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Network orchestration in a large inter-organizational project

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Abstract

Multiple organizations working jointly on shared activities in inter-organizational projects for a defined period of time are used increasingly to coordinate the supply of complex products, subsystems, and services across many industries. Despite the growth in inter-organizational networks as an organizational form, scholars have only recently begun to identify how lead organizations orchestrate the coordination of multiple parties with disparate goals, responsibilities, and capabilities. Prior work offers limited insights into the choice of network governance forms, and how coordination is undertaken by the network orchestrator to govern these networks. We conducted a longitudinal study of four networks to deliver vital services into a large project. We identified how the choice of network governance form was based on task complexity. A shared governance form was chosen for networks developed to deliver routine services, whereas a lead organization governance form was chosen for networks set up to deliver complex services. However, findings showed that the selection of an appropriate governance form was not sufficient for ensuring high performance. The network orchestrator's mode of coordination (formal or informal), the intensity of coordination (active or passive), and fit with the form of governance form (shared or lead organization governed) was important in driving performance.

KEYWORDS

coordination, governance, lnter-organizational networks, large projects, longitudinal study, network orchestrator

Highlights

- The performance of project networks depends on both the initial choice of network governance and their ongoing coordination
- The network orchestrator should select the form of network governance based on the complexity of tasks provided

Jens K. Roehrich and Jas Kalra contributed equally to this paper.

- The network orchestrator should align the mode and intensity of coordination with the form of network governance

1 | INTRODUCTION

The success of large-scale projects depends on the orchestration of temporary inter-organizational networks collaborating together to deliver an overall program despite disparate goals, responsibilities, and capabilities (Gil & Fu, 2022; Jones & Lichtenstein, 2008; Miller & Lessard, 2000). Network orchestration, defined as the process of assembling and managing inter-organizational networks (Perks et al., 2017), typically consists of three phases—first, creating initial connections, building legitimacy, and establishing cognitive and emotional trust; second, governing the networks by setting up collaborative and flexible structures, and providing clear goals; and, third, monitoring progress against networks' objectives (Paquin & Howard-Grenville, 2013; Reypens et al., 2021). While the first phase, and in particular issues of building network legitimacy and trust have received ample attention (e.g., Castello et al., 2016; Gulati & Gargiulo, 1999; Human & Provan, 2000), scholars have recently called for a better understanding of the phases which include the initial choice of governance form, and the subsequent process of coordination by the network orchestrator (Lunnan & McGaughey, 2019).

Our study examines network orchestration in an understudied context within large projects. While the focus of prior research has been on the integration of materials, components, and subsystems that form the infrastructure produced by large projects (e.g., Davies et al., 2009; Tee et al., 2019), network orchestration in large projects also includes the governance and coordination of ancillary services, such as the provision of catering, facilities management, transportation, and site accommodation for workers. Although entirely neglected in the literature, a poorly orchestrated service network can undermine the performance of the entire large project. For example, the construction of the London 2012 Olympics has the reputation of being a successful project (Davies & Mackenzie, 2014), yet the handover to the London Organising Committee of the Olympic and Paralympic Games (LOCOG)—the private company responsible for hosting the games—was "thrown into serious doubt" by the inadequate provision of security services 2 weeks before the opening ceremony (HoC, 2012). LOCOG was responsible for orchestrating networks of service suppliers, including G4S, the security firm contracted by LOCOG. But G4S failed to recruit, train, and manage the 23,700 security personnel needed for the Games. LOCOG's inadequate governance and poor coordination of the contract was eventually resolved when military personnel filled the gap left by G4S's inability to provide the service level required.

