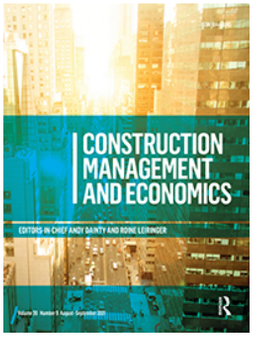

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The role of social ties in collaborative project networks: A tale of two construction cases

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ABSTRACT

Collaborative project delivery models (CPDMs) are increasing in popularity as infrastructure construction projects become more complex and grow in scale and scope. CPDMs build on high levels of trust, information exchange and formal contractual relations, creating complex relationships between actors in the project network. The literature emphasizes the procurement phase and contractual aspects of CPDMs; however, few studies explicitly focus on the role of social relationships in CPDM projects. Social network theory has recently been introduced in the architecture, engineering and construction industry industry to study relationships between network actors, but the role of social ties within CPDM project networks is still unclear. Through two qualitative case studies, we have analyzed the role of social ties in projects applying a CPDM contract. The empirical evidence of 41 semi-structured interviews and observations points to aspects that affect the development of social ties in CPDMs, such as initial project setup, project identification, perception of actors, resource sharing and shared space, as well as the importance of formal and informal ties for supporting collaborative project practices. The evidence shows how social ties develop into negative or positive bonds affecting the level of collaboration. This study contributes by emphasizing the interplay between project networks using CPDMs and social ties.

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Project networks; social ties; collaboration; relational project delivery arrangement; relational contracting

Introduction

Collaborative project delivery models have increased in popularity in the architecture, engineering and construction (AEC) industry as the growing complexity of large-scale infrastructure projects (Flyvbjerg 2014) has introduced new project management models (Bygballe and Swärd 2019). These models are expected to improve constructability, lower risks and improve teamwork amongst actors (Hansen-Addy and Nunoo 2014). Collaborative models, such as alliancing, early contractor involvement, and partnering, are known under the umbrella terms of *relational contracting* or *collaborative project delivery models* (CPDMs) (Rahman and Kumaraswamy 2004, Lahdenperä 2012, Bygballe and Swärd 2019). Projects utilizing a CPDM are characterized by 'early 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 a joint governance structure, establish CPDMs as relational management models (Lahdenperä 2012, Walker and Lloyd-Walker 2015). The anticipated success of CPDM-based projects thus relies on the social relationships that either enable or constrain the level of sharing activities and involvement of actors (Hietajärvi 2017).

The project model that is utilized determines the formal relationships between actors through the project organization and contractual aspects (Adami and Verschoore 2018) while the informal relationships have been given less attention. CPDMs are especially complex, as they depend on the sharing of resources, information and responsibilities (Lahdenperä 2012, Bygballe and Swärd 2019), which requires high levels of trust between project actors (Lahdenperä 2012).

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This is also the basis for the anticipated benefits of using CPDMs, enabling problem-solving and efficient resource use. The early inclusion of all project actors, combined with open communication fostered by trusting relationships, enables the actors to pool their knowledge from the start (Lahdenperä 2012). Co-location (Walker and Lloyd-Walker 2015), as well as the use of common project tools, such as document-sharing platforms (Eriksson *et al.* 2017), offer further support herein. Research on CPDMs has hitherto mainly focused on building projects in general and not so much on civil infrastructure; when the latter is concerned, contracts and the procurement phase of large-scale infrastructure projects have been the main focus.

Construction projects form a temporary organization where different actors collaborate to achieve a common goal (Manning 2008). Researchers have recently considered viewing this temporary organization as a project network (Pryke 2012, Adami and Verschoore 2018), often consisting of transitional and interdependent systems involving shared activities by a number of organizations in a given time (Lundin *et al.* 2015, van Fenema *et al.* 2016, Adami and Verschoore 2018). A project network consists of actors partaking in a project and the ties connecting them (Hellgren and Stjernberg 1995).

Thus far, research in construction projects has not explicitly focussed on how project models impact the social relationships arising in the project network and vice versa. This is an important topic to study, as temporary interorganisational arrangements, such as a project network, are initially shaped by the chosen project model, and thus affecting the project process. Furthermore, a social network perspective has lately become adopted more frequently in the study of inter-organisational arrangements in project networks (Pryke 2012, Ruan *et al.* 2013, Zheng *et al.* 2016, Pryke *et al.* 2017, Adami and Verschoore 2018, Steen *et al.* 2018, Loosemore *et al.* 2020). While much of the literature with a social network perspective studies the properties and structure of the networks themselves, less attention has been given to the social ties in the project network as a main unit of analysis. Previous research has shown (Papadonikolaki *et al.* 2017, Adami and Verschoore 2018, Wang *et al.* 2018) that social ties within the project have an effect on project governance and the network through both formal and informal relations, but the extent and role of the effect is still unclear. As collaborative project delivery models grow in popularity, the focus on such social ties increase. However, there is a lack of insight into the role of social relations and ties within project networks in large-scale infrastructure projects. We explore the role of this kind 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. Hence, the purpose of this study is to investigate the role of social ties in projects managed by a CPDM. More specifically, we define our research question as: *What is the role of social ties in projects using a CPDM*?

Our study's scope includes the project network created by the three main roles involved in realizing the project: 1) the client whose needs the project will meet; 2) the design engineer, who develops the design; and 3) the contractor, who is responsible for the building process. We strive to answer the calls of Adami and Verschoore (2018) as well as Pryke *et al.* (2018) by broadening the understanding of the interplay between project networks and social ties. Our work also supports requests for additional research to underpin more collaborative project relationships (e.g. Walker and Rowlinson 2019). This study contributes by broadening the understanding of the relationship between project networks created in projects using CPDMs and social ties, as well as the nature of social ties in such networks.

Theoretical frame of reference

Collaborative project delivery models in infrastructure construction

Many infrastructure projects, large in scope and scale, can be classified as major projects since they take decades to realize, involve multiple stakeholders and their total costs exceed 100 million dollars (Flyvbjerg 2014).

Multifaceted processes of coordination and control, combined with a great variety of inherent risks (Hughes and Murdoch 2003, Adami and Verschoore 2018) increase the level of difficulty of managing large-scale infrastructure projects, making them complex (Adami and Verschoore 2018, Pryke et al. 2018). To counteract the challenges presented by these aspects, CPDMs have been introduced into the infrastructure construction industry in recent years (Lahdenperä 2012, Chen *et al.* 2018, Bygballe and Swärd 2019). Research has identified several benefits of such models, such as including increased quality (Eadie and Graham 2014, Bygballe *et al.* 2015), less adversity in the project process (Song *et al.* 2008) and reduced project costs (Song *et al.* 2008, Eadie and Graham 2014).

