstein (2008) among others, argue that the behaviour of network actors is defined by the informal institutions, such as the aspects governing social relations, highlighting social ties an interesting object of study, while Borgatti and Halgin (2011) discuss the differences in tie characteristic when differentiating between stable states and temporal events.

Hitherto, literature on CPDMs has mainly focused on the procurement stage (cf. Chen et al., 2018; P. E. Eriksson, 2013; P. E. Eriksson et al., 2019; Volker, Eriksson, Kadefors, & Larsson, 2018) and how the contract impacts the project. Less attention has been paid to how different types of ties impact the project network and thus project delivery.

## 1.2. Purpose of the thesis

While the growth of literature pertaining to collaborative project models in general and in construction projects in particular has been impressive, there is a lack of research related to social relationships within project networks, especially in the field of construction management. This gap in literature is interesting, especially when taking the changing needs of projects into account. The larger projects grow, the greater numbers of people and organisations they involve, creating ever larger interpersonal and -organisational networks. There have been some forays into this area (cf. Adami & Verschoore, 2018; S. Pryke, Badi, Almadhoob, Soundararaj, & Addyman, 2018) but there is still little known about the interplay between social relations, project networks and the formal project structure and contracts in the context of interorganisational projects.

The lack of literature pertaining to the area, coupled with the new empirical phenomena, results in multiple interesting research possibilities. In this thesis, I will strive to answer the call for further research into the impact of project networks in the construction sector (S. Pryke et al., 2017) and interorganisational collaboration (Sydow & Braun, 2018), combined with the impact of relational ties (Adami & Verschoore, 2018; H. Wang et al., 2018).

This thesis focuses on interorganisational collaboration in infrastructure construction projects in a Nordic setting. The purpose of this thesis is **to examine the collaboration between actors in an interorganisational project utilising a collaborative project delivery model.**

## 1.3. Research questions

When reflecting on the aim of the thesis – to examine the collaboration between interorganisational project actors in a collaborative project delivery model – in conjunction with the existing body of knowledge concerning project management and the theoretical framework of network theory, two research questions were formulated:

- How do actors utilise the project network, manage resources available to them, and engage in activities?
- How do social relationships affect collaboration between actors in a project network?

A deeper insight into how actors utilise the project network and manage the available resources and activities will the impact of social relationships on actor interaction can broaden our understanding of actor roles and responsibilities in relation to the project network and organisation.

## 1.4. Structure of the thesis

The thesis starts with an introduction to the research field, as well as problem formulation and research purpose. After this, an overview of previous research on collaboration in the

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construction industry, the changing ways of managing infrastructure construction projects, project networks, and a frame of reference for the study are presented. After the theoretical framework is presented, the research methodology and design are expanded upon. This chapter also includes a deeper description of the empirical setting. This is followed by a summary of the appended papers and a discussion on the theoretical implications thereof. The thesis is concluded by conclusions covering both theory and practice, as well as suggestions for future research.

## 2. Previous research: the realm of projects

### 2.1. Interorganisational collaboration

An interorganisational project involves “two or more organizational actors from distinct organizations working jointly to create a tangible product/service in a limited period of time” (Jones & Lichtenstein, 2009, p. 234). The larger the project, the greater the number of participating organisations and thus the level of interorganisational collaboration.

The traditional approach to project studies, examining the individual project actor and their actions in an intra-organisational setting, has drawn critique (Jones & Lichtenstein, 2009; Sydow & Braun, 2018). Moreover, Sydow and Braun (2018) argue that classical frameworks establishing projects as temporary organisations suffer from a lack of attention given to interorganisational aspects of project management; issues that have grown larger in tandem with the growth of projects in general (Flyvbjerg, 2014; Lundin et al., 2015; Sydow & Braun, 2018).

The characteristics of interorganisational projects make the theory of project networks (focused on the single project) especially relevant, as the fields share many key issues. Three main overlapping fields are (1) *the nature of relationships within a project network*, described as either ‘the temporality and continuous reconstruction of projects’ (Hellgren & Stjernberg, 1995) or ‘a processual understanding of relationships’ (Sydow & Braun, 2018); (2) *the issue of coordinating decision-making and governance*, discussed under and ‘legitimate authority’ by Hellgren and Stjernberg (1995) and ‘modes of interorganisational governance’ by Sydow and Braun (2018); and (3) *the ambiguous nature and demarcation of projects*, leading to discussions on the difficulty of describing and analysing networks when their boundaries are undefined (Hellgren & Stjernberg, 1995) as well as the need for a multi-level approach to their study (Sydow & Braun, 2018).

*The nature of relationships within a project network* is a central theme of this discourse, as “interorganizational relationships have their own kind of governance which is typically different from hierarchies that are found in permanent organizations” (p.9) but that also are different from arms-length transactions commonly found in markets (Sydow & Braun, 2018). This is partly because interorganisational ties often connect organisations outside the scope of the project and they thus are linked to some degree, regardless of project duration. Hellgren and Stjernberg (1995) describe this as how “[a]n opponent in the short run, may in the longer perspective be seen as a potential partner. Similarly, the partner in the short run may be a competitor in future projects. This possible dual relationship between actors is an important feature of interorganizational relations in project networks” (p.382). The management of projects thus requires a different approach than traditional organisation theory prescribes (Hellgren & Stjernberg, 1995; Sydow & Braun, 2018).

The nature of relationships is further elaborated by the concepts of “relational and structural embeddedness”, as defined by Jones and Lichtenstein (2009), who show how low levels of so-called “relational embeddedness” result in an increase in the use of hierarchy as a tool to facilitate collaboration. They further note that “when structural embeddedness and thus density of relations is higher, shared knowledge about how to perform roles and who should coordinate with whom is more widely dispersed among field or industry organizations, obviating the need to formalize these relations” (p.237). “Relational embeddedness” is defined as the relationship between interacting parties and the degree of knowledge they have about each other’s needs and goals and how much they take these into account in their actions (Jones & Lichtenstein, 2009). “Structural embeddedness”, on the other hand, relates to the structure of the larger network and how the actor’s contacts are related to each other and it “facilitates shared understandings and rules for collaboration that distinct organizations bring to their joint activities, reducing transactional uncertainty and facilitating coordination” (Jones & Lichtenstein, 2009, p. 239). This indicates that a project with low relational embeddedness would lean more on formal

relationships and hierarchies, while a tightly connected network would share understanding of the project process, thus enabling collaboration. Therefore, the nature of the ties connecting the network can have a great impact on the structure of the project network and the outcome of project delivery.

The discussion about the relationships in a network continues in *the issue of coordinating decision-making and governance*. Hellgren and Stjernberg (1995) argue that “no single actor may act as a legitimate authority for the network as a whole” (p.380) and that the management and coordination of a network of organisations should be understood as a decision-making process based on politics. Organisations partaking in a project are beholden to the project organisation, while individuals have a dual role: project results are to be delivered to the project organisation, while the responsibility for long-term resource management and development lies within their parent organisations (Lundin et al., 2015). This view is also held by Jones and Lichtenstein (2009) who discuss the need for structural embeddedness to coordinate project activities, as well as Sydow and Braun (2018), who note the importance of informal ties in the modes of interorganisational management. When discussing project network management, the question of efficient coordination of non-hierarchically linked actors and the reciprocity this is based on (Sydow & Braun, 2018) must be taken into account.

Project network management is also affected by *the ambiguous nature and demarcation of projects*. As networks are defined by the beholder (Borgatti & Halgin, 2011; Hellgren & Stjernberg, 1995), the undefined border of project networks makes understanding and analysing networks difficult (Hellgren & Stjernberg, 1995). This calls for a multi-level approach (Sydow & Braun, 2018), enabling a deeper understanding of the network and how it is structured. This, furthermore, calls for a qualitative approach, in order to understand the nature of the network.

## 2.2. Collaborative project delivery models

An infrastructure development project consists of multiple organisations acting together to achieve a pre-determined goal. Many such projects are large in scope and scale, and can be classified as major projects: they take decades to realise, involve multiple stakeholders and their total costs exceed 100 million dollars (Flyvbjerg, 2014). Major projects are furthermore often complex due to their scale and the inherent risk of coordinating specialists from different organisations and fields (Gann & Salter, 2000).

As the nature of major infrastructure projects have changed, so has the nature of their management. In large projects, there is a great variety and inherent risk, as well as multifaceted processes related to coordination and control (Adami & Verschoore, 2018; Gann & Salter, 2000; Hughes & Murdoch, 2003), increasing the level of difficulty of managing such projects and making them complex (Adami & Verschoore, 2018). Further complications arise from the collaboration between different organisations arising in such a project, as large-scale infrastructure projects usually include several different organisations due to their scale and demands for specialist knowledge (Gann & Salter, 2000) and the complexity of coordinating multiple stakeholders (Hellgren & Stjernberg, 1995; Jones & Lichtenstein, 2009; Sydow & Braun, 2018).