We are particularly interested in the (temporal) interdependence between the form of governance and the ongoing coordination between the network orchestrator and the network members of ancillary services within a large project (e.g., Lunnan & McGaughey, 2019; Sydow, 2022). Governance and coordination are distinct activities, insofar as they differ both in terms of content and timing (Provan & Kenis, 2008), but inter-related as the initial choice of governance form partially determines the type of ongoing coordination required. They are also important as the selection of an inappropriate network governance form (and issues in subsequent coordination) are among the most frequently cited causes of large-scale project failure (Denicol et al., 2020). Understanding how such inter-organizational networks are set up and coordinated addresses two important gaps in the operations and project management literatures. First, prior work offers limited theoretical and empirical understanding of the factors that inform the choice of governance form (Provan & Kenis, 2008; Raab et al., 2015). In the early stages of network development, selecting an appropriate network governance form is the responsibility of the network orchestrator (Dagnino et al., 2016), and influences the legitimacy, efficiency, and effectiveness of decision making within the network (Moynihan, 2009; Provan et al., 2007; Provan & Kenis, 2008). Understanding how to make the choice between forms is therefore a key managerial challenge, and leads to our first research question: *How does a network orchestrator select governance forms for inter-organizational networks within the ancillary services of a large-scale project?*

Second, a poorly understood, yet critical governance activity performed by the network orchestrator, is the process of establishing coordination between the network orchestrator and all network members (Pathak et al., 2014). While prior work shows that effective coordination depends on the fit between needs and mechanisms (Gulati et al., 2012; Oliveira & Lumineau, 2017), extant studies provide an incomplete understanding of the formal and informal coordination undertaken by the network orchestrator to govern inter-organizational project networks (Fortwengel & Sydow, 2020; Reypens et al., 2021). Understanding the effectiveness of coordination mechanisms

within inter-organizational networks in a project setting matters because ineffective coordination can lead to conflict, disputes, and poor project outcomes (e.g., Kalra et al., 2021; van Marrewijk et al., 2016), and leads to our second question: *How does coordination by the network orchestrator influence performance outcomes within the ancillary services of a large-scale project?*

These questions are addressed through a longitudinal study of how a network orchestrator set up and managed four inter-organizational networks to deliver a large energy project. Our study makes two contributions. First, we find that the choice of network governance form is based on the complexity of tasks. While prior studies have provided theoretical and empirical insights, they focused on different network contexts, such as those within a single organization (Zhou, 2012), or the public sector (Moynihan, 2009). Our findings suggest that a shared governance form is chosen for networks developed to deliver routine services, whereas a lead-organization governance form is selected for networks set up to deliver more complex services. Second, we found that performance is shaped by the fit between the governance form, the mode and intensity of coordination, and the decomposability of the task. Coordination within our two high performing networks includes both formal and informal coordination, and that compliments the structure of the network. Coordination within our low performing networks either neglects a mode, or ignores network structure. Our cases also suggest that task decomposability facilitates this mismatch by enabling shared networks to become siloed and lead networks to become disintermediated. While previous research has shown that task decomposability can constrain structure (Zhou, 2012), our study indicates that it also has important implications for the coordination phase of orchestration.

2 | CONCEPTUAL BACKGROUND

2.1 | Inter-organizational networks and the network orchestrator

Managing inter-organizational networks requires the coordination of interdependent, and often complex, tasks without the benefit afforded by hierarchy (Provan & Lemaire, 2012) A network orchestrator therefore undertakes deliberate, purposeful actions to set up and manage multiple inter-organizational networks needed to create and access the assets, resources, and complementary capabilities of network members (e.g., Dhanaraj & Parkhe, 2006). These actions include developing shared goals, defining rules and norms of behavior, and spurring and sustaining actors' interest by building and maintaining network legitimacy (Paquin & Howard-Grenville, 2013). Prior studies have emphasized that the network orchestrator brings together organizations with complementary capabilities and resources who have often not worked with each other before (Human & Provan, 2000), and undertakes activities to create value for the network members including building network legitimacy, managing tensions, and resolving conflicts through coordinating the various interdependent tasks (Provan & Lemaire, 2012).

