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Analysing the stakeholder networks in collaborative project using network theory: implications for coordination and control

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Abstract: Our article aims to investigate network relationships from the perspective of a network of stakeholders involved in a complex and dynamic environment. We adopt the social network analysis approach to explore the structural characteristics of different types of networks and their implications in terms of the coordination and control of project stakeholders. A large hospital construction project in northern Finland was analysed in terms of structural characteristics, associated complexities, and the dynamics of different types (contractual, supply, information) of network relationships. We adopted the mixed methods approach by complementing quantitative research with qualitative research methods. Our findings show how different types of networks in projects influence the coordination and control of project stakeholders. Project management needs to intentionally consider managerial actions along the networks in question. Our study relates different theoretical perspectives to the networks of project stakeholders and their relationships, which constitute our main contribution.

Keywords: stakeholder networks; collaborative project; network theory; network relationships; construction project; social network analysis; SNA; coordination; control; mixed methods approach.

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1 Introduction

The relationship approach to project stakeholder management has been proposed by various scholars (Loosemore et al., 2020). This approach focuses on the relational aspects of project stakeholders, i.e., actors and their behaviours (Pryke et al., 2017). It adopts a social network perspective on construction projects as a network of stakeholders in a complex environment (Pryke, 2004, 2005) characterised by multiple types of network relationships i.e., contractual, supply, and information (Adami and Verschoore, 2018). Traditionally project relationships are described with a diagram where key stakeholders are linked with lines representing contractual relationships; however, this partial view does not reflect the complexity and dynamics of those relationships (Pryke and Smyth, 2006) in various project stages over the life cycle of a project (Loosemore et al., 2020). This relationship-based approach of stakeholder management in construction projects is evident in collaborative projects (i.e., project partnering and project alliancing) where project stakeholders work together with the spirit of achieving the mutual project goals through cooperation, early integration, coordination, trust, and risk sharing (Saukko et al., 2019; Le et al., 2022).

Hospital construction project (project) stakeholders typically include individuals, groups, owner organisations (permanent) and project organisations (temporary) who have an interest and can affect or are affected by the project (Brugha and Varvasovszky, 2000; Aaltonen et al., 2010; Sergeeva, 2019; Ershadi et al., 2021). The development of social network theory and the related network analysis in the construction industry are driven by the complexity of the temporary project network embedded in their permanent organisation network (Pryke et al., 2017). By having specific objectives delivered by the stakeholders through interdependencies of formal and informal relationships (Chowdhury et al., 2011; Li et al., 2011). These complexities of construction projects demand better coordination and control of project stakeholders (Whyte and Lobo, 2010; Yao et al., 2021).

Social network analysis (SNA) facilitates the study of the structural characteristics of stakeholders' relationships and the graphical and mathematical representations of these relationships (Adami and Verschoore, 2018). From this perspective, the focus is always on the network structure, its characteristics, associated complexities, and dynamics rather than the individual dyadic relationships among stakeholders. Kim et al. (2011) adopted this perspective by applying SNA to supply networks of the automotive industry to understand the structural characteristics and complexities of these networks. Li et al. (2020) argue that network characteristics can lead to a better understanding of supply-chain resilience. Pryke (2005) and Pryke et al. (2017) supports the application of SNA to capture the complexity of construction projects in terms of inter-organisational relationships and governance.

The focus of previous studies from this perspective has been on different aspects, such as the structural properties – density and centrality – of a network in relation to comparing different procurement approaches (Pryke, 2005, 2012), or explored a particular procurement approach in terms of structural characteristics by using detailed SNA metrics (Chowdhury et al., 2011). Other aspect of the network theory perspective focuses on the issue rather than firm or organisation centred (Frooman, 2010), or issues related to value co-creation in a network (Tóth et al., 2018), managing inter-organisational innovation networks (Cap et al., 2019), and relational patterns in project networks (Liu et al., 2021).

These studies considered network relationships associated with different supply chains, but did not distinguish the relationships that represented better coordination and control of complex project networks (Adami and Verschoore, 2018), especially for collaborative projects. These studies focus on structural properties at the actor (stakeholder) and network (project) levels. There was less focus on stakeholder relationships that transform into different types of network depending on the complexity of the project and the related interdependencies of project stakeholders. As different types of network relationships influence organisational communications (Ershadi et al., 2021) between permanent and temporary project organisations. More empirical research is needed to explore the project networks in different construction project contexts especially the collaborative hospital construction projects due to the multiplicity of stakeholders' involvement (Larsen et al., 2021b) as limited efforts have been made to study these projects (Larsen et al., 2021a) from this perspective. Therefore, our purpose is to investigate the structure of collaborative project networks and their types through the application of SNA metrics and discuss the theoretical interpretations of SNA metrics for network relationships and their implications for the coordination and control of project stakeholders. To fulfil our purpose, we generated the following research questions:

RQ1 What is the structure of the collaborative project networks, their types, and the position of stakeholders in the network?

RQ2 What are the implications of stakeholder network relationships for the coordination and control of project stakeholders?

To address our research questions, we adopted the mixed methods research approach (Creswell, 2009) by combining quantitative and qualitative approaches for data collection, analysis and reasoning. Our case context is a large hospital construction project comprised of two contractually separate alliance subprojects in northern Finland. After this introduction, the second section of this article presents the theoretical background in detail along with a theoretical framework forming the foundation for this study. The third section explains the research methodology adopted in this study. In the fourth section, findings related to project network structure and stakeholders' position are described (RQ1), and then these findings are discussed in relation to theoretical interpretations and implications of stakeholder network relationships (RQ2). Finally, the fifth section concludes the main contributions, managerial implications, limitations and future research suggestions.

2 Theoretical background

2.1 Stakeholder social network perspective

The concept of the stakeholder emerged in the mid-1980s and was defined as an individual or a group who can affect or be affected by the organisation (Freeman, 1984). Two years later, stakeholder thinking was introduced in the project management paradigm and emphasised the importance of project stakeholders and efficient management of their relationships regarding a project (Cleland, 1986). The development of stakeholder theory has concentrated either on the core concept of a stakeholder or classifying stakeholders into different groups to propose an understanding of their individual relationships (Donaldson, 1995) and how they influence focal organisations (Rowley, 1997) and the exchange of value between a focal organisation and stakeholders (Harrison et al., 2019). However, Rowley (1997) argues that a comprehensive theory requires not only an explanation of how stakeholders influence organisations but also how organisations influence stakeholders and respond to their demands.

To describe how organisations interact with stakeholders, one must consider the environment within which multiple and interdependent stakeholder relationships exist (Demir et al., 2015; Rajablu et al., 2017), and one approach for understanding stakeholders' environment is through the concept of social network theory (Rowley, 1997). Complex and uncertain stakeholder environments create a variety of challenges for projects, and to reduce such challenges, a project manager conducts stakeholder analysis to build up interpretations and a big picture of the stakeholder environment to ensure informed and careful decision making in the project (Aaltonen, 2011). The project management literature has not defined the concept of project stakeholder environment properly (Artto et al., 2008; Martinsuo and Lehtonen, 2009). Aaltonen (2011) defines the project stakeholder environment as the relationship network of all organisations that can affect or can be affected by the project.