Collaborative project delivery models (CPDSMs) have been increasing in popularity as a possible solution to the management challenge of large infrastructure projects (Chen et al., 2018; Lahdenperä, 2012; Schepker & Poppo, 2014). Research into the area has identified benefits of such models, including increased project quality (Bygballe, Håkansson, & Ingemansson, 2015; Eadie & Graham, 2014; Scheepbouwer & Humphries, 2011), less adversity in the project organisation (Song, Mohamed, & AbouRizk, 2008) and reduced costs (Eadie & Graham, 2014; Song et al., 2008). These models have been used in private construction projects for several

decades, for example in housing and industrial construction, but their introduction to the public infrastructure sector is a relatively recent phenomenon (Lahdenperä, 2012).

### 2.3. Change in project roles and relationships

Although there are several models applied in the construction industry today, such as alliancing, early contractor involvement, integrated project delivery and partnering, the organisation of CPDMs follow a similar structure and emphasise the importance of early inclusion of all key actors, communication and sharing of resources (Lahdenperä, 2012). These changes lead to changes in traditional roles and responsibilities as they require new skillsets from project actors, as can be seen in the analysis of a partnering project by Bygballe and Swärd (2019): “Partnering represented a fundamental change for the participants in this project and implied the discarding and replacement of existing ways of organizing and managing the construction process” (p.2).

As change of organizing leads to changes in the project process, the actor roles also change. Past research into construction projects has focused mainly on operational issues of work allocation, rather than analysis of required actor roles and responsibilities (Hughes & Murdoch, 2003). In traditional project organisations the responsibilities have been defined in the contract of the project, but with the introduction of earlier actor involvement and deeper integration between project actors into infrastructure projects due to the increasing use of CPDMs, there is a need to re-examine the traditional division of actor roles and responsibilities.

A role is “the relationship between a participant and an operation” (Hughes & Murdoch, 2003, p. 25), an operation being defined “a package of work that can be undertaken by one organizational unit without interruption by decision points” (Hughes & Murdoch, 2003, p. 22). This relationship is interesting, as those who participate in a project organisation belong, simultaneously, to multiple organisational settings (Hughes & Murdoch, 2003; Lundin et al., 2015; Sydow & Braun, 2018). There is therefore a need to coordinate decision-making and responsibilities between the separate organisations that make up the infrastructure project, as no one organisation can make decisions on behalf of other organisations (Hellgren & Stjernberg, 1995), as previously discussed. This may present a challenge for successful implementation of a CPDM, as many such models build on unanimous decision-making (Lahdenperä, 2012) and highlight the importance of defining roles and responsibilities in a project.

Furthermore, large infrastructure projects have project-specific goals. The organisations involved in the project also have their own objectives in engaging in the project (Hellgren & Stjernberg, 1995; Sydow & Braun, 2018), as do the individuals creating the organisations. In order for a project to fulfil its goals and objectives, role descriptions for performing, controlling and managing the tasks and responsibilities are needed to coordinate the work of actor organisations as well as individuals (Hughes & Murdoch, 2003).

Reflecting back to the discussion on interorganisational collaboration, the project organisation and network created by CPDM is shaped by the three questions of interorganisational collaboration: (1) *the nature of relationships within the project network*, as the CPDM requires early inclusion of all actors; (2) *the issue of coordinating decision-making and governance*, as the nature of these change due to the implications of ‘sharing’ essential to CPDM; and (3) *the ambiguous nature and demarcation of projects*, as infrastructure projects last for years, if not decades, and the actors participating in the project network, both organisations and individuals, may change during the process. The issues pertinent to a better understanding of these factors shaping interorganisational collaboration are thus also key to understanding the impact of CPDMs in the construction industry.

### 3. A project network perspective

#### 3.1. The use of network theory in project research

Network theory is “about the consequences of network variables, such as having many ties or being centrally located” (Borgatti & Halgin, 2011, p. 1172), or how the structure formed by a set of actors connected by specified ties enables or constricts actions.

A network consists of actors (or nodes), connected by ties (Borgatti & Halgin, 2011; S. Pryke, 2012a). The actors in the project network can be both the organisations as well as the individuals, depending on how the network is defined. As my research questions are concerned with the quality of the network structure and not the outcome of the structure per se, I will not focus here on network flow or actor characteristics, but rather the connections between actors in a network.

Network theory has recently become popular in both the field of project research (S. Pryke, 2012b; Steen et al., 2018) as well as within the construction community (S. Pryke et al., 2017). When taking the rising interest in interorganisational collaboration as well (Sydow & Braun, 2018), this rise can be interpreted as a growing interest in the relational aspects of projects and networks in the academic community. Furthermore, Pryke (2021a) argues that “None of the previous approaches provides the potential for quantitative analysis and a level of detail appropriate for the purposes of understanding the myriad of systems, typically freestanding rather than integrated, involved in the planning, design and delivery of our increasingly complex projects” (p.10).

#### 3.2. Project networks

For project organisations, the organisations and individuals create, besides a project organisation, also a project network. As discussed earlier, I will here use the definition of Hellgren and Stjernberg (1995), Adami and Verschoore (2018) and Pryke (2018), among others, and use the term “project network” to denote the network, created by ties connecting actors within a single project. This view can assist in understanding project dynamics. Furthermore, how project organisations are created as relationships in a single project can further the understanding of how interorganisational relationships affect the project and patterns of interaction in a specific setting become visible (Hellgren & Stjernberg, 1995), making it easier to identify possible causes and effects.

As project networks are formed by ties between actors participating in the project, project network boundaries become difficult to determine (Hellgren & Stjernberg, 1995). One reason for this fluidity might be the dynamic nature of project membership, as participating organisations allocate individuals to the project according to identified needs and the project participants thus belong to multiple organisations, or network settings, simultaneously (Hughes & Murdoch, 2003).

A project network is governed by responsibilities, routines, roles and relationships (Steen et al., 2018). The efficiency of the project network is contingent on the performance of the entire network, which in turn depends on how well individual goals of the organisational actors involved are aligned with the project goal (Hughes & Murdoch, 2003), as well as the flow of resources within the network (Borgatti & Halgin, 2011).

Project networks, the relational network formed around a project by the actors partaking in the project process, rely on different governance models than traditional organisations (Hellgren & Stjernberg, 1995; Steen et al., 2018; Sydow & Braun, 2018). Steen et al (2018) further discuss the importance of relational governance and mutual trust as discussed in literature, as well as the

impact of different actor roles on the network. These actors strive to fulfil both their own goals as well as project goals, while engaging in role-determined activities (Adami & Verschoore, 2018; Manning, 2008).

### Actors

Network theory focuses on the interaction between actors (or nodes). An actor is linked to other actors in the network through specified types of ties (Borgatti & Halgin, 2011; S. D. Pryke, 2005). In this work, I define the infrastructure development project network actors on the organisational level as client, design engineer and contractor, and on the individual level as the individuals partaking in the project as directed by their parent organisation.

In a project network, the dynamics between actors are of importance, as each participating organisation has their own power dynamics, creating a need for internal coordination (DeFillippi & Sydow, 2016; Hellgren & Stjernberg, 1995). DeFilippi and Sydow (2016) reflect on Provan and Kenis (2008) in their identification of three main forms of authority coordination: (1) shared governance; (2) appointing a lead coordinator from among the participating organisations; and (3) appointing a dedicated network administrative organisation. The effectiveness of these approaches depend on the level of trust and goal consensus (DeFillippi & Sydow, 2016), important aspects of the theory behind CPDMs.

### Ties

A tie is, in its simplest form, anything that connects two actors. In order to understand and analyse ties, it is nevertheless useful to distinguish types thereof, as their definition creates the network (Borgatti & Halgin, 2011). There are several different approaches to defining ties and their characteristics. Granovetter (1973), on the one hand, discusses the strength of ties, which has become one of the main definitions of the quality of ties, and Burt (2001) focuses on the structural holes left between actors in a network. Borgatti and Halgin (2011), on the other hand, define ties as ‘state’ or ‘event’, depending on their duration, while Wang et al (2018) among others discuss the formality thereof.

*A state tie* is a long-term connection, while *an event tie* is transitory. Borgatti and Halgin (2011) note that a state tie can be measured “in terms of strength, intensity, and duration” (p.1170), while an event tie is measured as occurrences over a period of time. An example of a state tie is a role-based relation in a project network, such as the one between the project managers from the client, the design engineer and the contractor, or a social connection, such as between two old school acquaintances who happen to work in the same project. An example of an event tie is a project meeting or a spontaneous discussion taking place at the coffee maker in the office.