A CPDM is based on the early involvement of all early actors in a construction project, shared processes and resources, joint governance and co-location (Lahdenperä 2012, Walker and Lloyd-Walker 2015). The successful implementation of a CPDM is based on social relationships between project actors, as the model builds on trust, enabling the sharing of resources and processes (Lahdenperä 2012, Hietajärvi 2017). CPDMs consist of both contractual mechanisms and non-contractual mechanisms like leadership, collaboration, communication and integration of resources and processes (Chen *et al*. 2018).

A CPDM is furthermore characterized by interorganizational collaboration as CPDMs mainly are used for complex, large-scale projects necessitating the inclusion of several organizations. This aspect, however, gives rise to further complications as the necessary interorganizational relationships are affected by the efforts to coordinate the multiple stakeholders involved (Hellgren and Stjernberg 1995, Jones and Lichtenstein 2009, Sydow and Braun 2018). As the success of a CPDM relies on social relationships, the roles of both interorganizational relationships and social ties between individuals becomes interesting to study.

A social network approach

Different views of network theory have recently become popular in the field of project and construction project research (Pryke 2012, Pryke *et al*. 2017, Steen *et al*. 2018). In order to investigate the relationships that form the basis for CPDMs, we have taken a social network approach as spearheaded by e.g. Pryke (2005, 2017, 2018), defining the social network as the project network that is created around the construction project (Hellgren and Stjernberg 1995, Lundin *et al*. 2015, Adami and Verschoore 2018). This results in a network of actors connected by ties which shape the network as "[t]he pattern of ties in a network yields a particular structure, and nodes occupy positions within this structure" (Borgatti and Halgin 2011, p. 1169).

When creating a project organization—the foundation for the project network—the focus is mostly on the inherent properties of the actors (Borgatti and Li 2009) and on selecting the most suitable actors for the project, as well as the management of the subsequent project network. Much emphasis is placed on the contractual relations in this stage (Pryke 2012). Actors connected to the project perform shared actions to achieve a common goal (Hughes and Murdoch 2003, Manning 2008). Unlike traditional construction projects, a CPDM requires the actors to share resources and have joint governance processes (Lahdenperä 2012, Walker and Lloyd-Walker 2015).

The usage of CPDM brings with it changing roles, activities and impacts on the project network, which relate to one of the main points of collaborative models: the relationships it promotes within the project network. These connections can be seen within the project network itself, but also in relationships involving parent companies and subcontractors taking part in the project.

The classical view in project network research emphasizes the individual actor. As there are multiple levels at which project networks interact with their environment, a multi-level approach to project network research has lately been argued for (Sydow and Braun 2018). In this research the focus is on the project network as a whole, discussing both the organizations and individual participants depending on the context, as it is the interaction between levels that disorder hierarchies and blur boundaries in interorganizational settings (Sydow and Braun 2018).

Social ties in projects

Interorganizational projects are embedded in social exchanges (Granovetter 1985, Uzzi 1996), such as personal relationships. Adami and Verschoore (2018) discuss different types of ties that impact the governance of project networks, identifying supply relations, contractual relations and information exchange as the main ties related to project governance, but also note a need for further research into the subject. Although there have been discussions related to interorganizational collaborations developing over time (Oh *et al*. 2004, Jones and Lichtenstein 2009, Adami and Verschoore 2018), less attention has been paid to the role of social ties, although e.g. Pryke (2005, 2017) and Loosemore *et al*. (2020) have made significant introductions to this aspect.

A social network approach considers the structure of and interactions between actors rather than the characteristics of the actors themselves (Borgatti and Halgin 2011). The ties included in the network are defined by the researcher (Borgatti and Halgin 2011) and are here discussed in terms of their level of formality (formal or informal) and their state of being (state or event). A formal tie can be measured and observed, such as in the form of contracts or organizational charts (Papadonikolaki *et al*. 2017, Wang *et al*. 2018). An informal tie is harder to observe or measure and often takes the form of a relation between actors (Papadonikolaki *et al*. 2017) and can influence an

Table 1. Case comparison.

	Case Bilateral	Case Multiparty
Length	9.5 years (estimated)	6.5 years (estimated)
Monetary value	475 million €	390 million €
Contract type	ECI, Bilateral (client-contractor)	Alliance, Multi-party (client-contractor-design engineer)
Research methods	Interviews, document analysis, observation	Interviews, document analysis, observation

actor's behaviour (Wang *et al.* 2018). As described by Borgatti and Halgin (2011), a state tie is a long-term connection, such as role-based relationships in a project organisation or a social relationship, while an event tie is transitory in nature, such as spontaneous discussions in a project office.

Although the rise in applying a social network approach has provided much information about social relations within project networks, and the nature of such ties has been discussed at length (see Granovetter 1973, 1985, Burt 1976), but the role of social ties is still unclear. One way to approach these social ties is by examining how embedded the ties are in the network.

Embedded relationships relate to the way relationships between project actors shape the project network (Uzzi 1996, Nell and Andersson 2012). A high level of embeddedness enables trust and collaboration and "shifts actors' motivations away from the narrow pursuit of immediate economic gains toward the enrichment of relationships through trust and reciprocity" (Uzzi 1996, p. 677), while a low level of embeddedness results in an arm's-length relationship between the actors (Nell and Andersson 2012). A high level of embedded relationships furthermore supports the formation of collaborative relationships where "stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain" (Wood and Gray 1991, p. 146). This structure of embedded social ties can thus be said to make resources available to other actors within the network (Oh *et al.* 2004) and can be used as a measure of the social ties within the project network.

Method

This research project is an exploratory study investigating the project network relations in large and complex infrastructure projects. To gain insight into the role of social ties in a project managed by a CPDM, we need a deep understanding of social relationships in project networks and their characteristics. To analyze the uncharted interdependencies of social ties, we looked for varied and detailed information (Langley 1999). This can be found in contrasting findings from two cases. Whereas one case could give us deep insights, contrasting two similar cases can help identify the characteristics of network ties. Case studies moreover permit a level of in-depth analysis not possible with other methodologies (Langley 1999).