A network of relationships has not only dyadic ties between a focal organisation and stakeholders, but stakeholders may have direct relationships with each other, so a network consists of multiple patterns of relationships (Rowley, 1997). According to Pryke (2004), all organisations are social networks, and they are suspended in complex webs of relationships, and it is unlikely to see the overall pattern from the perspective of one organisation. In Rowley's (1997) study, the density of the stakeholder network and the centrality of the focal organisation are considered important factors in managing relationships among stakeholders. Accordingly, Aaltonen and Kujala (2016) state that as the number of relationships increases, a network becomes denser, and it becomes challenging for the focal organisation to resist pressures from the stakeholders, and because of the shared expectations of the stakeholders, they are more likely to form coalitions. However, a denser network creates more challenges in terms of managing stakeholders if the goals of the stakeholders are not aligned with the project goal, but if the dense network is formed by the alliance partners with aligned goals, then it is helpful in achieving the project objectives and managing stakeholders (Aaltonen et al., 2010).

Moreover, the interdependencies between stakeholders in terms of information exchange and their concerns contribute to project complexities (Mok et al., 2017), and it is crucial to consider its implications for stakeholder management (Mok et al., 2015; Ershadi et al., 2021). Aaltonen and Kujala (2016) argue that patterns of relationships among stakeholders appear based on the centrality of organisations, which is defined by Rowley (1997) as the number of direct ties a stakeholder has in the network, based on which it occupies an important and influential position in the network. The presence of central stakeholders in the project network can lead to either shared project goals or diverging project goals due to their influential position, which depends on the adopted project delivery method, network dynamics, and environmental changes (Pryke, 2004; Clegg et al., 2016; Loosemore et al., 2020).

2.2 Coordination and control of project networks through SNA

Social networks and their analysis have roots in sociology, anthropology, psychology and graph theory, but over time, they have developed and emerged into an interdisciplinary field (Castells, 2000; Borgatti et al., 2009; Scott, 2017). It is a way of thinking about our social systems where the focus is on the relationships or ties among various stakeholders or nodes (individuals and collectives) and their characteristics (Borgatti et al., 2018). The concept of social network represents relationships among various stakeholders (i.e., individuals, groups and organisations) within an environment having different types (family and friendship ties, power, information and resource flows) and patterns of interactions (Scott, 2017). Kadushin (2012) states that there are different types and structures of networks, and they have different levels, such as networks at the organisational level, networks between professionals in different organisations and networks between individuals within an organisation.

From a structural perspective, a network has different properties at the node or stakeholder level and at the network or project level, such as degree and in-degree centrality are stakeholder-level properties, whereas density, centralisation and complexity are network-level properties (Kim et al., 2011; Adami and Verschoore, 2018). Degree centrality is the simplest measure of centrality for undirected networks in which the number of relationships (ties) a stakeholder has in any given network are measured. For instance, if the tie is a contractual relationship, then degree centrality is the number of contracts a stakeholder has in that network, which is seen as highly visible and important, whereas in-degree centrality is applied to directed networks to count the number of incoming ties (Borgatti et al., 2018). Thus, stakeholders with high degree centrality are associated with dominance over others, which means central stakeholder hold control and coordination power in the network (Todeva, 2006). Density is a network-level property that expresses the number of ties as a percentage of the maximum number of ties possible in the network (Borgatti et al., 2018), which reflects the overall interconnectedness of any network where a density of 1 represents all nodes being connected with each other (Scott, 2017). Centralisation is also a network-level property that is an extension of degree centrality and addresses the extent to which the authority or power in a network is concentrated or dispersed (Choi and Hong, 2002) or the extent to which a network is dominated by focal firms in terms of materials flow control and relationship management control (Kim et al., 2011). Complexity is another network-level property that arises from

the number and variety of subsystems and their varied goals present in an environment, or it can be defined as the number of dependency relationships within a network, such as the number of nodes and their degree of interconnectedness that require coordination (Choi and Hong, 2002; Adami and Verschoore, 2018). Core-periphery measures reveal the degree of complexity in terms of node classes and their level of dependency or equivalence pattern (Kim et al., 2011; Chowdhury et al., 2011; Borgatti et al., 2018).

Adami and Verschoore (2018) identified three types of network relationships – contractual, supply and information exchange – from the networks and projects literature. A contractual network refers to a group of companies linked through a contractual relationship (Kim et al., 2011). The contractual network is related to governance, as contracts between different companies or stakeholders are formal instruments of governance expressing the control of a stakeholder over other stakeholders in a project network (Pilbeam et al., 2012). Contractual arrangements and related incentive schemes have been considered a central element of project governance in the literature (Ruuska et al., 2011). In a project context, contractual arrangements involve several stakeholders interconnected through different contract types, related relationships (Winch, 2001, 2006), and allocation of risks (Lam et al., 2007). According to You et al. (2018), contractual provisions mainly serve three functions: control, coordination and adaptation. The control provisions include decision rights, restrictions, liquidated damages and dispute resolution (Weber et al., 2011; Gulati et al., 2012) to bring compliance and commitment to a desired outcome through the exercise of authority or power (Mellewigt et al., 2007). The provisions related to coordination include communication procedures and clear task descriptions and definitions to reduce task ambiguity and reach consensus to achieve a desired outcome (Argyres et al., 2007; Mellewigt et al., 2007; Gulati et al., 2012). The adaptation provisions are related to environmental uncertainty and related adjustments, such as price adjustments due to inflation and adverse weather (Luo, 2002; Zbaracki and Bergen, 2010).

The contractual network association with network-level properties reveals that high centralisation indicates disconnected relationships between stakeholders in a network, which leads to a lack of interactions between central and peripheral stakeholders (Kim et al., 2011). However, sometimes influential central stakeholders in a project network find a friendly way to interact and control the peripheral stakeholders (Adami and Verschoore, 2018). Choi and Hong (2002) state that contractual complexity is related to the number of relationships that require coordination, which relates to a higher number of formal interactions that lead to a slow decision-making process and higher coordination costs. On the other hand, Adami and Verschoore (2018) argue that the contractual network does not express the fullness of complexity in terms of relational coordination. The contractual network association with stakeholder-level properties indicates that the degree centrality reflects the extent of a stakeholder's influence on other stakeholders' behaviour and decision making in a project network (Ferguson et al., 2005; Cachon and Lariviere, 2005). Central stakeholders with a higher number of connections can impose greater influence over other stakeholders, and they act as coordinators or conflict resolver in a network (Kim et al., 2011). By contrast, Adami and Verschoore's (2018) findings suggest that contractual networks poorly capture the dynamics of influence and power, as there could be multiple central stakeholders present in a project network.

The supply network of services and goods is different from the contractual network because all relationships of supply are not specified in the formal contracts between organisations (buying companies); rather, the related group of suppliers is managed through the separate contracts and purchasing of buying companies (Choi and Krause, 2006). A supply network is a group of suppliers that exist upstream to any one organisation in the business network (Porter, 1985). Borgatti et al. (2013) argue that the supply network relates to the management and control of services and goods' transactions between suppliers and buyers in a project network. These transactions could also be viewed as relational events in which interactions are based on flows of intangibles (i.e., norms, attitudes, beliefs, etc.) and tangible items (goods or money) among stakeholders (Borgatti et al., 2018).