More recently, scholars have categorized the orchestration practices around three phases: first, creating initial connections between network members, building legitimacy, and turning serendipitous encounters into meaningful connections, ensuring harmony between network members through the development of cognitive and emotional trust; second, governing the network by setting up collaborative and flexible structures, clear goals; and, third, monitoring the achievement of these objectives (Paquin & Howard-Grenville, 2013; Reypens et al., 2021). While the issues of building network legitimacy and trust have received ample attention (e.g., Castello et al., 2016; Gulati & Gargiulo, 1999; Human & Provan, 2000), recently scholars have called for a better understanding of the governance of inter-organizational networks, which includes the initial set up (governance form), and the subsequent coordination process by the network orchestrator (Lunnan & McGaughey, 2019). Although the selection of governance form and coordination are sequential and interdependent activities for the network orchestrator (Provan & Kenis, 2008; Tee et al., 2019), they are rarely studied together. This is an important oversight as their combination is a driver of network performance (Lunnan & McGaughey, 2019).

Despite the growth in inter-organizational networks in various industries such as construction and biotechnology (Davies & Hobday, 2005; Mishra et al., 2015; Mishra & Browning, 2020; Mishra & Sinha, 2016; Oliveira et al., 2022), management scholars have only recently begun to identify how lead organizations coordinate multiple parties with disparate goals, responsibilities, and capabilities in projects (Manning, 2017; Oliveira & Lumineau, 2017; Tee et al., 2019). Inter-organizational networks in projects refer to the temporary relationships established between more than two organizations that have an input into a project (e.g., DeFillippi & Sydow, 2016). Network orchestration in inter-organizational projects (including network governance form and coordination) draws attention to the structure of authority and activities required to maintain project coherence and quality from initial project vision to delivery (Pathak et al., 2014). Large inter-organizational projects are comprised of many smaller projects, including the supply of services that require some form of network

orchestration, which may vary depending on the complexity of the task. Given the importance of governance and coordination in the deliberate, purposeful set up and ongoing management of projects, it is surprising that this concept has received limited attention in prior research of inter-organizational projects (Sydow & Braun, 2018). After selecting the forms of governance for a project, the network orchestrator is responsible for coordinating service supply networks throughout a project lifecycle characterized by high uncertainty, volatility, and dispersion of specialized resources and capabilities across organizations (Manning & Sydow, 2011).

While the study by Oliveira and Lumineau (2017) provides insights into how contracts and integrators achieve coordination, prior research neglects to address how formal and informal coordination is being enacted by a network orchestrator in managing multiple inter-organizational networks embedded in a larger project involving some new members, that may not be familiar with each other, with no shadow of the past or future (Swärd, 2016), and little or no information about each other's cultural and structural makeup. Following recent scholarly calls for a better understanding of the governance of inter-organizational networks (e.g., Lunnan & McGaughey, 2019), we specifically studied how a network orchestrator set up and coordinated inter-organizational networks embedded in a large project (Pathak et al., 2014).

2.2 | Governing inter-organizational networks: Governance forms and coordination

Network governance form is necessary to ensure that suppliers engage in mutually supportive actions, that conflict is addressed, and that network resources are acquired and utilized efficiently (Provan & Kenis, 2008). Prior work distinguished between three types of governance forms for inter-organizational networks: participant-governed, lead-organization governed, and network administrative organization (NAO) (Dagnino et al., 2016; Pathak et al., 2014; Provan & Kenis, 2008). Sydow and Braun (2018) have called for more research to examine how these three forms manifest in inter-organizational projects.

Participant-governed networks are led by members of the network, and have no centralized governing entity. Decision making is done by all, or a significant subset of, participants with authority equally distributed among members although organizations may differ with regards to size, resources, and capabilities (Berthod et al., 2017). The governance of some inter-organizational projects depends on shared governance where participants cooperate in a consensus-based way (Sydow & Braun, 2018). Participant-governed networks are: (i) more flexible in terms of their decision-making because governance is less bureaucratic in nature (Provan & Kenis, 2008); and (ii) decisions have more internal legitimacy as compared to other governance forms, because they are more inclusive by nature (Provan et al., 2007). However, in crisis situations, decision-making may be too slow to reach consensus between the network members (Moynihan, 2009).