Applying a qualitative method to network theory is in line with recent calls for more qualitative approaches within project network research (Steen *et al.* 2018, Loosemore *et al.* 2020) and can give a deeper understanding of the network and its ties as it allows for a contextual understanding of the network (Hersberger 2003). This study applies a social network perspective and combines qualitative methods with a social network analysis (SNA) which has been shown in early research as complementary (Steen *et al.* 2018). SNA has traditionally utilized quantitative methods in order to analyze networks, such as the directionality and strength of ties between network actors (see Granovetter 1973, Hersberger 2003, Pryke 2005, Borgatti and Halgin 2011). Qualitative research methods can, however, contribute to a richer understanding of the network context (Hersberger 2003). Furthermore, our research builds on a process perspective to understand the evolution of the project network and its organisation and obtains a more detailed time-bound examination of social relationships and their impact on project networks.

Empirical setting

This research project draws on two case studies in the Nordics. The projects started in 2016 and 2018, respectively, and are still ongoing. Both cases are among the first ones in their respective national infrastructure context to utilize a CPDM, which has brought network ties into a new focus. The two case studies (see Table 1) represent two Nordic infrastructure construction projects which are defined as "large and complex" by the client organization. The level of complexity is based on their evaluation regarding uncertainty and the level of collaboration, as well as the urban context of the projects. Since there currently are few projects utilizing a CPDM in the Nordics, the accessibility of these two projects furthermore made them suitable for our purpose. As both projects are utilizing a relational project model and are of suitable

Table 2. Method of data collection.

	Case Bilateral	Case Multiparty
Interviews	20 interviews	21 interviews
Interview lengths	45 min – 1.5 h	45 min – 3 h
Roles interviewed	client (8), contractor (8), design engineer/subcontractor (4)	client (5), design engineer (7), contractor/subcontractor (9)
Observations	Observations of meetings and big room activities (2 days)	Observations of meetings and big room activities (4 days)
Documents	Organization charts, news articles	Organization charts, news articles, internal project surveys

size, they were deemed fit for the study. The cases would be classified as "major projects" based on Flyvbjerg's (2014) classifications, since they cost between a hundred million and a billion euros, involve several organizations and span multiple years from planning to completion. The cases both have a two-stage contracting approach in which phase 1, which focuses on pre-design and development and on cost estimation of a budget price, is followed by phase 2, which focuses on the detailed design and execution of the project. In each case, all of CPDM's key competencies are involved in an early stage (phase 1) and the same team (client, design engineer and contractor) is involved from design to execution (Lahdenperä 2012, Hietajärvi 2017). Both cases further utilised some form of pre-qualification and tender preparation of the contractor and design engineer (i.e. initial setup phase) of partners before the selection of project actors by the client organization, with an initiation phase forming between selection and project start. Both projects are currently in phase 2 and are expected to be completed within a decade.

Case Bilateral, classified as a major infrastructure project, is being realized in a large Nordic city. The main objective of the project is to construct a new transportation infrastructure. The public client has defined a collaborative model to be used in comparable projects and has entered into a bilateral contract with the main contractor, who has subcontracted all other project moments, such as planning and design. Project development started in 2014, with phase 1 starting in 2016 and phase 2 in 2018. The project is estimated to be completed in 2026. The project organization is based on a division of tasks between the client organization and the main contractor, who strive to match each other's organizations within the project. The project manager was appointed by the main contractor. The project states in both contract and public materials that this is a collaborative project (applying early contractor involvement), and we can therefore classify it as using a CPDM.

Case Multiparty is also classified as a major infrastructure project and is being realized in a large Nordic city. The main objective of the project is to construct a new transportation infrastructure. The public client has defined a collaborative model to be used in comparable projects and has entered into a multiparty contract with the main contractors and design engineer firms. Project development started in earnest in 2016, followed by phase 1 in 2018 and phase 2 in 2019. The project has an estimated completion date of 2024. The project organization is based on a division of tasks between actors as well as balanced representation within the project organization. The project manager is appointed by a contractor organization. The project strives to appoint the most suitable candidate from the involved organizations to each task. The project states in both contract and public materials that this is a collaborative project (applying an alliance contract), and we can therefore classify it as using a CPDM.

Table 3. Respondents Bilateral.

Nr.	Work role	Actor affiliation
1	Block manager	contractor
2	Block manager	contractor, client
4	Design coordinator	client, contractor, design engineer
1	Design coordinator	contractor, design engineer
2	Line Manager	contractor, client
3	Line Manager	contractor, client
1	Collaboration coordinator	client
2	Project manager	contractor, client
3	Specialist	contractor, client

Data collection

Data were collected through interviews, document analysis, and observations (see Table 2). The main method for gathering data was through in-depth semi-structured interviews based on a common interview guide. 41 interviews were carried out, with 20 of them in Case Bilateral and 21 in Case Multiparty, each lasting between 45 minutes and three hours. Both cases employed a snowball strategy of identifying interview respondents, starting from the project manager. The snowball strategy was also applied to find the main actors in the project network. There are several organizations involved in each project, but we have classified the respondents according to their roles, i.e. client, design engineer and contractor

Table 4. Respondents Multiparty.

	Work role	Actor affiliation
2	Block manager	contractor
1	Collaboration manager	design engineer
3	Design coordinator	design engineer
3	Line Manager	contractor, client
1	Line Manager	contractor
1	Project manager	client
1	Project manager	contractor
8	Specialist	contractor, client, design engineer
1	Specialist	design engineer

representatives. We interviewed respondents from all the above-mentioned actor groups in the projects (see Tables 3 and 4). In addition, the interviewees represented all levels of the project organizations, from specialists to block managers to the project manager.

Most interviews were conducted face-to-face, with a handful completed through digital means. The interviews were recorded and transcribed (with a total of 663 pages of transcription). The interviews were conducted during phase 2 in both projects; however, the interviews covered all phases of the project (initial phase, phase 1 and phase 2).

In Case Bilateral, interviews were conducted over a six-month span from autumn 2019 through early spring of 2020. Observations were conducted over two days in the spring of 2020 for a total of 16 hours. In Case Multiparty, interviews were conducted during two week long spurts in autumn 2019 and observations were conducted during the same period over four days, for a total of 32 hours. During observations in both cases, the daily activities of the shared space were observed and interactions between actors were logged at regular intervals.

In both cases, the project manager provided access to project documents. In Multiparty, the project manager provided access to various other documents, including survey results, internal meeting memos and presentations. In Bilateral, access to project documents was restricted.

To further validate the study (Flick 2007), the data were triangulated by using additional material, such as organizational charts, meeting memoranda and news articles.