The supply network association with network-level properties reveals that a high supply network centralisation refers to higher control by the focal firms, which leads to higher complexity in terms of operational load borne by the flow of materials and their management (Kim et al., 2011). Adami and Verschoore (2018) argue that the supply networks of projects are considered complex because of their need for coordination and control rather than operational load. However, supply network association with stakeholder-level centrality reveals the buyers and suppliers in a network (Adami and Verschoore, 2018), where stakeholders with high in-degree centrality perform the role of integrator in a network to knit the outsourced materials and services into an integrated and coherent whole; basically, they have the task of coordinating the project supply-chain activities to achieve the desired project outcome (Parker and Anderson, 2002).

The information network is related to the flow of information among project stakeholders for routine activities and operations of the project (Pryke et al., 2017). Networks emerge in projects because of the different needs of stakeholders, such as gathering information from some stakeholders, processing it, and distributing it to other stakeholders (Pryke, 2012). In other words, the construction project can be viewed as a network of its stakeholders, in which different stakeholders have relationships, and based on those relationships, they exchange information (Milošević, 1989). Information network centralisation represents communication control by the central stakeholders and restrictions on information exchange among stakeholders in a network (Todeva, 2006). By contrast, according to Adami and Verschoore (2018), the centralisation of a project's information network is not related to communication restrictions; rather, it is related to the coordination procedures of the project. Pryke (2012) stated that high density in an information network represents the existence of informal exchanges, coordination and cooperation. Stakeholders with high degrees of centrality in the information network gain more influence and control over others irrespective of their formal relationships in the network (Adami and Verschoore, 2018), and they act as gatekeepers to filter and control the information flow or act as communicators to spread the required information (Pryke, 2012).

2.3 Collaborative project arrangements

Collaborative project arrangements such as project alliancing, integrated project delivery, and project partnering, have been around for some time in the construction industry (Lahdenperä, 2012; Halttula et al., 2015). In such arrangements, project stakeholders aim

to achieve the common project goals through integration, motivation, joint decision making, coordination, cooperation and collaboration to a varying degree depending on the adopted collaborative delivery method (Lahdenperä, 2012; Hietajärvi et al., 2017; Bohnstedt and Wandahl, 2019). Although these arrangements tend to evolve over time, and some practices have become common, there are still differences. Project alliancing focuses more on relational aspects and joint liability among alliance partners, as compared to integrated project delivery and project partnering. The key features of a project alliance include joint management structure, risk and opportunity sharing, no dispute mindset, unanimous decision making for the project's best, no blame culture, and open book documentation and reporting for transparency (Lahdenperä, 2012).

Hietajärvi et al. (2017) stated that inter-organisational integration is extremely important for project alliancing, as it develops cooperation among alliance partners that leads to a collaborative culture, which is a fundamental requirement for the success of a project alliance. Organisational integration is closely related to organisational coordination, which is a dynamic process instead of a static integration mechanism, such as a predefined and fixed information processing mechanism to be applied under certain situations. Coordination addresses how different stakeholders collectively accomplish their interdependent tasks; thus, coordination mechanisms are basically organisational arrangements (Okhuysen and Bechky, 2009). Alliance projects are characterised by a reciprocal model of interdependencies, such as having shared responsibilities rather than a traditional sequential model, and these shared responsibilities increase the complexity of the project organisation (Hietajärvi et al., 2017).

Coordination mechanisms are treated as activities as per the process view of coordination, and these activities are continuously created in a dynamic environment of social interactions, which indicates that there is no one best way to align organisational activities (Jarzabkowski et al., 2012). This is due to the fact that these mechanisms change during different phases of a project alliance (decision of project delivery model or strategy phase, procurement or selection phase, development phase, implementation phase, maintenance or defects correction phase) depending on the emergence of issues and unexpected events during different phases (Hietajärvi et al., 2017).

2.4 Theoretical framework

We synthesise the theoretical framework (Table 1) for the collection, analysis and interpretation of the data. It is synthesised based on the types of networks identified in the project networks literature and structural properties related to the networks at the stakeholder and network levels identified in both project networks literature and stakeholder social network perspective. The theoretical statements related to these network elements and properties were extracted from the relevant subsections of the theoretical background and placed in the relevant unit of the theoretical framework for testing that are driven from multiple related theories to obtain an in-depth understanding of the phenomenon.

Table 1 Theoretical framework for stakeholder network relationships in a collaborative project

		Stakeholder social network perspective	
	Network types	*Project alliance (network-level properties)*	*Key stakeholder/alliance partner (stakeholder-level properties)*
Coordination and control of project networks through SNA	Contractual	• High density network increase the ability of stakeholders to control or constrain the focal organisation's decisions (Rowley, 1997; Aaltonen and Kujala, 2016). • High centralisation indicates disconnected relationships, which leads to a lack of interactions between central and peripheral stakeholders (Kim et al., 2011). • Sometimes influential central stakeholders find a friendly way to interact and control the peripheral stakeholders (Adami and Verschoore, 2018) through inter-organisational integration (Hietajärvi et al., 2017). • Contractual networks express complexity in terms of relational coordination (Choi and Hong, 2002) which is limited to the formal relationships corresponding to the adopted delivery method (Adami and Verschoore, 2018). • High complexity associated with a reciprocal model of interdependencies such as having shared responsibilities in project alliance (Hietajärvi et al., 2017). • Contractual provisions serve control and coordination functions (You et al., 2018).	• High degree centrality correspond to the influential position of a stakeholder in a network (Rowley, 1997; Aaltonen and Kujala, 2016). • The control of a central stakeholder over other stakeholders in a project network (Pilbeam et al., 2012). • High degree centrality reflects the extent of an stakeholder's influence on other stakeholders' behaviour and decision making (Ferguson et al., 2005; Cachon and Lariviere, 2005). • Central stakeholders can impose greater influence over other stakeholders, and they act as coordinators or conflict resolver (Kim et al., 2011). • Contractual networks poorly capture the dynamics of influence and power of central stakeholders (Adami and Verschoore, 2018).
	Supply	• High in-degree centralisation refers to higher control by the focal firms which leads to higher complexity in terms of operational load born by the flow of materials and their management (Kim et al., 2011). • The supply networks of projects are considered complex because of their need for coordination and control rather than operational load (Adami and Verschoore, 2018).	• Stakeholders with high in-degree centrality perform the role of integrator, they have the task of coordinating the project supply-chain activities to achieve the desired project outcome (Parker and Anderson, 2002). • Stakeholder-level centrality reveals the buyers and suppliers in a network (Adami and Verschoore, 2018).
	Information	• High complexity associated with high interdependencies between stakeholders in terms of information exchange (Mok et al., 2017). • High centralisation represents the communication control by the central stakeholders and restrictions on the information exchange (Todeva, 2006). • High centralisation is not related to communication restrictions; rather, it is related to coordination procedures (Adami and Verschoore, 2018). • High density represents the existence of informal exchanges, coordination and cooperation (Pryke, 2012).	• High degree centrality is associated with dominance over others, that means hold control and coordination power in the network (Todeva, 2006). • Stakeholders with high degree centrality gain more influence and control over others, and they act as gatekeepers, to filter and control the information flow or act as communicators, to spread the required information (Pryke, 2012; Adami and Verschoore, 2018).