Lead organization-governed and NAO-governed networks are controlled and coordinated by a central governing organization, either emerging from the existing network members (lead organization-governed), or mandated by an external organization (NAO-governed; Raab et al., 2015). Unlike participant-governed networks, the two governance forms favor stability over flexibility of the network, and have been found to result in more efficient decision-making (Moynihan, 2009; Provan et al., 2007; Raab et al., 2015). The governance of many large inter-organizational projects depends on a lead organization—often a client, prime contractor, or project delivery organization—using a mix of hierarchical and collaborative structures across organizational members (Sydow & Braun, 2018). Although governance forms are conceptually well understood, prior work offers few insights about their selection and set up (Provan & Kenis, 2008; Raab et al., 2015), and how the selected governance form impacts on network performance and the process of inter-organizational coordination.

Coordination therefore "addresses the pooling of resources, the division of labor across partners, and the subsequent integration of the dispersed activities" to complete tasks effectively (Hoetker & Mellewigt, 2009, p. 1026), and achieve jointly determined goals (Gulati et al., 2012). The literature on the governance of inter-organizational relationships has recently focused on the functions of formal and informal governance mechanisms in terms of control and coordination (e.g., Cao & Lumineau, 2015; Roehrich et al., 2020). While prior work has investigated the role of control to safeguard relationships from opportunism in more detail (e.g., Schepker et al., 2014), governance studies have only started to explore coordination in relationships (e.g., Caldwell et al., 2017; Oliveira & Lumineau, 2017).

Research on coordination has focused on the mechanisms through which actions are aligned, and flows of information are managed and processed (Caldwell et al., 2017; Lumineau, 2017; Roehrich & Lewis, 2014), which are particularly important when there is little shared knowledge between organizations (Gulati et al., 2005). Research can be divided into formal and informal perspectives (Gulati et al., 2012). The formal

perspective draws on the role of hierarchies and formal contracts for coordinating a partnering organization's actions (Thompson, 1967). A contract, and its various coordination clauses, may help to divide authority and labor, outline operation procedures, and specify contingency plans (Faems et al., 2008). The informal perspective emphasizes the role participants play in actively coordinating through more emerging communication and decision-making channels (Gittell, 2002; Gulati et al., 2012), as interaction is developed over time when organizations engage with and built trust in each other (Claggett & Karahanna, 2018). Coordination is achieved through mutual adjustment instead of the formal systems and procedures specified in the contract (Faems et al., 2008).

In summary, our study of inter-organizational networks embedded in a large, inter-organizational project addresses two distinct, yet inter-related, network governance challenges, and contributes to network and governance literatures. First, prior work offers few empirical insights into the set up and choice of network governance forms, and thus research provides a limited theoretical and empirical understanding of why a particular governance form—shared versus lead—was selected, and its impact on performance and coordination (Provan & Kenis, 2008; Raab et al., 2015). Second, a key, but poorly understood, governance activity performed by the network orchestrator, is how coordination is intentionally established (Pathak et al., 2014). Extant studies provided very limited insights about the formal and informal coordination undertaken by the network orchestrator on ensuring network performance (Fortwengel & Sydow, 2020; Reypens et al., 2021). Our study unpacks the mode of coordination (formal or informal), the intensity of coordination (active or passive), and fit with the form of governance form (shared or lead).

3 | METHODOLOGY

We conducted a longitudinal, multi-method in-depth case study (Eisenhardt, 1989) to understand how a network orchestrator selected a governance form, and coordinated inter-organizational networks in a large project. This method yielded rich observations of governance forms, and the coordination process across four inter-organizational networks (Golden-Biddle & Locke, 2007).

3.1 | Research setting and case selection

The network orchestrator, Atom (fictional name due to confidentiality), is a UK-based subsidiary of Atom Group (fictional name), a large, international, integrated electricity company, active in all areas of energy including generation, transmission, distribution, and supply. In 2013, Atom was granted approval by the government to start building a new nuclear power plant with a current value of $25 billion, and when completed, will meet about seven percent of UK's energy needs (Frazer-Nash, 2018).