*Bridging ties* (Borgatti and Halgin 2011, referencing Granovetter), connect network clusters. This is of particular interest in a collaborative project network which consists of separate clusters, formed by the participating actor organisations. The bridging ties are both the contract, linking organisational actors together, but also meetings where both individuals meet in a social setting, but organisations meet through the moderating ties of role-based attendance, as well as social ties connecting individuals from separate clusters. Social ties, however, can only form between individuals as ‘social’ relates to the way people interact. Organisations are unable to form social connections.

Ties can furthermore be formal or informal. *A formal tie* is often observable and measurable, such as a contract or organisational structures (Papadonikolaki et al., 2017; H. Wang et al., 2018). Formal ties are also often state ties (H. Wang et al., 2018). *An informal tie* is often a relation between two actors (Papadonikolaki et al., 2017) and can influence actor behaviour (H. Wang et al., 2018). Recent research has postulated that the alignment of the formal network, shaped by formal ties, with the informal network of relations could result in a positive correlation with project performance (H. Wang et al., 2018).



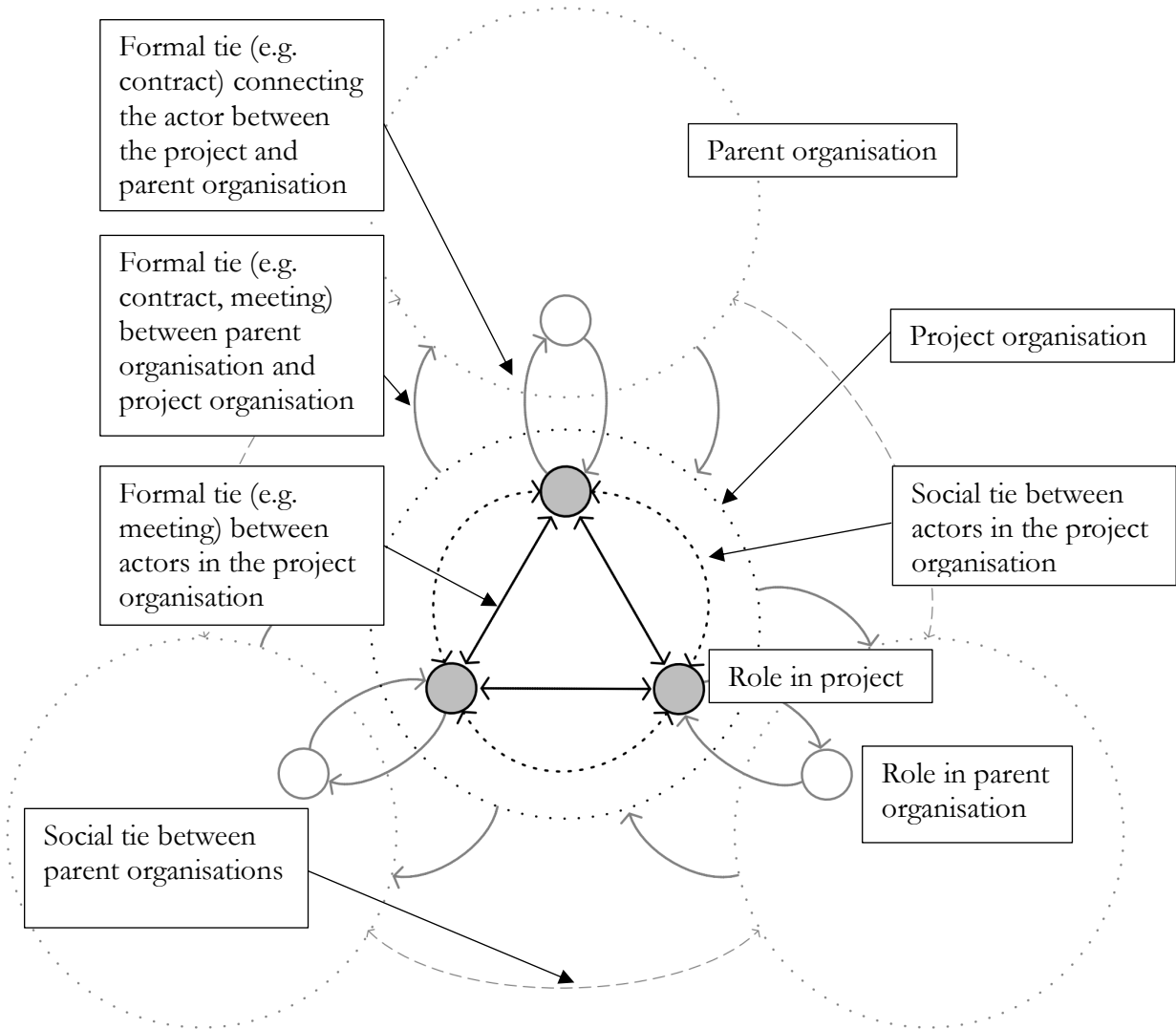
### **Project networks: multiple levels**

I am here demarcating the project network to two levels, following Sydow and Braun's (2018) proposal of taking a multi-level approach. One network is formed between the organisations participating in the project, held together by state ties in the form of legal contracts. A second network forms between the individuals taking part in the project, as ordained by their parent organisations. They have a state tie in the form of their employment to their parent organisation while event ties within the project create new state ties (relationships) to other individuals, from other organisations, also engaged in the project. This structure is pictured in Figure 1 which depicts the dynamics between individual project actors and the ties influencing their roles within the project.

When participating in a project, the parent organisation coordinates its resources, e.g. employees, in order to fulfil its internal goals as well as those defined by the formal state tie (contract) linking the organisation with the project. This formal state tie restricts the parent company's ability to utilise its resources by, for example, instituting a certain level of experience for the participating individuals.

The individual actors have certain roles in their parent organisation and in the project organisation. Their participation in the project is defined by both the formal state tie (contractual relationship) between their parent company and the project organisation, but also by their own formal state tie (employment contract) with their parent company. The individual actors are further connected to each other through formal event ties, such as project meetings, but also through informal social ties.

It is the dichotomy between project and parent organisation and the actor's role in both contexts which is a source of conflict within the project organisation. The project manager does not have the authority or formal tie of an employer to manage the individual actors from other organisations, while the individual's role in the project is shaped by both the project context and network created by the project, but also by their relationship to their parent organisation.



**Figure 1:** *The interconnectedness of project networks*

Coordination of the project network is paramount in accomplishing the objectives of the project (Hellgren & Stjernberg, 1995; Sydow & Braun, 2018). As Gann and Salter (2000) observe, “Success often depends upon the knowledge that people at every level of the organisation bring to bear in new, semi-autonomous and often temporary, cross-functional teams” (p.967).

There are several theories looking at the structure of networks in general, such as Granovetter’s strength of weak ties (1973) and Burt’s structural holes (2001), but few investigate the characteristics of the network structure. There is furthermore even less literature on network structure in the construction field, although there has been a growing interest in this field (cf. Bygballe & Swärd, 2019; S. Pryke et al., 2017; Zheng, Le, Chan, Hu, & Li, 2016).

## 4. Methodology

This chapter outlines how the research questions can be answered through the design of the included studies, as well as the methods chosen for data collection and analysis. It closes with reflections on research quality.

I have based my research on analysing the organising process of project networks, following Gioia and Pietre's (1990) seminal paper where they state that "the goal of theory building in the interpretive paradigm is to generate descriptions, insights, and explanations of events so that the system of interpretations and meaning, and the structuring and organizing processes, are revealed" (Gioia & Pitre, 1990, p. 588). People are, after all, the foundation and creator of their realities (Lincoln & Guba, 2000).

### 4.1. Research design

Interorganisational collaboration, as exemplified by the rise of collaboration in infrastructure development projects, is an emerging empirical phenomenon (Sydow & Braun, 2018). Qualitative research, combined with an explorative approach was deemed most useful due to the novelty of the phenomenon, as qualitative research is particularly suited to study social relations and attain rich data about the object of study (Flick, 2018). The research is also empirical, or "knowledge based on real world observations" (Flynn, Sakakibara, Schroeder, Bates, & Flynn, 1990, p. 251).

In this context, most value can be gained from deep and probing studies rather than a more quantitatively driven research, focused on multiple data originators, as my research questions will best be answered by the depth provided by qualitative methods. There is also the complexity of my topic to take into account, which is challenging to approach from a quantitative angle. I therefore rely heavily on the real-life insight from practitioners. To achieve this, I have based my data collection on *contrasting case studies*, where I gather detailed information from several similar project sites (Flynn et al., 1990). The cases are presented in table 1.

#### Case research

The cases were selected based on size, contract form and availability. CPDM requires a project complex enough to warrant activities across organisational boundaries, which, coupled with my empirical setting of infrastructure development, led to an interest in large-scale projects due to the inherent scale of most infrastructure projects. As collaborative procurement forms have increased in the infrastructure sector, the contract form was also of significance. There are few projects utilising a CPDM in Nordic countries, which led to the last selection criteria: availability. I had access to one project utilising such a contract form through the reference group created by the institution funding the research project and one project through my previous experience in the industry.