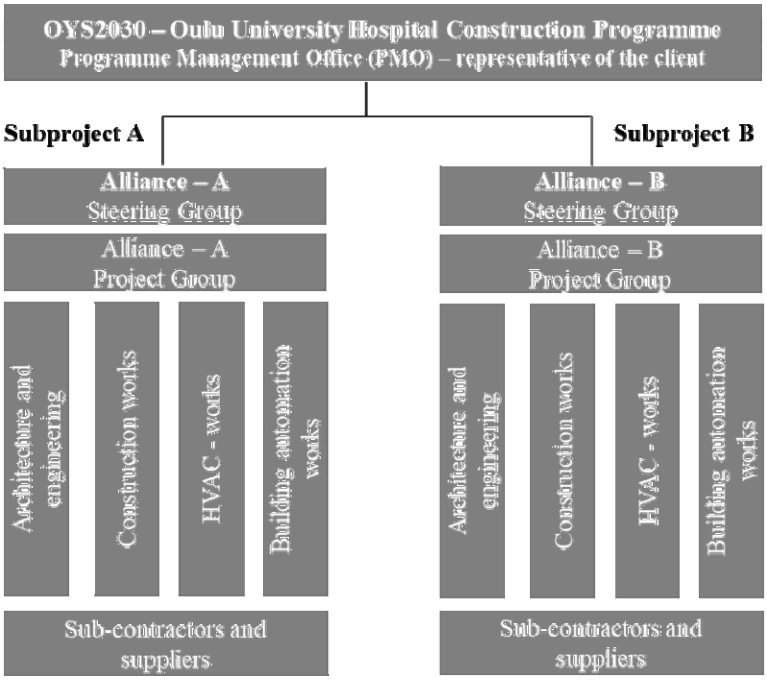
3 Research approach and methods

This is an empirical exploratory study to investigate stakeholder network relationships in project alliance networks using a mixed methods approach that includes quantitative and qualitative tools (Creswell, 2009; Kim et al., 2011; Adami and Verschoore, 2018; Peltokorpi et al., 2020) to deepen our understanding of the phenomenon. In the first step, we adopted a quantitative approach to implement the SNA to describe the project network structure and identify its important and influential stakeholders with snowball sampling (Borgatti et al., 2018). In the second step, SNA analysis was complemented with the qualitative data, which was collected through semi-structured interviews with the key stakeholders (alliance partners) to gain a complete and in-depth understanding of situations. The aim of this step was to complement the quantitative findings (Creswell, 2009) to validate the related theoretical statements listed in the theoretical framework. The empirical analysis findings were also tested and validated through the alliance contracts documentation to enable methodological and data triangulation (Creswell, 2009; Oyegoke, 2011; Peltokorpi et al., 2020).

3.1 Empirical context

Our study context is a hospital construction project comprised of two contractually separated alliance subprojects in which each alliance consists of several alliance partners, subcontractors and suppliers. The two alliance subprojects – Alliance A and Alliance B – are selected for comparative analysis to produce a more accurate understanding of the network relationships and their implications for coordination and control. This project is a new university hospital in Finland located in the Northern Ostrobothnia Hospital District (NOHD), which acts as a client in this project. The term 'client' has been defined as per different roles – owner, customer, partner, user or sponsor – often used to label it in construction projects (Denicol et al., 2021). In our study, this term represents the role of NOHD in the context of a university hospital construction project. The NOHD is an organisation owned by 29 municipalities located in northern Finland. An extensive and long-term Oulu University hospital construction programme (OYS 2030) was launched by NOHD in 2012. The goals of this programme are to improve the quality, productivity and cost efficiency of health services by replacing the old university hospital facilities with a new state-of-the-art university hospital. In addition to constructing new healthcare facilities, improving the operational processes, operating models and organisational structures based on a patient-centred approach are included as the aims of new hospital construction. Therefore, this type of project demands multi-discipline skills and the involvement of various stakeholders, including patients, medical operations management, medical staff, owners, contractors, designers, subcontractors and suppliers. These stakeholders require coordination among each other, the organisation of project activities and the control of activities according to the defined time and cost targets. The two subprojects for the construction of the university hospital facilities were launched in 2018; construction works started in mid-2019 and planned to be completed within five years (Figure 1).

Figure 1 Hospital construction programme organisation



The delivery method adopted in both subprojects is project alliancing. The execution of the subprojects involves the development and implementation phases. During the development phase, various professionals (non-medical and medical staff) along with a client representative, engineers and architects contributed to defining the requirements for the new university hospital. This phase also included the project planning and design, the development of the target cost and schedule, the agreement on risks, pain and gain sharing, and the development of the alliance partners. During the implementation phase, the project plans and agreed targets were being implemented by the alliance partners along with their subcontractors and suppliers, and they committed themselves to achieving the project targets collectively.

In these projects, risks are not allocated to project parties; rather, they are shared among the parties through the pain and gain model. The subcontracting strategy adopted on these projects is based on traditional lump sum or schedule of rates type arrangements; accordingly, subcontractors and suppliers were appointed. However, they were informed and guided about the rationale for the main project alliance model adopted on these subprojects. Accordingly, bonus schemes were introduced in some major subcontracts that are linked to the performance indicators, and if they achieve the desired performance, they get bonuses, which support the alliance philosophy adopted on these subprojects.

The subprojects are governed by the steering group of each alliance, where all decisions are made collectively and unanimously, while the day-to-day management of the subprojects is carried out by the project group of each alliance (Figure 1). The formation of the project group and its function is based on the best-for-project approach regardless of the members employed by which party.

Table 2 Respondents in the interviews of stakeholder relationships

Respondent	*Position*	*Stakeholder type*	*Role*	*Alliance*	*Label*
1	Project manager	Main contractor	Alliance project manager	A	NCCSO
2	Area manager	Main contractor	Construction works – a member of alliance steering group	A	NCCSO
3	Business director	HVAC contractor	HVAC works – a member of alliance steering group	A	ASOT
4	Managing director	Building Technology contractor	Building technologies – a member of alliance steering group	A	ASOM
5	Project manager	Main contractor	Alliance project manager	B	STO
6	Regional director	Main contractor	Construction works – a member of alliance steering group	B	STO
7	Business unit head	Automation contractor	Building automation – a member of alliance steering group	A and B	SOT
8	CEO	Architect	Main architect – a member of alliance steering group	A and B	ATO
9	CEO	Architect	Architect planning – a member of alliance steering group	A and B	LAO
10	CEO	Architect	Architect planning – a member of alliance steering group	A and B	UAO
11	Construction manager	Project management	Project Management – a member of alliance steering group	A and B	AIR
12	Business unit manager	Structural engineering	Engineering management – a member of alliance steering group	A and B	AIS
13	Business unit manager	HVAC design	HVAC design – a member of alliance steering group	A and B	GKO
14	Client representative	Client	Programme management office – a member of alliance steering group	A and B	CEU

3.2 Data collection and analysis

In the quantitative stage, the stakeholders, including the key alliance partners and other companies involved in the activities of each project alliance, were identified and delimited through the snowball sampling technique (Borgatti et al., 2018), in which a set of alliance partners were asked to identify other stakeholders involved in the project, and this process was repeated until saturation. When the list of all the stakeholders involved in the project was established, we excluded those who were not directly involved in the project activities, such as suppliers of raw materials and cleaning and food services. Accordingly, we identified 69 stakeholders in Alliance A, from which we considered 40 more relevant (Appendix 1), and 31 stakeholders out of 58 in Alliance B were considered as more relevant (Appendix 2) for this study.