Data analysis

We sought to understand the different ties and events linking actors to each other, the characteristics of these and how they affected the network. Due to the uncharted waters of the topic, the transcribed interviews were inductively coded in NVivo to achieve a deep understanding of the data. All the qualitative data were put through systematic stages of naming data reduction, focussed coding, and data display (Locke 2001). Through open coding, we found dominant themes that focussed on the importance of the initial phase of the project, the perspectives of other actors, the sharing of resources and the impact of the project office in relation to the social ties in the project, as well as formal and informal ties. As the majority of the events in phase 1 had occurred prior to the interviews, the main mode of coding was a retrospective analysis.

Next to the inductive coding, a qualitative social network analysis was applied. The social network was formed by asking the respondents who the persons they worked with most. Ties were categorized as strong when a respondent mentioned they worked together very often (e.g. daily or several times per week), medium when they worked together often (e.g. a few times a week) and weak when they worked together occasionally. We restricted the network to actors directly involved in the project and excluded e.g. persons in the respondent's home organization. Social ties were identified by comparing the social network to interview data and analyzing observation notes.

Network density was chosen as the key metric to provide measurements of the network. Network density captures the degree of connectedness within a network. In an unweighted network (i.e. a network where strengths and directionality of ties are ignored), this is done by calculating the ratio between the number of existing ties between actors and the theoretical maximum number of ties (see e.g. Pauget and Wald 2013, Wang *et al*. 2018, Pandit *et al*. 2020).

The analyzed organizations are coded as the client (CL); contractor (CO); and the design engineer (DE). If a group belonged to the project organization, it is coded as PROJECT. The roles are project manager (PM), manager (MA), design manager (DM), block manager (BM), block design manager (BDM), block supervisor (BS), site engineer (SE), specialist (SP), and team member (TM). Other groups were different subgroups appended with the theme of the group (e.g. GReconomy), home organization (HO), and steering committee (SG).

The SNA analysis was performed by adding the relationships as reported by the interviewees in SocNetV, software for visualizing and analyzing social networks. After several iterations of the network presentation, the Fruchterman–Reingold visualization was chosen due to the clarity of the algorithm's result (Fruchterman and Reingold 1991). The network visualizations were rendered with node sizes corresponding

to degree centrality to identify actors who had a greater ability to influence the network.

Results

The results are divided by case and by phase in the project process: initializing phase, phase 1 and phase 2. The main themes found in the coding phase (initial phase, project identification, perception of actors, sharing resources, co-location and ties) are further highlighted in the text.

Case Bilateral

Initializing phase

The client had already selected the governance model based on the expected complexity of the project and based the tender procedure on this. The main contractor was selected based on the estimation in their tender of the total target construction costs, as well as proven collaboration and teamwork within their appointed project team in the development phase. In Case Bilateral, the contractor had formed a team of their anticipated subcontractors, which collaboratively developed the tender proposal that was later accepted by the client. This team consisted of several engineer design firms and subcontractor firms and many of them had worked together previously. This team was seen as a well-functioning and collaborative entity by the team participants.

Phase 1

Phase 1 was commonly viewed as a phase for predesign and development as well as determining the budget price, where the ideal project process included deep involvement from all project actors. This was perceived to be facilitated by shared project spaces and tools (*sharing resources*).

The project was organized around a bilateral contract between the client and the contractor, while the contractor had separate contracts with their subcontractors. As the design work was subcontracted through the contractor, the design engineers viewed themselves as a part of the contractor's organization and the project as a traditional project (*project identification)*.

The design engineers were primarily seated at their home organization and came to the project office mainly for meetings. The contractor and the team they had formed during the initializing phase continued with the same organization, using shared tools and project spaces, provided by the client. The client also joined the shared co-located project space, but their seating arrangement occupied a separate space apart from the contractor's team, which influenced the other actors' attitude towards the client: "*There were a lot of discussions about that [seating choice] and we thought that 'Yes, but that—we cannot work like that', but so it was*", as a design engineer put it (*co-location*).

For all actors, the phase was marked by discussions related to the target price as well as conflicts associated with the understanding of the project process. The relationship between the two main actors of client and contractor was in this phase characterized to a large extent by a discussion regarding the target price for phase 2.

The two actors perceived phase 1 and the outcome of phase 1 differently. For the client, "*the delivery of phase 1 is mainly to produce the documents in order to be able to set the correct target costs*". For the contractor, the phase "*is very much about obtaining the deal for phase 2, simply put. Partly towards the [client], to define the project and set a price for the project, but also of course internally towards [the contractor]. We need to get a decent deal. So, there was a lot there: create the project, create the business*" (*project identification; perception of actors*).

The client and contractor actors also had different expectations of each other's roles where both actors had hoped for more collaboration. The client stated the following: "*[The project delivery process] was not as we expected it to be. Either we [the client] have been very bad at explaining that what it was we wanted out of this, or for some reason, the contractor did not interpret it as we expected them to*". The contractor on the other hand had expected proactive engagement from the client in phase 1. The lack of collaboration and attitude towards other actors was also seen in low levels of trust. "*Being open and honest means building trust. So, when you have a long period of denial, or self-censorship in … where there is no openness at all, then it is clear that something happens in the relationship*", as the collaboration coordinator stated (*perception of other actors*).

The phase ended in a drawn-out discussion regarding the target price, delaying the start of phase 2 with approximately nine months. Strong negative ties formed between the actors based on mismatched expectations of the results of phase 1, of diverse expectations of the role of the client as well as the contractor, which contributed to disagreements related to the target price.

Phase 2

The perception of phase 2 depended on the respondent's role: Client representatives saw the phase as a