As the research was inductive in nature, theorizing about a new phenomenon from the data gathered (Fisher & Aguinis, 2017; Whetten, 1989), insight into contrasting characteristics developed alongside the data gathering process with the insights garnered from the data. Following recommendations by Flynn et al (1990), I gathered detailed information at each case site and made notes about possible differences and similarities as they emerged.

As the research design is based on multiple case studies, it is necessary to mention the main benefits and drawbacks of the case study as a basis for research. Case studies can give in-depth knowledge about the investigated phenomena (Dubois & Gadde, 2002; Flynn et al., 1990). This methodology is especially suited to research complex organisational structures with a multitude

of interrelated variables and actors in areas where little previous research has been conducted (Dubois & Gadde, 2002).

A weakness in research based on case studies, is the temporal boundary determined by the research project. As the process is continuous, special care must be taken to frame the context of the research’s conclusions (Dubois & Gadde, 2002). Another concern is the risk of losing one’s sense of proportion when working with rich and detailed case data (Eisenhardt, 1989).

Access to the case projects and organisations has helped me further specify my theoretical definitions and concepts. As I have close cooperation with industry partners in my project, this gives me access to cases as well as input from industry, enabling a deeper understanding of both industry realities and the academic phenomenon.

The case projects also enable the analysis and examination of possible other influencing variables, such as project size, time span, or size of participating organisations, to name a few. Systematic research on such variables in the field can both create insights on the current state of the field as well as create more generalisable data on longitudinal changes (Flynn et al., 1990).

**Case studies**

The study includes two case studies, as well as a pre-study, focused on projects in the Nordics where a CPDM model is used. These cases were chosen as my research focus was on the collaboration and project network rather than just the governance model. These cases were stated to work with a high level of collaboration based on their contracts and the stated wish from the Client.

The pre-study is focused on a small-scale renovation project of a bridge. The first case study is a remodelling of a railway station, which is done in relation to a major rail expansion and refurbishment project. The second case study focused on a light rail construction project. These studies were chosen for their governance models, as all chosen projects are using a CPDM model. As the utilisation of CPDM models is relatively new, there is still a lack of large-scale infrastructure projects using such a model in Nordic contexts. The cases are presented in table 1.

*Table 1: Overview of the case studies*

Project	CPDM	Budget	Construction project timeframe	Country	Client
Pre-study	Design-build	-	2005-2013	Sweden	Public organisation
Case 1	Early Contractor Involvement	4,7 bil. SEK	2018-2026	Sweden	Public organisation
Case 2	Alliance	4,6 bil. SEK	2017-2024	Finland	Several public organisations

The initial empirical basis for this study was developed from a pre-study examining a bridge renovation project. The project site is situated near Stockholm, Sweden, and was a part of the main traffic system of the region, as well as a national construction heritage site, which placed special requirements on the project execution. This study can be characterized as a retrospective

study, ranging from the start of the planning and procurement through to the completion of the bridge. Data has been collected through interviews and document analysis.

The first main case is a railway project in Sweden. It is managed with an ECI model, through a design and build contract between the client and the main contractor who subcontracted all other work throughout the process. The case is currently in the production stage. Data was collected through interviews, document analysis and observation.

The second main case is a light-rail project based in Finland and is managed through an alliance model and a multi-party contract. The case is currently in phase 2, production. Data was collected through interviews, document analysis, and observation. We also received the results for the project's own questionnaire related to the actors' perception of the project.

## 4.2. Methods

As “qualitative research is of specific relevance to the study of social relations” (Flick, 2014, p. 11), a qualitative approach is a good base for developing a set of methods to study project management, a field based on social interaction (Flynn et al., 1990). I have used mainly qualitative methods in my research thus far. The main methods have been *interviews*, *observation*, and *document analysis*. I also included a trial of a *kinesthetic methods* during interviews, as there is a connection between working with your hands and shaping knowledge (Pallasmaa, 2009). My approach to this method was to ask all interview respondents to draw their organisational structure as part of the interview situation. This method could help in clarifying network structures, perceptions of the network, as well as the individual's understanding of their position in the project organisation.

Data collection in the case studies were mainly based on *semi-structured interviews* with representatives from the actors involved in the project. I have completed 44 interviews, including actors on all levels of the organisation, from project managers to collaboration coordinators, members of the steering group to experts and block chiefs. The focus was on project network actors. The respondents were determined through a snowball sampling method, applied to the cases separately. The interviews ranged between half an hour to three hours in length, with a mean duration of 70 minutes. I interviewed similar roles in both cases. The topics centred on the respondent's perception of both collaboration and the project, and their immediate network. The interviewer also took notes during the interview. Most interviews were conducted in person, but a few took place over the phone. All the interviews were tape recorded and transcribed. Some of the data gathering through interviews resulted in retrospective data, as my research questions pertained to the whole project process and the interviews were done during phase two, necessitating a recall of events in the respondents.

I have also used *observation*. Observations focused on the way collaboration is realised in the project by observing structured moments of collaboration, such as planned collaboration meetings, as well as unstructured collaboration, such as what spontaneously arises in a shared space. I have observed a number of collaborative planning meetings in which many of the network actors are involved, as well as the daily processes at the project offices of both main cases. During the meetings, I focused particularly on participant's activity levels. During the project office observation, my attention was directed especially towards seating arrangements and social interaction. The data was collected by taking notes at pre-determined intervals of the observation day, noting the position of actors as well as activities taking place in the space. Pictures were taken of artifacts in the space, such as schedules and meeting places. The recent introduction of relational management models was seen in the low portion of respondents with experience in CPDM.

I have also used *document analysis*. Documents analysis was carried out on materials provided by the organisations and project participants, as well as publicly available information.

Table 2 shows an overview of the respondents.

**Table 2:** Respondents in case 1 and 2, their roles and experience of collaborative project models

Nr.	Work role	Actor affiliation	Experience of CPDM
5	Block manager	contractor, client	20 % had experience
2	Collaboration coordinator	client, design engineer	50 % had experience
8	Design coordinator	client, contractor, design engineer	12,5 % had experience
9	Manager	contractor, client	33 % had experience
4	Project manager	contractor, client	25 % had experience
12	Specialist	contractor, client	8 % had experience

### 4.3. Analysis

Using a combination of qualitative methods can improve our understanding of the gathered data, as it helps balance out the limitations of the different methods (Bryman & Bell, 2015). Qualitative data was taped, transcribed and coded according to a thematic approach as well as saved to a secure online platform.

The collected data was saved both on- and offline. Online, the recordings, transcripts, and notes were saved in a secure cloud storage service. Offline, the recordings, transcripts, and notes were saved on my computer as well as on an external hard-drive. The interview notes were further physically saved and placed in a secure archive.

#### Coding

In order to reach the deep understanding qualitative research demands, data was inductively coded in NVivo according to established coding methods. The coding template grew organically as themes emerged from the data. The process included identifying e.g. roles, events, relationships, objects, tools, and the interviewees interpretation thereof. Discovered concepts were then classified according to the theoretical framework and overarching themes found during the coding phase.

#### Social network analysis

Social network analysis (SNA) is a useful approach to fulfilling my aim of understanding how actors utilise the project network and how social ties affect collaboration within the network, as it helps us understand “the myriad of systems, typically freestanding rather than integrated, involved in the planning, design and delivery of our increasingly complex [construction] projects” (S. Pryke, 2012b, p. 10). SNA offers a framework for understanding relationships between network actors and flows of resources within the network and has enjoyed a rise in popularity in the social sciences over the last decades (Borgatti & Halgin, 2011). Recent work has introduced the theory to project management (Blackburn, 2002; S. D. Pryke, 2005; Steen et al., 2018) and construction research as well (Adami & Verschoore, 2018; Pauget & Wald, 2013; S.

Pryke, 2012b; S. Pryke et al., 2018; Zheng et al., 2016). Although SNA has been widely used in social sciences, its use in project management and construction research has hitherto been limited. There have been recent calls for further investigation into especially the relationships connecting network actors (Adami & Verschoore, 2018) as well as aspects of collaboration (Sydow & Braun, 2018), indicating a need for research in this area.

Applying qualitative methods to network theory are in line with recent calls for more qualitative approaches in the field (Steen et al., 2018) and can give a deeper understanding of the network and its ties as it allows for a contextual understanding of the network (Hersberger, 2003). As network theory mainly focuses on quantitative aspects of networks, such as the directionality and strength of ties between network actors (cf. Borgatti & Halgin, 2011; Granovetter, 1973; Hersberger, 2003; S. D. Pryke, 2005), there is a dearth of contextualisation. A deeper understanding of how networks are structured will also allow for a deeper understanding of the nature of the network and to identify themes overlooked by quantitative methods (Hersberger, 2003).