Accordingly, we organised a Webropol survey for 40 stakeholders for Alliance A and 31 stakeholders for Alliance B. The survey contained a list of stakeholders working for each alliance, and each stakeholder was asked to indicate on the list according to the survey questionnaire. The survey questionnaire contains four questions.

1 Please indicate on the list which companies (stakeholders) are your suppliers?

2 Please indicate on the list which stakeholders are your buyers?

3 Please indicate on the list with which stakeholders do you have a formal agreement or contract?

4 Please indicate on the list with which stakeholders you exchange information for the project?

The data from the survey was used to generate adjacency matrices (Borgatti et al., 2018) for each alliance. These matrices were inserted into UCINET 6 software for SNA and sociogram preparation (Borgatti et al., 2002), which are diagrams representing the structure of project alliance networks and patterns of relationships among stakeholders. This software was selected due to its wide acceptance in academic research (Adami and Verschoore, 2018). The centrality of each stakeholder in the diagrams is reflected by the size of the squares representing the stakeholders. The larger the size of the square, the higher the degree centrality of that stakeholder in the network.

In the qualitative stage, we developed an interview guideline for semi-structured interviews (Clifford et al., 2016) based on the theoretical framework of this study to develop an in-depth understanding of the stakeholder relationships and validation of the theoretical statements. Interview respondents were selected based on their association with Alliances A and B. We interviewed 14 respondents (Table 2), with an average duration of 45 min. They were selected based on various roles they had in their respective alliances to obtain different perspectives on the phenomenon, and they were the most central stakeholders in their respective networks. The interview guideline was provided to the respondents in advance, and the guideline was prepared to give an idea of the scope of the interview to the respondents. Interview sessions were recorded, and each recorded interview was transcribed word by word into a word document. The original transcriptions were double-checked and edited to ensure their quality. Content analysis (Duriau et al., 2007; Neuendorf, 2019) was applied to the empirical data through NVivo, which formed the basis of our qualitative analysis. We conducted the content analysis according to the theoretical framework of the study and hence organised the content of

the data into two categories. The first category was related to the types of networks: contractual, supply and information. The second category was related to the association of different types of networks with stakeholder-level and network-level properties. Consequently, the data was organised into six units (code groups) conforming to the intersection of these categorisations under the theoretical framework to test and validate the related statements. Consequently, analytic reduction was applied through systematic abstraction of meaning units within each code group, and the content of each code group was reduced to condensates (Malterud, 2012) to test and validate related statements of the theoretical framework. The condensates related to each code group are presented in Appendix 3.

4 Findings

4.1 Project network structure and stakeholders' position

The structure of the project network and their types are presented in Figure 2. The degree centrality of each stakeholder corresponds to the size of the nodes in the relevant type of network. The stakeholder groups involved in both alliance A and alliance B are presented in Appendices 1 and 2, along with their functions and characteristics.

In contractual networks, the centralisation of power, control and coordination is lower as it is shared among alliance partners and most stakeholders, such as subcontractors and suppliers, are disconnected [Figure 2(a)]. The supply network of both alliances [Figure 2(b)] is dominated by the main contractors (NCCSO and STO), as they have dyadic relationships with the subcontractors and suppliers based on subcontracts or purchase orders. The information network of both alliances is denser than that of the contractual and supply networks [Figure 2(c)].

Table 3 SNA metrics at the network or project level

Network level metrics	*Contractual network*		*Supply network*		*Information network*	
	Alliance A	*Alliance B*	*Alliance A*	*Alliance B*	*Alliance A*	*Alliance B*
Average degree (density)	3.300	3.548	1.500	1.290	5.375	5.806
Density	0.085	0.118	0.038	0.043	0.138	0.194
Degree centralisation	0.208	0.230	NA	NA	0.888	0.832
In-degree centralisation	NA	NA	0.881	0.851	NA	NA
Core group size	12	11	7	6	12	11
Core block density	1.000	1.000	0.357	0.367	0.977	0.973
Peripheral block density	0.000	0.000	0.008	0.002	0.012	0.008
Core-periphery block density	0.000	0.000	0.004	0.007	0.095	0.118

Table 4 Degree centrality(1), in-degree centrality(2) at the stakeholder level

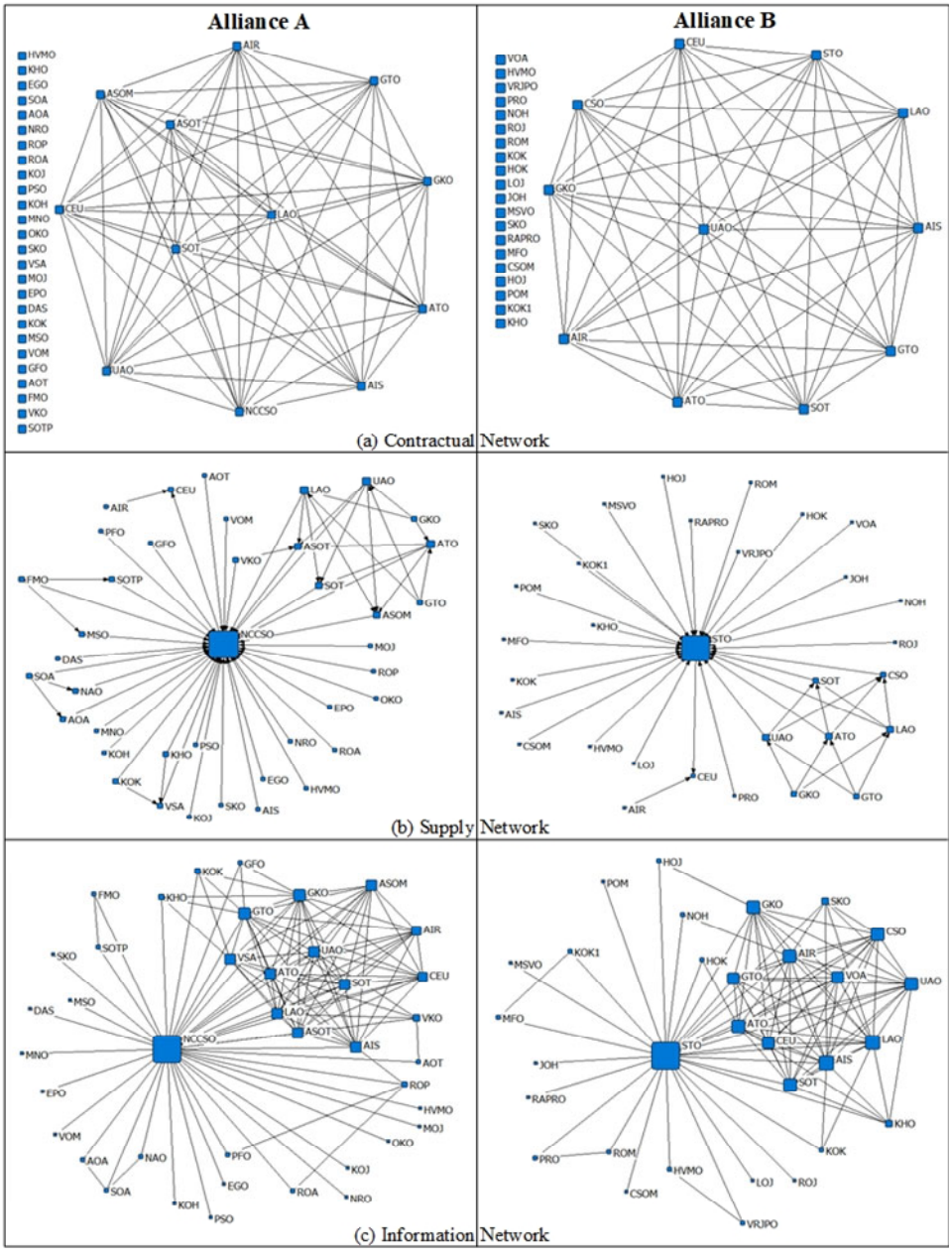
Network	*Alliance*	*Centrality*
Contractual(1)	A	NCCSO (0.282), ASOT (0.282), ASOM (0.282), SOT (0.282), ATO (0.282), LAO (0.282), UAO (0.282), AIR (0.282), AIS (0.282), GKO (0.282), GTO (0.282), CEU (0.282)
	B	STO (0.333), CSO (0.333), SOT (0.333), ATO (0.333), LAO (0.333), UAO (0.333), AIR (0.333), AIS (0.333), GKO (0.333), GTO (0.333), CEU (0.333)
Supply(2)	A	NCCSO (0.897), ASOT (0.103), ASOM (0.077), SOT (0.077), ATO (0.051), LAO (0.051), UAO (0.051), CEU (0.051), VSA (0.051)
	B	STO (0.867), CSO (0.100), SOT (0.100), ATO (0.100), LAO (0.100), UAO (0.100), GKO (0.100), GTO (0.100), CEU (0.067)
Information(1)	A	NCCSO (1.000), GKO (0.359), ATO (0.333), LAO (0.333), UAO (0.333), AIS (0.333), GTO (0.333), ASOT (0.308), ASOM (0.282), SOT (0.282), AIR (0.282), CEU (0.282), VSA (0.282)
	B	STO (1.000), LAO (0.467), AIS (0.467), ATO (0.433), UAO (0.433), AIR (0.433), GKO (0.400), CSO (0.367), SOT (0.367), GTO (0.367), CEU (0.367), VOA (0.367)