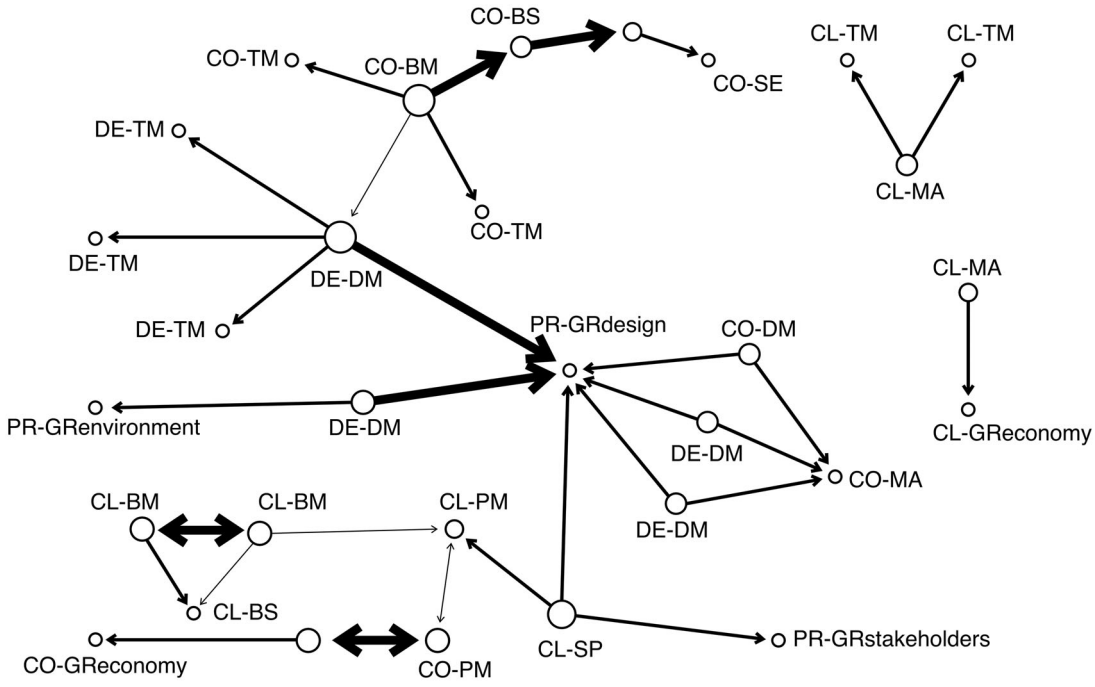

Figure 1. Fruchterman-Reingold visualization of the project network in case Bilateral.

continuation of phase 1, while contractor representatives viewed it as a separate phase. Even though the ECI contract of phase 2 was managed through a bilateral contract between the client and the main contractor who then subcontracted all other work, the phase was perceived more like a traditional design-and-build project, with actors taking on familiar roles: "*In Phase 2, it was more of a traditional design and build contract*" (client representative) and "*right now we are probably in this traditional role that I am used to*" (collaboration coordinator). The contract was based on industry standards and followed a traditional division of responsibilities, with references to collaboration. This was seen as part of the root cause of confusion in regard to the project process, as there were uncertainties related to the new, collaborative roles and demands placed on the actors. The client and contractor views furthermore differed with regard to the division of responsibilities between the phases. This uncertainty led to the actors reverting back to familiar roles, since "*you want to build as you've always built, in a way*", as one respondent said (*perception of actors)*.

The changes towards more traditional roles could also be observed in the shared project space. The project office had separate meeting rooms for the client and the contractor and there was little social exchange over coffee or lunch breaks. When asked about their closest co-workers (ties), there was a clear separation between the actors, as each organization mainly worked within their home organization's boundaries, with a few connection points between the different organizations. Respondents also often talked about the project organization and their home organization in unconnected terms (ties).

The perception of the project also varied between respondents: "*It is quite a bad working environment. It is – I have probably not been on anything worse [laughs], just with how– what treatment you get. Like… mistrust, questioning, harsh controls, there are nasty comments,*" according to a design manager from the design engineer, while a design manager from the contractor stated that "*90% of the project works, it's just the other 10% that we complain about*" (*perception of actors).*

The lack of collaboration was also seen in a lack of resource sharing. On the block level, individuals kept within their own project organization and did not talk to people from the other construction blocks. There was also little sharing of resources outside the contractually specified project process between the client and contractor. There was, for example, a ban on partaking in social gatherings where the contractor offered refreshments, as this went against the client's home organization's guidelines (*resource sharing).*

The other actors in the network, like the design engineer firms and subcontractors, were all subcontractors and perceived the main contractor as their client, and these actors did not interact with the main public project client (*project identification).*

The social network is presented in Figure 1. The thickness of the lines is based on reported tie strength, with the thickest lines representing the strongest ties. The direction of the arrows shows the directionality of the tie. The unweighted network density was 0.037. However, the network was disconnected, as two subgroups were not connected to the main network.

The social ties were weak, and respondents identified few bridging ties between organizations or role-based groups such as the design team. The main connecting ties, as identified by respondents, were state ties (relationships and contracts) and event ties in the form of meetings and e-mail exchanges. The main link between actors was the contract, which respondents from all actor organizations referred to.

Case Multiparty

Initializing phase

In Case Multiparty, the design engineer formed a pre-project team and started the planning of the project organization with the client before the contractor was chosen due to the client's procurement process. The involved people started designing the project organization and the project process. After approximately two months, the chosen contractor and their representatives joined the initializing phase.

Phase 1

Phase 1 was commonly viewed as a phase for pre-design and development as well as determining the budget price, where the ideal project process included deep involvement from all project actors. This was perceived to be facilitated by shared project spaces and tools, as all main actors were seated in the same shared project office for a pre-determined amount of time each week (*sharing resources; co-location*).

The project was governed through a multiparty contract. The late inclusion of the contractor, as well as a general lack of contractor resources, were perceived by many of the respondents as having a negative impact on the anticipated benefits of the CPDM employed in this phase. A client respondent exemplified this with "*It probably turned out to be the wrong decision in the way that– because we had fewer builder resources available – it didn't allow for such a comprehensive design-builder collaboration as probably would have been needed to really reap the benefits from it*" (*project identification*; *perception of actors*). The phase ended with the client organizations deciding on the continuation of the project. The decisions were made in the home organizations of the clients, where the discussion regarding the target price delayed the decision-making, resulting in a postponement of the start of phase 2 of approximately three to four months.

There were positive ties between the actors, although some tension related to the lack of contractor personnel and their late inclusion in the phase remained. The project also changed its project manager at the end of phase 1. This was seen as having an impact on both the project organization and the start of phase 2, through both the new leadership style and the organizational change necessary for the changing circumstances of moving from planning and design to construction.

Phase 2

In Case Multiparty, phase 2 was regarded as a continuation of phase 1 and the projected climate was good, although there were some conflicts related to different ways of working between the designers and the contractors. The participating actors were all part of the same multi-party contract and the respondents focussed on the project organisation. Few respondents referred to the contract, and those that did were in managerial positions. The project process exhibited communication across organisational boundaries, high levels of trust, and a focus on the project's goals instead of the individual actors' goals.

The client organization was small and was involved in the project on a daily basis. The client representatives saw their role as facilitating the daily workings of the project, such as managing office supplies, as well as ensuring good contact with their home organizations and stakeholder management.

The contractor organization formed the main part of the project organization in phase 2 and was seated both at the project office and the block offices, as construction had begun. They saw their role as building the project, which was corroborated by the other actors.