As SNA is a traditionally quantitative approach (S. D. Pryke, 2005; Zheng et al., 2016), a possible conflict of methodologies and philosophies could arise, but following recent calls for more mixed methods and further qualitative applications of project network research (Steen et al., 2018), there is much insight to be gained from analysing the social network through qualitative lenses.

The network information was gathered by asking respondents about the colleagues they worked the most with. The SNA analysis was performed by adding the relationships as reported by the interviewees in SocNetV. After several iterations of the network presentation, the Fruchterman-Reingold visualisation was chosen due to the clarity of the algorithm's result (Fruchterman & Reingold, 1991).

#### 4.4. Quality of data

Research must be both of a high standard and trustworthy to be able to contribute to the scientific discussion. To ensure the quality of research, I follow the commonly accepted five criteria of quality, as discussed by Treharne and Riggs (2015): credibility, confirmability, authenticity, transferability and dependability.

*Credibility*, i.e. that the findings represent the experience of the object of study, has been ensured by engaging a reference group consisting of experts from both industry and academia. The data collected is, however, always affected by the methods employed and to a certain shaped by the researchers inherent biases and the boundaries defined by the research project. (Dubois & Gadde, 2002; Flynn et al., 1990; Gould, 1996; Van Maanen, Sørensen, & Mitchell, 2007). The reference group helped in establishing *confirmability*, i.e. the impact of my own biases and perceptions, as well as credibility. The reference group has furthermore helped with *authenticity* and to evaluate the usefulness of the findings. To maintain *transferability*, the participant's responses and my observations of the project offices have been documented by note-taking comparable to journaling. Methods to ensure transferability included keeping diligent records regarding the data gathered, having an open book policy with our respondents and ensuring anonymity for them in order to solicit honest and truthful answers. By interviewing people from different levels of the project hierarchy as well as from separate participating organisations, in addition to document analysis, the triangulation of data and thus *dependability* of the research has been fortified.

As trustworthiness is a sign of the authenticity of the findings (Lincoln & Guba, 2000), I have furthermore strived for a high level of transparency in reporting my findings (Treharne & Riggs, 2015), both in article format as well as this thesis, within the bounds of anonymity guaranteed to

the respondents. As a part of the transparency of my research, I have participated in several scientific conferences within my field and presented the research conducted in accordance with established academic practices and my supervisors' commendation.

**Ethics**

I have followed Chalmers' guidelines regarding ethical conduct as well as general codes of ethics, such as the ones presented in Flick (2014). My research has been based on informed consent, I have avoided causing harm to participants during the data collection, and I have maintained confidentiality. As my study consists of a limited number of cases, this third aspect is especially important, as the context is narrowly defined, and it may thus be easier to identify respondents from the data. The anonymity of interviewees and projects is therefore paramount.

Table 3 details factors impacting research quality and how I have striven to mitigate them.

*Table 3: Factors impacting reliability*

Factor	Risk	Mitigation strategy
<b>Trustworthiness of data</b>	Data gathered is not authentic or trustworthy; not able to contribute to theory	<ul style="list-style-type: none"> <li>• Diligent record keeping</li> <li>• Open book policy with respondents</li> <li>• Ensuring anonymity to solicit truthful answers</li> <li>• Prepare analysis guidelines</li> <li>• Identify and analyse own biases</li> </ul>
<b>Transparency</b>	Research method unclear;	<ul style="list-style-type: none"> <li>• Clear descriptions of methods employed</li> <li>• Clear, rich descriptions of data</li> <li>• Engage reference group to ensure clarity</li> </ul>
	Unable to communicate findings	<ul style="list-style-type: none"> <li>• Participate in conferences and seminars to share and discuss findings</li> </ul>
Credibility	Findings not representative of object of study	<ul style="list-style-type: none"> <li>• Triangulate data</li> <li>• Engage reference group to ensure clarity</li> </ul>
Confirmability	The findings are unduly influenced by the researcher's perspective	<ul style="list-style-type: none"> <li>• Triangulate data</li> <li>• Engage reference group to ensure clarity</li> </ul>
Authenticity	The findings do not represent the whole of the object of study	<ul style="list-style-type: none"> <li>• Triangulate data</li> <li>• Engage reference group to ensure clarity</li> </ul>
Transferability	Study results not applicable in other contexts	<ul style="list-style-type: none"> <li>• Clear descriptions of methods employed</li> <li>• Clear, rich descriptions of data</li> <li>• Engage reference group to ensure clarity</li> </ul>
Dependability	Study results not reproducible	<ul style="list-style-type: none"> <li>• Audit process and findings with other researchers and reference group</li> </ul>

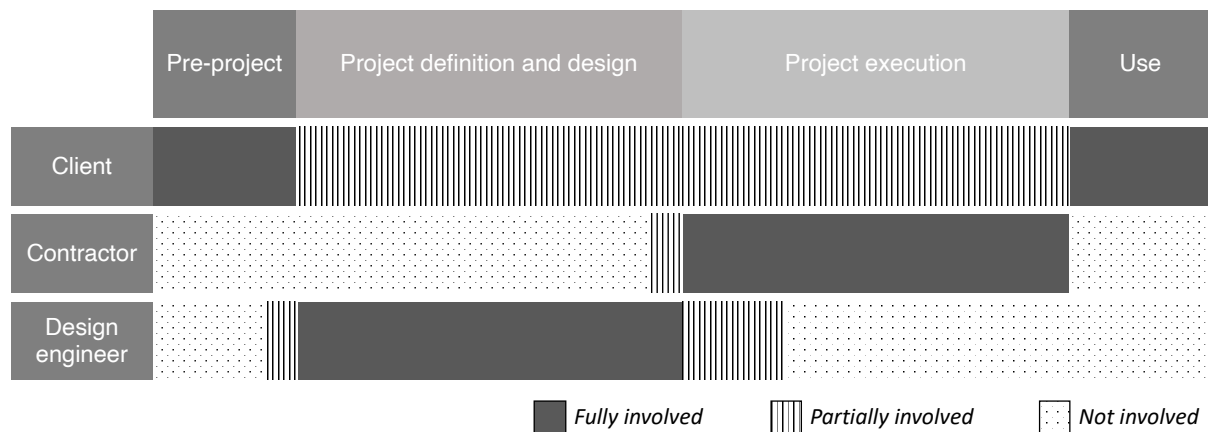


#### 4.5. Empirical setting

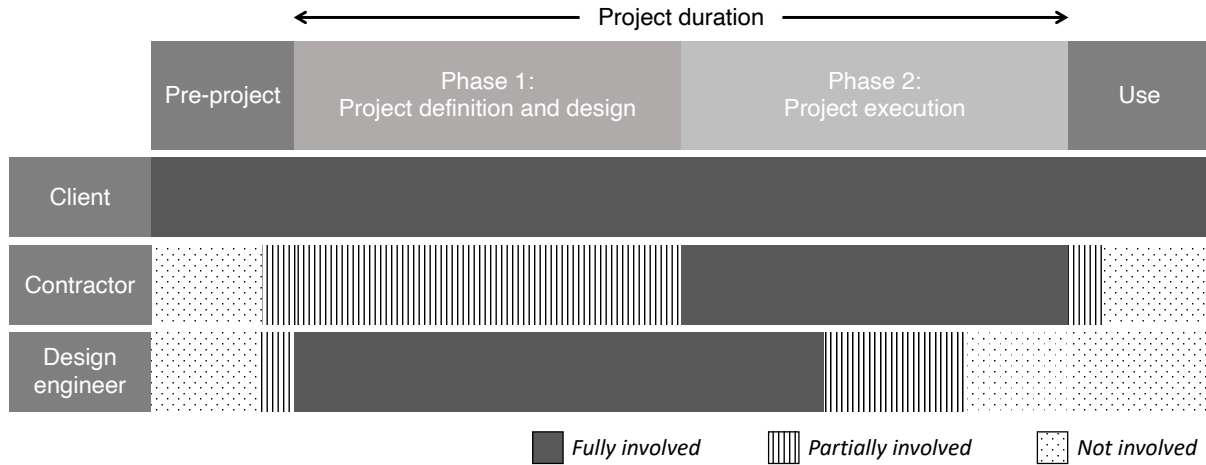
Interorganisational collaboration has been highlighted as an relevant setting for further research in the project community (Sydow & Braun, 2018) and the infrastructure industry is an interesting empirical setting for research into the phenomena. The projects within this field are often large-scale, comprising of multiple organisations and the growth of collaborative project models within the sector (Chen et al., 2018) indicates a need for further research in this area.