The network-level metrics associated with density, centralisation and complexity are presented in Table 3, and the stakeholder-level metrics associated with degree and in-degree centrality are presented in Table 4. The degree centralisation and centrality measures were adopted for contractual and information networks, whereas in-degree centralisation and centrality were adopted for supply networks due to their directional relationships or ties.

Based on a visible drop in the degree and in-degree centrality scores, cut-off points were decided to separate the most central stakeholders, namely, 0.051 for the supply network and 0.282 for the information network.

The results of the statistical analysis at the network or project level (Table 3) shows the average degree and density figures of the contractual, supply and information networks. Average degree figures are computed by simply calculating the average number of relationships (ties) per stakeholder (node) in the network which makes them comparable figures across the networks. The density figures express the number of relationships as a percentage of the maximum possible relationships in the network. Both the average degree and the density figures indicate the overall interconnectedness of the respective networks. Degree centralisation figures express the extent to which an undirected network (contractual and information) is dominated by central stakeholders in terms of control of relationship management and information flow. In-degree centralisation figures express the same for supply network. For instance, centralisation of 1 represents that a stakeholder has ties to all other stakeholders in the network and there are no other ties between other stakeholders. The figures for core block density, peripheral block density, and core-periphery block density are interrelated and express the degree of complexity in terms of interdependency of stakeholder groups and related coordination and control. The results of statistical analysis at the stakeholder level (Table 4) shows degree centrality and in-degree centrality figures related to different networks. Degree centrality figures express the number of direct relationships a stakeholder has in an undirected network and in-degree centrality express the same for directed (supply) networks. These network and stakeholder level measures are further discussed and explained in Section 4.2.

Figure 2 Networks of alliance projects (see online version for colours)



4.2 Discussion and implications

The quantitative findings stated in Table 3 show that the density of contractual networks is higher than that of supply networks but lower than that of information networks in both alliances. The diagrams in Figure 2(a) show that most of the stakeholders are

disconnected, which indicates that subcontractors and suppliers are not integrated into the main alliance contractual arrangement; they have been engaged under a different arrangement. These quantitative findings are complemented by qualitative evidence (Appendix 3) gathered from interview respondents. According to this, *an increase in network density does not bring about any change in terms of the ability of stakeholders to control or constrain the focal organisation's decisions, especially in collaborative projects*, as *the focus of the stakeholders in such projects is on shared and aligned goals* instead of constraining the focal organisation's decisions (Rowley, 1997; Aaltonen and Kujala, 2016). The findings of the core-periphery measures shown in Table 3 show that its null, which indicates the lowest complexity in terms of coordination and control as compared to the supply and information networks. However, in practice, coordination and control of the projects demands interactions between central and peripheral stakeholders, which are not captured by the contractual networks. According to qualitative evidence and the alliance contracts documentation, the contractual network is between the alliance partners, and apparently there is lack of interactions between central and peripheral stakeholders (subcontractors, suppliers), but the contractual provisions related to the responsibilities of the alliance management and project teams and the entire management system serve as an instrument to coordinate and control the peripheral stakeholders, as suggested by You et al. (2018). This evidence challenges the findings of Kim et al. (2011) on the disconnected relationships and lack of interactions between central and peripheral stakeholders due to centralisation. The qualitative evidence also indicates that the contractual relationships among limited alliance partners because of the project alliancing delivery method does not limit the direct interference of these partners in the operations of subcontractors and suppliers, as these are managed through the contractual management system, which limits the theoretical statement regarding finding a friendly way through inter-organisational integration to interact and control the peripheral stakeholders in a certain context (Hietajärvi et al., 2017; Adami and Verschoore, 2018).

Based on these findings, we can confirm that the contractual networks represent only the formal relationships, and the pattern of these depends on the adopted project delivery method. Therefore, contractual networks do not express coordination complexity, as suggested by Choi and Hong (2002); rather, it supports the findings of Adami and Verschoore (2018) that contractual networks are limited to representing formal relationships. Moreover, the qualitative evidence suggests that the complexity of decision making in collaborative projects increases when there are no mechanisms in place for joint decision making in terms of shared responsibilities, which deviates slightly from the statement of Hietajärvi et al. (2017) concerning shared responsibilities in project alliancing.