Used by governments and organizations to build infrastructure and deliver services, large projects are often subject to intense political and public scrutiny about the value the project creates including new employment opportunities and contributing to the prosperity of a region or country (Useful Projects, 2020). For our selected project, Atom was concerned that the construction of the nuclear power plant might have a negative impact on the local community, and that the prosperity of local businesses might be adversely affected by the establishment of large companies in the region for the duration of the project. To address these concerns, and to create value for the region and the country more broadly, Atom needed to build a compelling economic and social argument for the construction of the nuclear power plant in the region. As part of its government agreement, Atom made a commitment to award a portion of its contracts to companies in the region. The key issue posed by making this commitment was that the project was set up in a rural, deprived region in the United Kingdom, thus most organizations in the region were SMEs with little or no experience of working with large organizations such as Atom, or delivering at the scale that is typically required in these large projects (Clegg, 2018).

Our longitudinal study (period of examination: 2008–2019) investigated how the network orchestrator selected the governance form (in our setting a governance form which did not change over the course of our investigation), and managed subsequent coordination processes of four inter-organizational networks established to provide the project with a range of ancillary services. The construction phase of these large projects is supported by a number of inter-organizational networks delivering different ancillary services such as catering, transportation, accommodation for workers, and site infrastructure services to ensure that the construction site is functioning properly (Drion et al., 2012; Figure 1). Generally, these services are delivered by large organizations with established supply networks with prior experience of delivering these services in large projects. SMEs, by contrast, seldom have the expertise, resources, and capabilities to deliver on such a large scale (Terziovski, 2010). We selected these inter-organizational networks as the network orchestrator needed to engage actively with network members to set up and manage these inter-

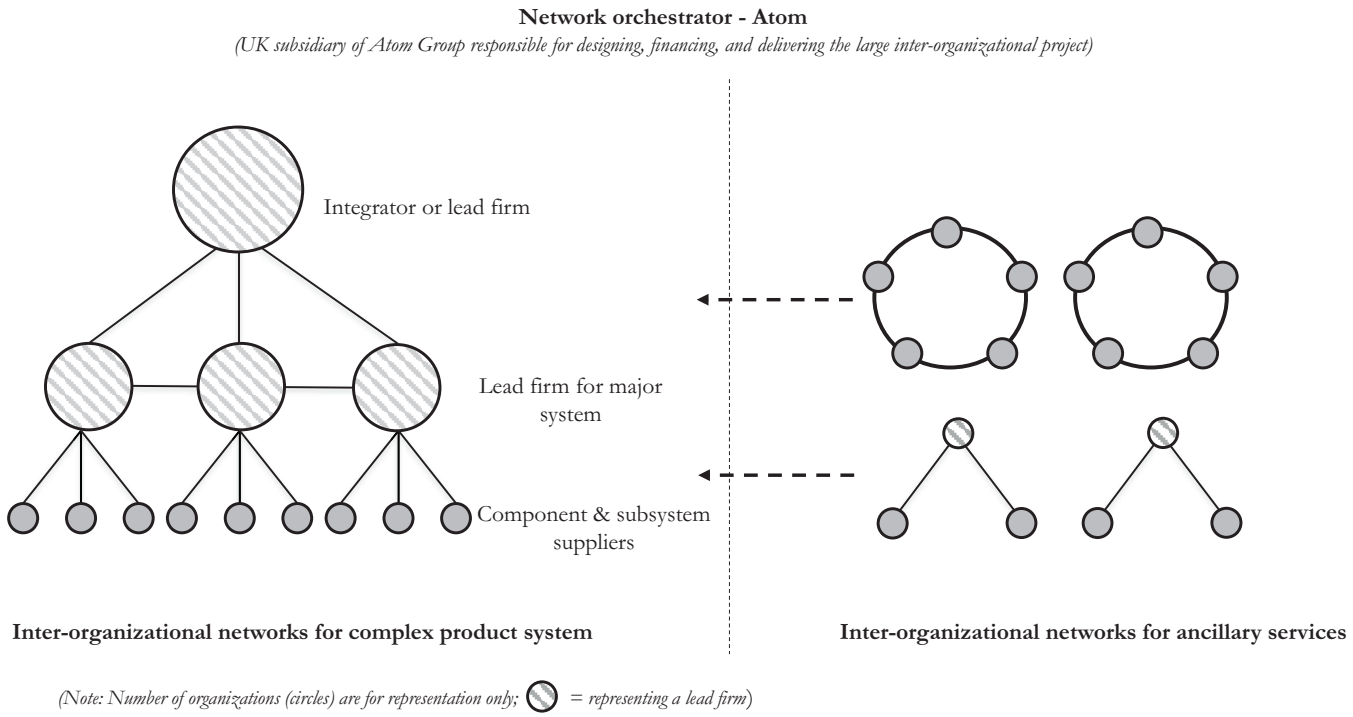

FIGURE 1 Illustration of the network orchestrator and inter-organizational networks (simplified).