The construction project life cycle consists of requirement specifications and procurement before the project starts, project definition and design, project execution, use and end-of-life. The life cycle of a CPDM follows this general division, but often defines project definition and design as *phase 1* and detailed design and project execution as *phase 2*, as the idea is to involve all key competences in an early stage and thus continue with the same team from design to execution (A. Hietajärvi, 2017; Lahdenperä, 2012; Derek H T Walker & Lloyd-walker, 2012). Following a more conventional model, the client oversees project definition and design, and then chooses a contractor for the execution stage separately (see figure 2). In this work, I will focus mainly on the two phases particular to CPDMs: project definition and design and project execution, although I will also touch upon the initial stage of client need specification. This delimitation is done as there might be other network dynamics at play during the first phase (need specification and procurement) and the last phases (use and end-of-life) which fall outside the scope of this thesis. These chosen phases are also the ones with the greatest change by applying a CPDM as compared to a traditional model, as can be seen in figure 2 and 3.

An infrastructure project moreover comprises of many organisations, ranging from client and governance specialists to construction companies, design engineering firms and subcontractors. As existing literature on CPDM focuses on the relationships between the client, contractor and design engineer, with a skew towards the relationship between the client and the contractor, I have focused on these three actors.



**Figure 2:** Traditional project life cycle and actor involvement



**Figure 3:** Project life cycle and actor involvement when using a CPDM

### CPDM life cycle

*Pre-project*, or requirement specification and procurement, is well covered (cf. Chen et al., 2018; P. E. Eriksson et al., 2019; P. E. Eriksson, Lingegård, Borg, & Nyström, 2017; Jefferies, Brewer, Rowlinson, Cheung, & Satchell, 2006; Volker et al., 2018). During this phase, the client formulates their requirements so as to be able to decide on a governance model for the project and procures the necessary services as determined by the governance model chosen. The contractor and design engineer will often be involved with a smaller planning team in the end of this phase, when the project organisation and process is designed.

*Phase 1* includes concept development and pre-engineering (A. Hietajärvi, 2017; Derek H T Walker & Lloyd-walker, 2012). This is also the main adjustment from traditional infrastructure projects, as most CPDMs include expertise and input from both the client and the contractor in this phase (Chen et al., 2018; Lahdenperä, 2012) while traditional project models either keep each separate project phase in the client’s control, as in design-bid-build where each step is decided upon separately, or design-build, where the client outsources the whole process (Antoine, Alleman, & Molenaar, 2019). The inclusion of the main stakeholders is due to the expectation that a collaborative approach can include client specifications in the design better as well as counteract a potential need for rework due to the contractor’s expertise. As rework can cost over 10 % of the original contract value and is due mainly to design errors and quality defects (Lee, Park, & Won, 2012) this can lead to great cost increases in large-scale infrastructure projects. Moreover, literature on CPDMs emphasises the need for involving all actors already during project design definition and design in order for the project to benefit from their expertise regarding construction solutions (Chen et al., 2018; Lahdenperä, 2012; Derek H.T. Walker, Davis, & Stevenson, 2017). The phase includes partial input from the contractor, as the goal is to incorporate industry-specific knowledge, but not actual construction work. Phase 1 commonly ends with a target price for phase 2.

*Phase 2*, implementation, encompasses project production (A. Hietajärvi, 2017; Derek H T Walker & Lloyd-walker, 2012). This phase can overlap with phase 1 to a certain extent, as it often encompasses detailed design and engineering, thus necessitating partial input from the design engineer.

*Post-project*, including use and end-of-life, the client has full ownership of the end result. This phase may incorporate a warranty period (A. Hietajärvi, 2017).

### Actors

An infrastructure construction process is initiated by a public client who has a specific need they want to satisfy. The need is therefore tied to the client's overall purpose and goal and the construction project is "an instrument or a technology for meeting a purpose" (Ryd, 2014, p. 136) – the purpose of public projects is often a goal for society. The client is a part of the whole project process.

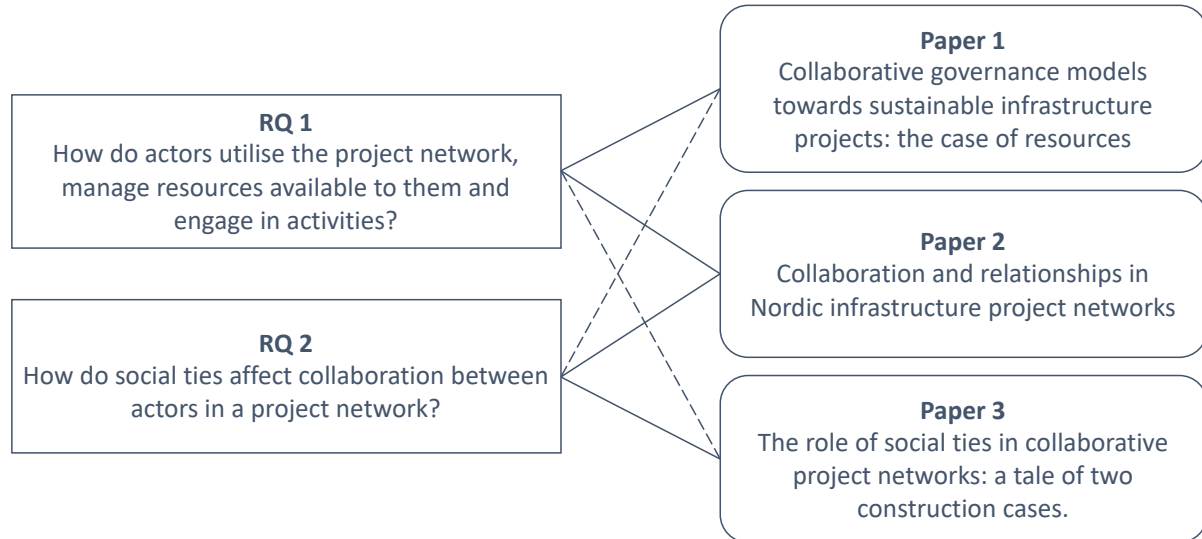
The design engineer's role is to develop the plan to build the intended construct. Current literature focuses on the contractual relationships of designers with either client or contractor, but in a project process the contractual relation is of secondary importance to the actions the actor takes and role they fulfil. The design engineer can be part of the pre-project phase if the client has contracted them to help develop needs and governance models as well as the detailed engineering in the implementation phase, but their main role is during phase 1.

The contractor's role is to build the project according to the specifications drawn up by the design engineer and accepted by the client. In a CPDM, the contractor's role starts in phase 1 as construction expertise is needed in order to develop the design and continues in phase 2, where the majority of their input is.

These are the three main actors in infrastructure development, as defined earlier. They are comprised of individuals with roles derived from both the project goal as well as their parent organisation role in the project (H. Wang et al., 2018) and can be further divided by contractual lines or their individual roles in the project, according to their expertise, but in this work, I will focus on these three main actors.

## 5. Appended papers

The papers appended in this licentiate dissertation are introduced by title, abstract, main contributions and findings. All three papers are collaborations, two of them co-authored with my main supervisor and the third co-authored with my supervising team and an interested researcher.



**Figure 4:** *The relationship between the research questions and the appended papers*

Research question one is explored mainly in paper 1, which focuses on the impact of CPDM on resource efficiency and indicates a change in actor, and especially the client, role. This is further elaborated on in paper 2, a study into the project process and the benefits of changing actor roles. Paper 2 also observes difficulties in changing the roles to allow for the full advantages of using CPDM to emerge. Paper 3, furthermore, answers research question two and elaborates on the social ties in a project network, a subject touched upon in paper 1 and 2 and further investigated in paper 3.

### **Paper 1:**

#### **Collaborative governance models towards sustainable infrastructure projects: the case of resources**

*Abstract:* The construction and infrastructure industry contribute to almost a quarter of global greenhouse gas emissions and is one of the largest drivers of resource use. This sector of the global economy is thus a promising area to look at for reducing environmental impact and increase sustainability. The impact of collaboration and cooperation within the project organisation has begun to garner more attention as the scale and scope, as well as the levels of uncertainty and complexity in construction and infrastructure projects have grown. This has led to an increase in collaborative contracting models applied to complex construction projects. In order to investigate the impact of collaborative contracting and the possibilities to advance the goal of resource efficiency and decrease environmental impact, a case study of two Nordic projects, utilising a collaborative project management model, is conducted. The findings suggest that the potential of using collaborative project management models in order to increase the sustainability of construction solutions is high. However, the use and understanding of the models vary between project actors. We conclude that the new collaborative project

management models are important features in reducing environmental impact from infrastructure construction, yet several organisational and practical issues remain to be solved.

*Purpose:* To examine the impact of collaborative project management models on infrastructure construction and resource utilisation

*Design/methodology/approach:* Two case studies, investigated through interviews, document analysis and observation.

*Findings:* The main findings relate to the significance of the client's role in the project, the unified view of the possible benefits of applying a CPDM and the importance of the contractual framework for furthering innovation.

*Theoretical implications:* Insight into the process of resource usage, how actors engage in the project network (or not) and how they engage in activities. The paper furthermore gives an insight in the importance of social relationships in contrast to the focus on contracts/procurement.