Figure 2(a) and Table 4 show that the degree centrality of the contractual network is equally distributed among the alliance partners in both alliances due to the adopted project alliancing delivery method. Qualitative evidence (Appendix 3) on stakeholder-level properties validates that the role of central stakeholders and their power in collaborative projects is limited to decision making, resolution of conflicts and the facilitation of coordination, as these projects are influenced only by common goals and related policies and procedures. These findings challenge the relationship between high degree centrality and influential positions in a network (Rowley, 1997; Aaltonen and Kujala, 2016) and control over other stakeholders (Pilbeam et al., 2012), rather they support the findings of Adami and Verschoore (2018) concerning the poor relation

between power and influence captured by the contractual networks regarding project governance. Therefore, it can be concluded that *stakeholders with high centrality in contractual networks have influence and control limited to their contractual roles and responsibilities that vary from one delivery method to another.*

The quantitative findings of the supply networks stated in Table 3 show that the density is lower than the contractual and information networks, and the centralisation is higher than the contractual network in both alliances. These findings indicate that supply networks are dominated by a single stakeholder, as reflected in the diagrams [Figure 2(b)] and Table 4, in which the most central stakeholders are the main contractors, such as NCCSO in Alliance A and STO in Alliance B, and they have mainly dyadic relationships with their subcontractors and suppliers, revealing the buyer and suppliers as suggested by Adami and Verschoore (2018). These findings are supported by qualitative evidence (Appendix 3), according to which high in-degree centralisation refers to higher control in terms of coordination of activities (Adami and Verschoore, 2018), where subcontractors are involved, and operational load (Kim et al., 2011), where suppliers are involved. The core-periphery measures are slightly higher than the contractual networks, which indicates higher complexity in terms of coordination and control due to interactions between central (alliance partners) and peripheral stakeholders (subcontractors and suppliers). Therefore, we can conclude, based on these findings, that *the supply networks of projects are considered complex because of their need for coordination and control, as well as operational load, and that can vary depending on the adopted delivery method and related organisational arrangements.* The findings related to in-degree centrality (Table 4), and qualitative evidence (Appendix 3) also demonstrate that each alliance partner has a role in coordinating the related activities (integrator), such as planning, design, HVAC, programme management, site supervision, building automation, con struction and the related supply chain, as suggested by Parker and Anderson (2002).

The quantitative findings of the information networks presented in Tables 3 and 4 show that the density, complexity (core-periphery) and centrality metrics are higher than those of the contractual and supply networks in both alliances. Moreover, the structure of the networks [Figure 2(c)] is more intense in terms of cohesion as compared to the contractual and supply networks but is concentrated to the alliance partners, of which the main contractors (NCCSO and STO) are the most central stakeholders, which could be interpreted as the flow of information being controlled by them. Qualitative evidence (Appendix 3) demonstrates that there is a need for information exchange at multiple levels and between multiple specialised groups due to the complexity of the project and the high interdependencies of stakeholders in terms of information exchange, as suggested by Mok et al. (2017) and related decision making. Discussions and information exchanges are conducted on different levels, such as alliance management groups, project management groups and different specialised work groups, which help in resolving issues and building trust among stakeholders. Open communication across different levels forms the foundation for coordination and trust. This evidence contradicts the findings of Todeva (2006) that high centralisation leads to communication control and restrictions on the information exchange; instead, it supports the findings of Adami and Verschoore (2018) that high centralisation is unrelated to communication constraints but to coordination procedures. This evidence also supports the findings of Pryke (2012) that informal relationships with open communication lead to coordination and cooperation. These findings allow us to confirm that quantitative metrics of a network could be interpreted in different ways, but it is important to realise the context in which a given

network is embedded. *In project alliancing contexts, information networks are not formal relationship bonds, nor do they impose any restrictions or control over the information exchange; rather, they facilitate network coordination in terms of information interdependencies* that lead to cooperation.

The qualitative evidence also indicates that the aim of meetings is to exchange information with regards to coordination issues such as conflicts in schedules and organisation of activities, managing the interfaces of activities, resolution of conflicts and related decision making. Although communication is extremely important in resolving challenges related to collective responsibility and ownership, such situations could be controlled through coordination authority. However, dominance over others by using power is quite difficult in collaborative projects, a finding that is not completely aligned with Todeva (2006), Pryke (2012) and Adami and Verschoore's (2018) statements concerning high degree centrality relation with influence and dominance over others. Based on these findings, we can confirm that in alliance projects, no one plays the role of gatekeeper, nor does anyone have dominance over others in terms of the information flow; rather, they act as communicators to share the required information with the concerned stakeholders in a spirit of mutual trust and cooperation. These findings are summarised in Table 5 to highlight the implications of stakeholder network relationships.

Table 5 Implications of stakeholder network relationships

Network types	*Implications for coordination and control*
Contractual	The contractual networks represent only formal relationships in accordance with the adopted project delivery method; nevertheless, they do not fully express the complexity and interfaces of the project in terms of coordination and control.
	In collaborative projects, a high-density network does not impact the ability of stakeholders to control or constrain the focal organisation's decisions, as the focus of stakeholders in such projects is on shared and aligned goals.
	The central stakeholders in contractual networks have influence and control limited to their contractual roles and responsibilities, which vary in different forms of contract.
Supply	The supply networks of projects are considered complex because of their need for coordination, control, and operational load; these roles are assigned to the respective stakeholders that can vary depending on the adopted delivery method and related organisational arrangements.
Information	The information networks of collaborative projects are not formal relationship bonds. They also impose no restrictions, and no one has dominance over others in terms of information exchange, rather they facilitate network coordination in terms of information interdependencies.

5 Conclusions

Our study contributes to the call for research on the coordination and control of network relationships. We explored the structure of collaborative networks in projects in terms of SNA metrics and their interpretations and implications for the stakeholders' coordination and control. We analysed two contractually separate alliances of a large hospital project in northern Finland in terms of structural characteristics, associated complexities and dynamics of different types (i.e., contractual, supply and information) of network

relationships. Consequently, our study reveals the implications of different types of networks for the coordination and control of stakeholders in collaborative projects.

Our results show that from a structural perspective, there are three types of network relationships that exist in a project with varying degrees of influence, control and coordination depending on the adopted project delivery method. The structure of the contractual network is based on formal relationships, and the concerned central stakeholders have influence and control limited to their contractual roles and responsibilities only. The structure of the supply network is dominated by a central stakeholder in terms of coordination of activities and operational load, which can vary depending on the contractual and organisational arrangements. The structure of the information network is dense and concentrates on the central stakeholders for information exchange with regard to coordination issues on different levels, which depends on the context in which a network is embedded.

The findings of our study suggest that projects are confronted with three different types of network relationships – contractual, supply and information. Accordingly, we propose that managers consider these while managing relationships among stakeholders in a project, as these three networks have varying complexities and dynamics. Managers should also note that each network type will have a different structure and a different set of salient stakeholders. A stakeholder holding a central position in one network may not appear as central in another network. Depending on the type of network, the position and role of a stakeholder change accordingly. Moreover, SNA could help managers identify multiple tiers of stakeholders and patterns associated with their links. Therefore, managers should be vigilant about such dynamics and associated challenges in project network relationships.

We acknowledge that our study is case specific; therefore, generalisations require careful attention as the study is confined to a specific project delivery method. Apart from the hospital construction project, there are several other infrastructure projects being procured through collaborative project arrangements in Finland which are not included in this study; by doing so, different perspectives on the study phenomenon would have been revealed. The roles of key stakeholders are dictated by the adopted delivery method. The majority of the findings are related to the roles and positions of the stakeholders in the project networks, which cannot be considered as a general statement regarding these stakeholders. These might change significantly in different project settings. Some limitations are inherent in sample sizes for both survey and interviews, which could have been expanded (i.e., including those who were indirectly involved in the project activities) to achieve the high level of theoretical saturation. Furthermore, data collection covers the implementation phase of the project. Prior and later phases (development and maintenance) are not covered in this research.