The design engineers were seated at the project office and visited the block offices regularly. They saw their role as ensuring sufficient specifications and plans for the project. They were also part of a conflict that arose in the project between the design engineers and the contractors. There was some delay in the planning process that designers and contractors were disagreeing about. The contractors were upset with the designers as they had missed scheduled deadlines for delivering plans, while the designers saw the plans as unfinished and would have needed more

input from the contractors to develop them further (*perception of actors),*

The shared office space had been separated into the main office and block offices as the construction phase started. The utilization of the spaces was active, although there were some worries related to the lack of presence of design engineer representatives at the block offices. According to the design engineers, this was due to the lack of IT infrastructure at the block offices, which hindered their work. The actor representatives were seated according to their main area of responsibility: the client's project manager was seated close to the contractor's corresponding person, while people involved in detailed planning were seated close to the design engineers and were visiting the block offices. The project office was further divided according to project roles with designated places for those most involved in the project and 'open spaces' for occasional visitors (*co-location*).

Regular information gatherings and weekly steering group meetings were held in the common areas in the project office, with the goal of facilitating open information flow. There was a significant social exchange during lunch and coffee breaks, as well as through social recreation groups outside work hours. When asked about their closest co-workers, there was some clustering according to the respondent's role and home organization, but there were multiple points of contact over both organizational and role-based boundaries. According to respondents, the division of tasks was based mainly on ability, within certain parameters, and, for example, a person's vacation deputy could thus be from another organization (*perception of actors*; *co-location*).

Perception of and attitude towards other actors had improved when construction started, according to respondents: all actor groups mentioned the importance of daily interaction in building a common understanding and appreciation of the other's work. As one interviewee said, "*When you work and go through enough together, you see that the other part also knows their stuff and then you don't have to worry so much about things that you might not understand so well yourself*" (*perception of actors*).

The level of trust was also improving throughout the project process according to the respondents, which was seen as a prerequisite for successful collaboration in a multi-party project network. According to a design coordinator, the level of trust had "*improved all the time. It is born from the long haul, and in the beginning, there were a lot of problems and little by little, this situation has improved.*" According to the collaboration coordinator, "*It is good to know and get to know each other, other than in the workplace. It increases trustbuilding*". "*Trust is the alpha and omega of everything [in collaboration],*" a specialist from the contractor said. And as a manager from the contractor stated, "*You just have to trust [in the process]. Usually, if there's a problem, the information will come, and the problem will be dealt with*".

Resources were also shared to a degree. The project organization was built with resource sharing in mind, but there were some difficulties on the designer side due to actor-specific tools and processes. Sharing of resources, such as planning competencies and knowledge, seemed a bit easier on the contractor side, as the tasks were seen as easier to exchange (*resource sharing*).

The network is presented in Figure 2. The thickness of the lines is based on reported tie strength, with the thickest lines representing the strongest ties. The direction of the arrows shows the directionality of the tie. The unweighted network density was 0.052. The network was connected.

The social ties were strong, and respondents identified multiple bridging ties between organizations or role-based groups such as the design team. The main connecting ties, as identified by respondents, were state ties (of contracts and relationships) and event ties in the form of meetings and social events, which were both planned and happened spontaneously at the project office, via e-mail exchanges, on instant messaging/communication platforms and at social events. There were multiple social ties between actors and individuals. The main link between actors was social ties. The main findings of both cases are presented in Table 5.

Discussion

In the broader sense of construction project management, our findings contribute to the understanding of social networks in the construction industry, as discussed previously by e.g. Pryke et al. (2017), Adami and Verschoore (2018) and Loosemore et al. (2020). While social and project network frameworks have been increasing in popularity in the research community (Pryke 2005, 2012, Zheng *et al.* 2016, Papadonikolaki *et al.* 2017, Pryke *et al.* 2017), there have also been more calls for qualitative approaches to the area (see e.g. Loosemore *et al.* 2020). While the current literature gives us valuable insights into the procurement stage and contractual aspects of CPDMs, our findings show that the social ties that