*Practical implications:* Insight into the effect of client requirements in the sustainability impacts of large-scale infrastructure projects.

The increasing interest in collaborative project management models are especially interesting from a resource use perspective, as current literature indicates benefits in resource use as well as the quality of the construction solution through the use of collaborative project practices.

Paper 1 explores the impact of using a CPDM in infrastructure construction and resource use in the project and strives to broaden our knowledge on using collaborative project management models in order to increase the sustainability of construction solutions.

## **Paper 2:**

### **Collaboration and relationships in Nordic infrastructure project networks**

*Abstract:* Since the turn of the millennium, project planners have tried reducing the adversity commonly seen in infrastructure construction projects by employing collaborative project management models, such as alliancing, early contractor involvement, or partnering. In the public sphere these models are utilised with the hope that public funds would be used efficiently to meet the needs of society through well-executed projects. One of the major drivers for these expectations is the practice inherent in the models of early-stage collaboration between all involved actors, e.g. client, design consultant, and contractor, which opens up the opportunity to focus more on intangible metrics, such as life-cycle perspectives, sustainability and societal good: factors that have recently become more significant through societal demands. In the Nordic countries, several different models are currently being applied in practice. Employing a project network perspective, we look at two infrastructure projects, employing collaborative project management models in the Nordic countries and study the expectations on collaboration models as well as the actual collaboration between the different actors in these project models. The empirical evidence, consisting of 41 semi-structured interviews, points to a discrepancy in the application of collaborative project management models as well as changing actor roles in the project network. There seem to be clear benefits realised through employing such models, such as time savings and resource use reduction, but as the benefits depend on the changing roles, it is uncertain if the projects will realise these. Results indicate a collective interest to produce a common good in all involved actors, i.e. a well-functioning, qualitative infrastructure project, while simultaneously highlighting the discrepancy between expectations and actions.

*Purpose:* To describe changing actor roles in complex, large-scale, collaborative infrastructure development projects

*Design/methodology/approach:* Case study, interviews, observations

*Findings:* The paper indicates that there are several benefits tied to changing actor roles in a more collaborative way when compared to traditional project management practices, but that there are several obstacles in achieving the change necessary to achieve the benefits.

*Theoretical implications:* Insight into the relevance of social relations and the development thereof.

*Practical implications:* Different actor roles and relationships between the actors need a transition if a CPDM is to be successful, but this transition is not always easy in a rather institutionalized industry as the architecture, engineering and construction industry.

Recent efforts in mitigating the adversity commonly seen in infrastructure construction projects have concentrated around the use of different collaborative project management models (CPDMs). The early inclusion of key stakeholders and close relationships the use of a CPDM promotes within the project network is one of the main arguments for adapting such models, as they, according to theory, will lower adversity and increase trust within the network as well as increase the quality of the decided upon solution.

Our findings show that a lack of client involvement, especially at an early stage, can have far-reaching consequences in the project organisation and process. In a collaborative project, the client cannot outsource expertise as, according to a respondent, “the [collaborative] model affects specifically the role of the client”.

### **Paper 3:**

#### **The role of social ties in collaborative project networks: a tale of two construction cases**

*Abstract:* Collaborative project delivery models (CPDMs) are increasing in popularity as infrastructure construction projects become more complex and grow in scale and scope. These models build on high levels of trust and information exchange, as well as formal contractual relationships, creating complex relationships between actors in the project network. Literature emphasises the procurement phase and the contractual aspects of CPDMs; however, few studies explicitly focus on the role of social relationships or ties in a project utilising a CPDM. Social network theory and social network analysis (SNA) have recently been introduced in the construction field to better the study of relationships between network actors in, but the role of social relations and ties within project networks applying a CPDM is still unclear. Through two qualitative case studies, we have analysed how social ties affect collaboration between actors in the project network. The empirical evidence, consisting of 41 semi-structured interviews and observations, points to a number of aspects that affect the development of social ties in CPDMs as well as shows how social ties develop into negative or positive bonds affecting the level of collaboration. The study contributes by broadening the understanding on the interplay between project networks using CPDMs and social ties.

*Purpose:* To explore the role of social embeddedness in project networks where social ties —as opposed to institutional and contractual relationships— at the interorganisational level have not yet been examined systematically in the project network literature.

*Design/methodology/approach:* Two case studies involving interviews, document analysis, observation and social network analysis

*Findings:* The level of social ties, both formal and informal, affect the project network and therefore project delivery, when the project is viewed through a network lens. Formal ties are especially important in shaping the network in initial phases of the project, while informal ties gain in importance as the project progresses and social ties have had time to develop.

*Theoretical implications:* A deeper understanding of the interplay of formal and informal ties in a project network: “With a contract that supports collaborative project practices in place, and a common understanding of the expectations thereof, the formal tie (of the contract between participating organisations) supports the creation of informal ties (social bonds between individuals engaged in the project).” (p.25)

*Practical implications:* The insight in the effect of the contract (a formal state-type tie) in shaping the social bonds between individuals (informal state-type ties) and the impact this has on communication, knowledge sharing (informal event-type ties) and trust (informal state-type tie) can help practitioners ensure a successful initiation phase, as well as a common understanding of the chosen governance model.

This journal paper expands on findings in paper 2, focusing on the social relations between actors in a project network. It examines the role of social ties in projects utilising a CPDM. Results indicate the importance of the project initiation phase to build strong social ties within the project network, enabling collaboration and the wished-for benefits of CPDMs: “As the success of a CPDM is based on changes in the project network and actor roles, the concept of social ties in a project network contributes to our understanding of the relationships between project network actors” as is stated in the findings.

The paper is under revision.

## 6. Discussion

Factors impacting actor collaboration in interorganisational settings can be understood through insight in three areas: (1) the nature of relationships within the project network; (2) the issue of coordinating decision-making and governance; and (3) the ambiguous nature and demarcation of projects (Hellgren & Stjernberg, 1995; Sydow & Braun, 2018).

*The nature of relationships within the project network:* A project network is only as strong as the ties between the actors of the network and as large-scale projects often involve multiple organisations, the strength and nature of the ties between them become important for successful project delivery. Interorganisational relations are often different from structures found in permanent organisations due to their bridging nature, connecting organisations across project boundaries (Hellgren & Stjernberg, 1995; Sydow & Braun, 2018), but also requiring new management forms in the single project. According to Jones and Lichtenstein (2009), the nature of relationships formed within the project network will impact project delivery. They suggest that projects with a high number of connections would work collaboratively and that the nature of ties connecting the network can impact both project structure and delivery.

CPDM, requiring early inclusion of all project actors, builds on this premise and the nature of ties connecting actors affect the project network, as seen in paper 3. Formal ties in an early stage of the project can help support the creation of informal ties, enabling the tight connections and collaboration as described by Jones and Lichtenstein (2009) which are linked to the bridging ties discussed by both Hellgren and Stjernberg (1995) and Sydow and Braun (2018).

*The issue of coordinating decision-making and governance:* Project participants belong to multiple organisational settings (Hughes & Murdoch, 2003; Lundin et al., 2015; Sydow & Braun, 2018), which indicates that the management of project networks is divided between the responsibilities actors have towards their parent organisation and the project organisation (Lundin et al., 2015). This results in decision-making based on politics (Hellgren & Stjernberg, 1995) and non-hierarchically linked actors (Sydow & Braun, 2018).

CPDMs are based on sharing resources, responsibilities and decision-making, among others (Lahdenperä, 2012), but as no organisation can make decisions on behalf of other organisations partaking in the project (Hellgren & Stjernberg, 1995), informal ties become important to enable collaboration and coordinate decision-making (Jones & Lichtenstein, 2009). This is further discussed in papers 2 and 3 as the high level of connections and informal ties in one case enabled changes in roles and responsibilities as well as a common understanding of the project model and goals.

*The ambiguous nature and demarcation of projects:* As the researcher defines the network (Borgatti & Halgin, 2011), the issues discussed previously concerning the nature of relationships and coordinating the project network become dependent on the definition thereof. Furthermore, as major projects involve multiple stakeholders (cf. Gann & Salter, 2000; Hellgren & Stjernberg, 1995; Jones & Lichtenstein, 2009; Sydow & Braun, 2018) and the life cycle of an infrastructure project can span decades (T. Eriksson, 2015; Flyvbjerg, 2014), the actors participating in the project network have a high probability of changing during the process, compounding this issue.

### 6.1. How actors utilise the project network: resources and activities

CPDM emphasises the importance of including all main actors in an early stage of the project as well as communication and sharing of resources (Lahdenperä, 2012). The rising use of CPDMs as a way to manage major infrastructure projects has introduced several changes in the project process compared to traditional models of managing projects. In a traditional model, the project process is divided into clearly separate phases, governed with unconnected contracts. The roles



and responsibilities of actors are also clearly defined with the client supervising the work, the design engineer procuring plans and designs, and the contractor building in accordance with predetermined designs. In a CPDM, there are three main aspects to take into account: first, the early inclusion of actors; second, the changing roles and perception arising from the changes; and third, sharing within the project organisation.