However, our study raised several questions that can be addressed in future studies. First, it considers contractual networks based on the main alliance contracts among alliance partners, which cover formal alliance relationships only. Future studies can explore these networks deeper by including the subcontracts that are embedded in the main alliance contracts. Second, our study did not consider the mechanisms involved in the coordination of activities in the supply networks and the flow of information in the information networks, which can be covered in future studies. Finally, future studies can link the different aspects of contractual, supply and information networks with project performance as well.

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Appendix 1

Table A1 Alliance A

S. nr	*Stakeholder*	*Label*	*Activity type*
1	Alliance partner and client representative	CEU	Management, architecture and engineering
2	Alliance partner and main architect	ATO	
3	Alliance partner and planning architect	LAO	
4	Alliance partner and planning architect	UAO	
5	Alliance partner and project management consultant	AIR	
6	Alliance partner and structural engineering consultant	AIS	
7	Alliance partner and electrical engineering consultant	GTO	

Table A1 Alliance A (continued)

S. nr	*Stakeholder*	*Label*	*Activity type*
8	Alliance partner and main contractor	NCCSO	Construction works
9	Alliance partner and building technology contractor	ASOM	
10	Alliance partner and HVAC contractor	ASOT	HVAC works
11	Alliance partner and HVAC designer	GKO	
12	Alliance partner and automation contractor	SOT	Building automation works
13	Subcontractor for the demolishing and pilling works	HVMO	Subcontractors and suppliers
14	Subcontractor for the wall element assembly	AOA	
15	Subcontractor for the reinforcement works	NRO	
16	Subcontractor for the civil works (excavations)	KOJ	
17	Subcontractor for the waterproofing and roofing works	KOH	
18	Subcontractor for the masonry works	MNO	
19	Subcontractor for the sheet metal works	OKO	
20	Subcontractor for the walls' construction	SKO	
21	Subcontractor for the customised cleanrooms	VSA	
22	Subcontractor for the mobile cranes on site	NAO	
23	Supplier of elevators	KHO	
24	Supplier of waste piping system	EGO	
25	Supplier of lifting equipment on site	SOA	
26	Supplier of wall element delivery	ROP	
27	Supplier of stair elements	ROA	
28	Supplier of mould equipment	PSO	
29	Supplier of medical devices	MOJ	
30	Supplier of medical devices	EPO	
31	Supplier of medical devices	DAS	
32	Supplier of medical devices	KOK	
33	Supplier of medical devices	MSO	
34	Supplier of medical devices	VOM	
35	Supplier of medical devices	GFO	
36	Supplier of medical devices	AOT	
37	Supplier of medical devices	FMO	
38	Supplier of medical devices	SOTP	
39	Supplier of shower seats, railings, and handles	VKO	
40	Supplier of beams	PFO	

Appendix 2

Table A2 Alliance B

S. nr	*Stakeholder*	*Label*	*Activity type*
1	Alliance partner and client representative	CEU	Management, architecture and engineering
2	Alliance partner and main architect	ATO	
3	Alliance partner and planning architect	LAO	
4	Alliance partner and planning architect	UAO	
5	Alliance partner and project management consultant	AIR	
6	Alliance partner and structural engineering consultant	AIS	
7	Alliance partner and electrical engineering consultant	GTO	
8	Alliance management consultant	VOA	
9	Alliance partner and main contractor	STO	Construction works
10	Alliance partner and HVAC contractor	CSO	HVAC works
11	Alliance partner and HVAC designer	GKO	
12	Alliance partner and automation contractor	SOT	Building automation works
13	Subcontractor for the demolishing and pilling works	HVMO	Subcontractors and suppliers
14	Subcontractor for the reinforcement works	PRO	
15	Subcontractor for the civil works (excavations)	VRJPO	
16	Subcontractor for the walls and masonry works	MSVO	
17	Subcontractor for the exterior walls' construction	SKO	
18	Subcontractor for the painting works	POM	
19	Subcontractor for the floor and tiling works	RAPRO	
20	Supplier of elevators	KHO	
21	Supplier of wall element delivery	ROM	
22	Supplier of stair elements	ROJ	
23	Supplier of windows	KOK	
24	Supplier of windows	HOK	
25	Supplier of doors	LOJ	
26	Supplier of doors	JOH	
27	Supplier of medical devices	MFO	
28	Supplier of medical devices	CSOM	
29	Supplier of medical devices	HOJ	
30	Supplier of medical devices	KOK1	
31	Supplier of steel beams	NOH	

Appendix 3

Table A3 Condensates – qualitative content analysis quotations

Network types	*Network-level*	*Stakeholder-level*
Contractual	We are the main alliance partners … there are always new subcontractors, and suppliers coming to the project but nothing, no major changes have happened … in terms of the ability of stakeholders to challenge the main organization's decisions, especially in project alliancing as focus of the actors in such projects is on shared and aligned goals. The contractual network is between alliance partners … operations of subcontractors and suppliers are managed through the alliance management board and project board … which is called contractual management system. Every stakeholder has limited rights to make their own decisions, limited in that sense that if it is affecting the other partners … we have agreed that must be agreed together … it must bring to the alliance project board and discuss which indicates that in such projects there must be mechanisms in place for joint decision making otherwise it could lead to problems.	We have formed our alliance organization so that we have people from other shareholders or companies … we have the central stakeholders in this alliance … which is project group and alliance steering group who makes the ultimate decisions … their role and power in this project is limited to decision making, resolving conflicts, and facilitating coordination.
Supply	We are the main construction company … I think there was a little problems with our project and I think the main problem was for resources in that sense … it was not working … there was a little time, that it was not clear that who should coordinate and what, and in a way it leads to a situation that we have had to step in and take the coordination responsibility … even there is no contract demand or it is not written anywhere but of course, we have to look around and if someone (suppliers, subcontractors) is not taking care of that task, we have to do it.	I hired one additional resource even we don't have any direct responsibility in that area … to make sure the coordination of activities among alliance partners … each alliance partner has a role in the project … to coordinate the related activities (integrator) such as, planning, design, HVAC, program management, supervision, building automation, construction, and related supply chain.

Table A3 Condensates – qualitative content analysis quotations (continued)

Network types	*Network-level*	*Stakeholder-level*
Information	Well, there's plenty of different meetings and workshops. For example, this project management group, cost management group, change management group, then lots of design meetings, design workshops. Then we have site meetings and then there's a weekly information event … in which almost everybody is present who works in the project. We have those unofficial discussions, but also, we have this type of (official) meetings … you need to have the discussions and of course it should be in the phase to phase and teams to teams (alliance management group, different specialised work groups) … I think it's better to build that trust in all the directions and it is the only way to do with this (coordination) … to know and understand people better.	I have many, kind of level of meetings, for example, this morning I was participating in site meeting where we are looking, how their schedules are going on concerning construction timetables. I participate in these (meetings) because I want to follow the project and the problems there, so if there will be a big problem, I will stand there, and my role is how to solve these big problems … we have many kind of problems between design companies, architects, construction companies … but also, we discuss about problems concerning construction phase and what shall we do together (coordination) to solve these problems. I think it's mostly negotiation. I had to find out the compromise and of course when we are speaking, how I am resolving these challenges. I'm using the power which we have inside the project (coordination authority), and that's quite critical in alliance contract because we must have a common understanding and if you use the power not to agree with something then that is difficult in such projects.