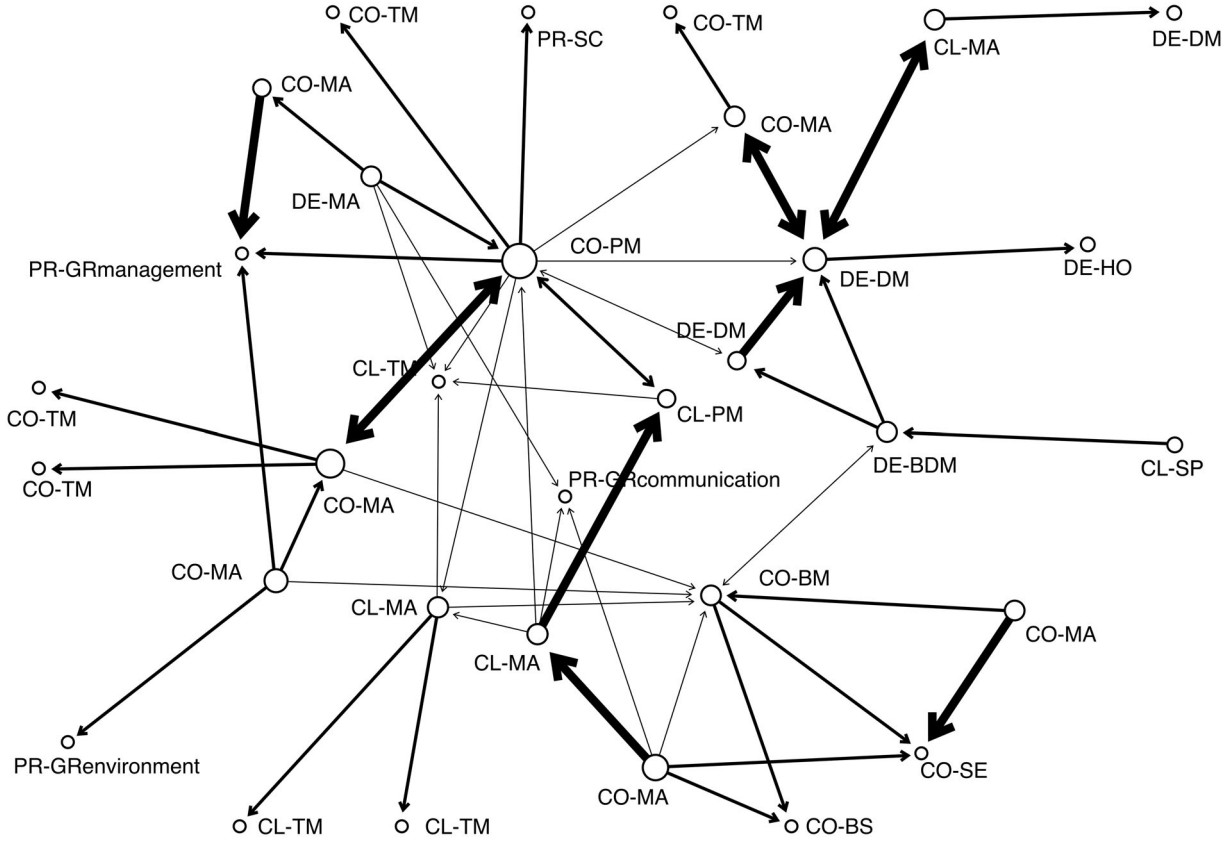

Figure 2. Fruchterman-Reingold visualization of the project network in case Multiparty. In order to ensure readability, tables and figures are provided as separate files.

Table 5. Empirical findings.

	Relationship	State ties: contract	State ties: relationship	Event ties
Bilateral Phase 1	client – contractor	Bilateral contract – ECI	Close – Negative Informal ties; different expectations/perceptions	Meetings; e-mail; project office
	contractor – design engineer/subcontractor	Bilateral contract	Close – Positive informal ties	Meetings; e-mail
	design engineer – client	none	Few to no informal ties – go via contractor	Meetings; e-mail; project office; communication platform
Bilateral phase 2	client – contractor	Bilateral – ECI	Close – Negative to neutral Informal ties; change towards a traditional project relationship	Meetings; e-mail; project office
	contractor – design engineer/subcontractor	Bilateral contract	Close – Positive informal ties	Meetings; e-mail
	design engineer – client	none	Few to no informal ties – go via contractor	Meetings; e-mail; project office; communication platform
Multiparty phase 1	client – design engineer – contractor	Alliance	Positive informal ties (exclusion of the contractor delayed the formation of a social network and the bonds necessary for knowledge development, trust-building and resource sharing	Meetings; e-mail; project office; communication platform
Multiparty phase 2	client – design engineer – contractor	Alliance	Positive informal ties – some differences in expectations between contractor and design engineering firms.	Meetings; e-mail; project office; communication platform

are created in the project network, based on the project organisation that starts to grow from the initialising phase ("phase 0") and nurtured by the active use of a co-location "big room", impact actors' perceptions of other actors' roles and responsibilities and the extent to which sharing activities take place.

Aspects affecting social ties for collaboration

From the data, we found that a number of aspects influence the development of social ties between the network actors. The state tie of the formal contract has implications for the development of formal social ties (Adami and Verschoore 2018). However, a number of other elements influence the development of informal ties supporting collaboration between the actors: the initial setup and project identification, sharing of resources, shared space and perception of each other's roles and responsibilities.

Initial setup and project identification: Following the literature (Adami and Verschoore 2018, Pryke *et al.* 2018) the initial set-up of the project organization shaped the project network in the early phases of the project process. It is also in the initial phases that the delivery method selected is finalized and put into action by the client, which has implications on the contract in phases 1 and 2. In both projects, initial difficulties in involving all three actors led to conflict later in the project process, thus weakening social embeddedness and collaboration. Another factor contributing to collaboration in CPDM, is actor commitment to the project and identification towards the project. The realisation for desired networks seems to be dependent on the level of actor identification with the project and the stated goal of applying a CPDM. In Case Bilateral, few respondents identified with the project organisation; rather, they identified more with their home organisation. The project network was thus not what was expected when the project was procured, although it followed the contract structure. In Case Multiparty, the respondents talked about the project as a CPDM and identified with the project organization. The organization followed the contract and desired project network. The project network was also denser in Case Multiparty than in Bilateral, reflecting closer ties between actors.

Perception of actors: The perception of actors of other actors' roles and responsibilities, and even their behaviour, became relevant in both cases and is also discussed in relation to the social ties literature (Adami and Verschoore 2018). In Case Bilateral, the actors had ambiguous perceptions of each other's roles and responsibilities which had implications for the project, and project members returned to their traditional roles. In Case Multiparty, network actors clearly stated that they had changed their perceptions of the different roles and responsibilities and that these perceptions developed over time into a reformed interpretation of the different actors' roles.

Sharing of resources: The sharing of resources was another aspect highlighting the social embeddedness of the project network. In Case Bilateral, resources were hardly shared, partly due to policies and guidelines from the home organizations which made it more difficult to create a shared identity. The lack of social ties also contributed to the lack of sharing, as there were clear boundaries between actors within the cluster formed by the contractor's subcontractors regarding responsibilities, as well as a lack of trust due to diverging views on the contract between the client and the contractor. In Case Multiparty, resources were shared across organizational boundaries and the unitary view of the project process enabled a concerted effort to reach the project goal. There were, however, some problems related to sharing resources between the design engineer organizations, due to the use of different technical tools and standards, which was seen as a challenge. Sharing resources is often perceived as one of the examples of embedded relationships (Lahdenperä 2012, Bygballe and Swärd 2019).

Co-location: In the CPDM literature, the usage of a shared project office, often balled a "big room", is repeatedly mentioned as a factor contributing to collaboration, due to the spontaneous meetings and communication opportunities (event ties) it enables (Eriksson *et al.* 2017). Both cases had organized shared office space. However, when contrasting these cases, we find that merely the presence of shared space is not enough to support collaboration or the development of social ties. In Case Bilateral, the project had organized co-located office space, but actors of the different organizations were seated in separate rooms and had their own meeting rooms. The contractor and the client were furthermore the only ones to be permanently at the space, as the design engineers were mainly working from their home organization and spent time in the shared office only during meetings. In Case Multiparty, meanwhile, the co-located space was in active use and actors were seated close to those persons they interacted with the most . Both cases thus had shared space, but only one of them managed to utilize it to create social ties between individuals. The usage of a shared space for CPDM is

not commonly discussed in the literature but becomes relevant when examining the level of social ties between the different network actors.

The abovementioned aspects affect the development of social ties but also reinforce the development either positively or negatively as seen in the two empirical cases.