First, the central change in a CPDM is the inclusion of all actors early in the process. The main benefit thereof is based on the introduction of contractor knowledge in the planning stage as well as a clearer picture of client needs, which is thought to improve planning outcomes and design implementation (Lahdenperä 2012, paper 1, paper 2). This proved to be a challenge in the observed cases, however, as the actors are unaccustomed to working in close contact with each other (paper 2). Second, as actors are involved earlier and expected to change their familiar processes, their own roles change, but also the perception of other actors.

When the project model changes, so does the project network, routines, responsibilities and behaviour within the project organisation (paper 2). This change is especially visible in the construction industry and recent efforts to introduce collaborative project management are visible in an increased literature related to the procurement of such projects: less is known about the project process and delivery phases, partly due to the novelty of the field.

The client's role changes from the role of an overseer to an active participant (paper 2). As clients are normally unaccustomed to working in projects, the project being a unique one-off endeavour for them (Hughes & Murdoch, 2003), there was also a need to assure enough resources for the client to engage in the process (paper 1). This was especially important early in the project process, since the client's involvement in early stages of the process was seen as necessary by the respondents as noted in paper 3. This role change helps client's access the knowledge base of both design engineer and contractor early in the process, if they are engaged in the planning phase of the project, as discussed in paper 2. It also impacts the activities they engage in during the process, as the traditional model of overseeing the project life cycle gives way to a more involved role, especially in phase 1.

In the design engineer's role, the changes were focused mainly on the individual designer's work balance (paper 2). The design engineers were accustomed to work both iteratively and collaboratively, as prescribed by CPDM, as well as within project networks, but their usual work process included working on multiple projects at once (paper 2). This became a problem in a CPDM where frequent and instant iteration was assumed and a prerequisite for a successful application of the model; the design engineer's resource use and activity engagement thus changed mainly due to the external demands regarding their internal resource management and work allocation.

The contractor's role changes related to their involvement in the early planning process and iterative design processes (paper 2). Several contractor representatives mentioned how they "just wanted to get to the real work" (paper 2, p.8) in the early, iterative planning stages, indicating a difficulty in adapting to the role change related to deeper involvement in the planning as required in phase 1. As the inclusion of contractor expertise in the planning stage is one of the key aspects of CPDM, there is therefore a need to redefine their role in the early phases of construction projects and how they see as "real" work. The contractor's activity engagement was thus affected the greatest, especially in phase 1 as they had to engage in previously unfamiliar activities. These changes in the project network could, however, lead to a more efficient resource usage in phase 2, both from the contractor's but also the whole project's point of view, as discussed in paper 1.

Moreover, the sharing of resources is emphasised as an essential tenet of CPDM (Chen et al., 2018; Lahdenperä, 2012) and a signal of the success of social cohesion and tie formation within the project (paper 1, paper 3). This includes, depending on the CPDM in use, sharing knowledge, risk, time and ideas, both connected to the project itself, but arguably also to how actors view

the process. One commonly discussed contributor to a successful collaboration is the shared office space (P. E. Eriksson et al., 2017), but it is only in recent contributions that highlight how the use thereof affect the process within a CPDM (paper 1, paper 3).

Network theory has long been a quantitative stronghold, an approach that has yielded interesting insights into the structure of networks. Applying a qualitative lens, we can gain deeper understanding of the properties described by network theory (Hersberger, 2003; Steen et al., 2018). The findings presented here give greater insight into the reasons a network is shaped as it is and can help project managers plan for more efficient network development. It also broadens our understanding of how actors utilise the network in order to manage resources available to them and engage in activities within the project.

## 6.2. How social relations impact collaboration within a project network

As the project organisation builds the framework of the project network, the participating organisations and individuals become involved as actors in the network. Project networks do, however, rely on different governance models than traditional organisations (Steen et al., 2018; Sydow & Braun, 2018) and draw their process from the interaction of responsibilities, routines, roles and relationships (DeFillippi & Sydow, 2016). An especially important part of this interaction is the role of ties, a hitherto underdeveloped part of network theory.

The idea of collaboration in CPDMs is based on social ties in the form of non-contractual aspects of the project process, partly connected to the early inclusion of actors in the project and the creation of trust within the project (Bygballe & Swärd, 2019; Chen et al., 2018; Kadefors, 2004; Lahdenperä, 2012). When such a network is closely connected with multiple ties, there is a higher probability of a shared understanding as the actors get the same information simultaneously (Borgatti & Halgin, 2011; S. D. Pryke, 2005). There is, however, little information on how such ties impact the network and the actors within.

The impact of social ties could be seen in paper 2 and 3, where findings show how differing levels of such ties impact the project process. In the network without close ties, there was a discrepancy between the client and the contractor as the lack of close ties led to differing understandings of the project process and a state of conflict. In the network with close social ties, the project network shared an understanding of the project process (paper 2, paper 3).

Social ties would, therefore, seem to impact the levels of collaboration within a project network as their presence enable the flow of information and the building of trust between actors, or alternatively, a lack thereof hinders the formation of trust and therefore collaboration.

The focus on the initial set-up and project identification, perception of other actors, as well as the prescribed sharing of resources such as office space (paper 3) all contribute to trust and a unified view of the project's goal: key prerequisites for a successful CPDM according to literature (Chen et al., 2018; Lahdenperä, 2012). These factors are also key contributors to the formation of social cohesion and ties within the project network.

Although qualitative approaches to network theory and SNA have been advanced in recent years, there is still little known on the interplay between different ties. The main focus in network theory and applications of SNA have focused on the strength of ties (cf. Burt, 2001; Granovetter, 1973; J. Wang, 2016); not an unreasonable choice as network theory is based on mathematical formulations and quantified properties. By applying a qualitative lens to the social network uncovered, the explanation for the network structure and tie formation becomes clearer and the impact of social ties on the level of collaboration within the network becomes clearer. The findings indicate that the current literature, although the insight into contracts is valuable, is not showing the whole picture related to collaboration.

## 7. Conclusion and future research possibilities

Interorganisational collaboration in projects has recently risen as a topic of interest within the project community, as has a call for research into network properties of projects. By using a qualitative approach to network theory in an empirical setting of infrastructure projects, the development of a project network structure becomes clearer and a deeper understanding is gained of the role of ties. With the papers presented in this thesis, I show that project network roles change due to a more collaborative project management model affecting actors' network utilisation, resource management and activity engagement, and that the success of this change depends on the social ties as the level of social ties affect collaboration between actors in the network.

- The client's role changes from the role of an overseer to an active participant (paper 2), as the collaborative model requires constant input and interaction with the client
- The design engineer's role changes were focused mainly on the individual designer's work balance (paper 2), changing from a fractured multi-project approach to focusing on one project at a time
- The contractor's role changes from purely executive to include more multi-faceted tasks and responsibilities related to planning and knowledge sharing, necessitating an adjustment in their role and how they see "real" work
- Social ties enable the flow of information and the building of trust between actors

A network approach enables a broader view of interorganisational collaboration than a traditional organisational view, as it takes into account the ties between both participating organisations as well as individuals. The appended papers touch upon the effect of social relations in project networks, as well as the changes in project process that arises from the application of new management models. The findings indicate that the current literature, although the insight into contracts is valuable, is not showing the whole picture related to collaboration.

### 7.1. Future research

Possible future venues include, but are not limited to: the importance of the initiation phase in shaping the network; the impact of social ties in project networks as CPDMs becomes more prevalent and actors move from one CPDM to another; an understanding of collaboration an cooperation as CPDMs become more common; and the interplay between the state tie that is the contract and the rest of the ties in the network.

Especially the difference between collaboration and cooperation is an interesting topic and deserving of future research as there seems to be little definition of the two terms in current literature on collaborative project management models. There are also some signs of a so-called "dark side" of collaboration: although collaborative practices improve information flow and resource utilisation, they also constrict the network and actors. As most of current literature portrays a very positive view of collaboration and focus on benefits to collaborative practices rather than possible negative outcomes of such practices, the question about this "dark side" arises. Are there downsides to increasing collaboration, and if so, what are they?

When considering project networks and how ties shape collaboration in interorganisational project networks, an especially interesting topic to investigate is the influence of the parent organisation on the project network. Projects, especially large-scale and complex ones, often bridge decades and the project organisation has to be designed in order to allow for the exchange of participating people. The influence of the parent organisation and its culture on the project organisation and, in extension, the project network is an unexplored field which could help us understand tie dynamics of project networks.

## DRAFT

In order to gain further insight in these project network aspects, I will focus on mixed methods in the next phase of my PhD. This will enable me to validate some of my initial findings, especially related to the view and definition of collaboration as well as the importance of the initial phase.

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