The role of social ties in CPDM

The literature on CPDM, although focussed on the procurement phase, emphasises the non-contractual mechanisms of the models (Lahdenperä 2012, Chen *et al.* 2018, Bygballe and Swärd 2019) and the early involvement of client, contractor and design engineer in the project process. High levels of collaboration, as introduced through the use of CPDMs, are expected to improve project outcomes (Bygballe *et al.* 2010, Lahdenperä 2012). These models are the foundation for temporal project networks of interdependent actors, based on the project organisation (van Fenema *et al.* 2016, Adami and Verschoore 2018). While CPDMs, and especially aspects related to the procurement and governance of such models (Bygballe *et al.* 2010, Lahdenperä 2012), are well-known in the literature, less research has been conducted on how social ties shape the CPDM and which elements impact the development of social ties in CPDMs. We find that a high level of social ties is more likely to induce collaboration and adherence to the chosen CPDM, while low levels of social ties seem to lead to a retreat to more traditional roles.

From the data, we found that as a project progresses, the ties between actors start to shape the project network. Project governance is based on both formal ties, such as contracts (Adami and Verschoore 2018) and project organization, but also on informal, social ties (Chen *et al.* 2018, Pryke *et al.* 2018). Formal ties impact the collaboration within the project network and the organization in the initial phases, while the influence of informal ties begins at the later phases, during project delivery. This is partly due to the time it takes for relationships to grow, but also due to the level of embeddedness of social ties.

The formal, contractual ties seem to affect the project network to differing degrees, although the largest impact is in the initial phases of the project. In Case Bilateral, the contract was brought up by representatives of all actors, although they held somewhat differing views on it. The client representatives focussed on the desired CPDM, while the contractor representatives viewed the project as a design-and-build project. In Case Multiparty, however, almost no-one outside of the project management team reflected upon the contract. Respondents in managerial roles only brought it up to discuss the multi-party aspect of it. This implies that the formal contract tie thus has an impact on the project process but that its impact lessens during the project process if there is a sufficient common understanding of the project goals and model. 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). This, according to the literature (Wood and Gray 1991), facilitates commitment and trust which "builds the basis for higher-order knowledge-sharing and collaborative routines" (Nell and Andersson 2012, p. 1088) which are essential for the formation of informal ties. In a project with a low level of shared understanding regarding the formal tie, as happened in Case Bilateral, the foundation for subsequent informal ties is lacking, and their formation becomes difficult.

There is also a need to look closer at the social tie of information exchange, as CPDMs are based on trust (Lahdenperä 2012) and depend on a high level of collaboration, which in turn relies on close social ties (Wood and Gray 1991). In Case Bilateral, the weak informal ties did not contribute to the expected benefits of utilizing a CPDM, e.g. shared knowledge or resources. The network structure was also dispersed (see Figure 1), with few links connecting actors or roles. This led to conflict and a return to traditional arms-length relationships among the actors. This could, as discussed in connection with formal contractual ties, be the result of low levels of contractual ties. In Case Multiparty, there was a common view of the contract and what it entailed, and consequently highly embedded informal ties were cultivated.

High levels of social ties help build trust and collaboration within a project network (Nell and Andersson 2012) and facilitate the shift of actor focus from individual short-term gains to long-term relationships and project goals (Uzzi 1996). Formal relationships, such as contracts, are codified and agreed upon by actors, becoming embedded in the fabric of the network, although the individuals involved in the project have not yet had the possibility to develop social ties with one another. A highly embedded formal tie is accepted in both letter and spirit by project actors and individuals in the project, as seen in Case Multiparty. A formal tie with low embeddedness is

accepted only in the letter, as seen in Case Bilateral. Informal ties, such as communication channels and social relationships, require resources. Individuals involved in the project have to actively engage in creating highly embedded informal ties, which was also seen as an essential condition for CPDM to succeed. The conflicts in phase 1 in Case Bilateral prohibited the formation of strong informal ties, or social bonds, between the individuals engaged in the project. This, coupled with the traditional contract form used in phase 2, led actors to fall back on traditional patterns and arms-length relations. In Case Multiparty, the conflicts in phase 1 were mainly dealt with during this phase and a common understanding of the contract as well as project goals enabled the formation of highly embedded informal relationships between individuals. This, in turn, led to trust and resource sharing, key conditions for a successful implementation of CPDM, and a unified view among project actors of the project.

In line with Granovetter (1973), we would further argue that highly embedded relationships and social ties can be viewed as strong ties. The strength of ties relates not only to linking separate networks together but also to the flows within a network. The development of social ties is thus connected to both state and event ties, embeddedness of relations, contributing to project network theory and our understanding of the role of ties.

Our contribution relates to the role of ties in a social network formed around a construction project and the construction management literature on collaboration in general and CPDMs in particular, showing the relevance of not only focussing on the contract but considering different ties —social ties— to understand collaboration in such projects.

Managerial implications

The management of complex projects requires sharing knowledge and resources, as well as trust and collaboration (Bygballe and Swärd 2019). The insight into 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. Attention in this area facilitates the creation of a functional CPDM as well as the development of social ties, lessening the risk of falling back on traditional arms-length relations.

Conclusion

The question guiding this research was the following: *What is the role of social ties in projects using a relational project delivery model*? In answering the calls for further research into the relationships in project networks and for a greater understanding of collaborative project models, we contribute to the field of project network theory and extend the knowledge of the role of social ties. Although the existing literature discusses the governance model and the formal contractual relationship between the organizations participating in the project, previous research has neglected the role of social ties between individuals. Our results revealed differences in how the CPDMs are implemented in the two cases under study, leading to differing levels of social ties in the project networks. The results also show aspects that influence the development of social ties, including the initial setup and project identification, resource sharing, shared space, and expectations of actors' roles. The degree of embeddedness was related to the shared use of resources and cooperation, as well as the adaption to novel forms of project organizations and the resulting networks. The formal ties are strongest at the beginning of the process and are a prerequisite for the formation of informal ties later on.

As our results indicate, the interplay between the formal and informal social ties becomes relevant for collaboration in a project network and highlight the role of social ties as well as their influence on collaboration within a project network employing a CPDM model, showing the relevance of not only focussing on the contract but also taking into account different actors and social ties to understand collaboration in such projects.

Limitations of the study are twofold; firstly, that we examined only two CPDM projects in a Nordic context andsecondly, that we focused primarily on qualitative methods. Since the selected cases of this study were both in Nordic countries which share a relatively similar working culture, future work could focus on the project networks of CPDM projects in geographically different and culturally dissimilar places. Furthermore, it would be useful to study actors' role transitions through multiple case studies and use quantitative means. Finally, it would be relevant to study how different types of network ties, such as project meetings,

enable or constrict embeddedness in CPDMs, as well as longitudinal changes in the network.

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