organizational networks for the benefit of the overall project. These inter-organizational networks delivering ancillary services are some of the first networks to be set up in large projects (Drion et al., 2012). Pressures from various stakeholders to deliver the project on time, and to cost and quality specifications, further emphasized the need for a proactive role of the network orchestrator, thus making it an ideal setting for our investigation.

The whole network of suppliers within the large project under investigation is our unit of analysis, with the inter-organizational (service) networks as the embedded unit of analysis. The four cases we selected had a number of unique qualities that made them logical candidates for sampling (Shah & Corley, 2006; Table 1). Two of the networks were of low service complexity, while the other two were of high service complexity. Following Handley and Benton (2013) and Salvador et al. (2021), we operationalized service complexity as "an objective task characteristic" (Campbell, 1988, p. 42), and defined service complexity as the "number and intricacy of steps required to perform it" (Shostack, 1987, p. 35). Therefore, reprographic and catering networks were placed in low complexity (from hereon, routine) category, and facilities management (FM) and site infrastructure networks were placed in the high complexity (from hereon, complex) category. Two networks were high performing, while the other two were low-performing networks, which allowed us to contrast the performance implications of governance forms and coordination. We operationalized performance as the client's (network orchestrator) satisfaction in terms of time, cost, and quality, as well as the relationship performance as perceived by the orchestrator (Cao & Lumineau, 2015; Poppo & Zenger, 2002; Zaheer et al., 1998). In terms of performance, we not only built on a primary dataset (i.e., interviews and site observations), but also rich performance measures (in terms of time, cost, quality, and relationship satisfaction) which was captured on a monthly and quarterly basis by the network orchestrator (Atom) and all network members. This was further supported with reports (internal and industry/government), as well as quality certifications. This helped to triangulated primary and secondary datasets from multiple perspectives to arrive at the network's performance measures.

3.2 | Data collection and sources

Primary (observations, interviews, site visits) and secondary data sources (presentation slides from the network orchestrator, government and industry reports) were collected between 2017 and 2019 (Appendix A; Gibbert et al., 2008), and live (i.e., during the set up and running of the networks), and retrospective data were gathered to address our research questions. This approach enabled us to deepen our understanding of how governance forms were selected, and how the network orchestrator managed coordination activities.

TABLE 1 A description of the investigated inter-organizational networks.

Networks/key characteristics	Reprographics	Catering	Facilities management (FM)	Site infrastructure
Complexity of service operation	**Low** The service involved servicing the reprographic requirements of Atom and its other suppliers that are working on the construction site. This involved printing drawings, posters and promotional material, and document copying.	**Low** The service involved food production, food vending, management of cashless vending systems, operating four bars, retail displays and shops. It also included the management of pre- and post-production food waste, distribution of chilled and ambient goods, cleaning and equipment maintenance, VIP hospitality when required, and promotion and delivery of healthy eating in menu choices and allergen information.	**High** The facilities management contract constituted of a range of services on the site for Atom and other developments associated with it. The scope of the service is broad and included several packages: computer-aided facilities management, general office services (such as reception, porters, drivers), postal services, room bookings, cleaning, domestic waste removal, office space planning, mechanical and electrical building fabric maintenance, plumbing, handyman, and AV equipment management and support.	**High** The infrastructure operations and maintenance (O&M) contract formed an essential element of the logistics work stream within site operations. It consisted of the planning, management, integration, and delivery of various infrastructure services (such as temporary roads and parking spaces) to operate within Atom's project site and between parts of the associated development sites.
Network members; network turnover	Number of organizations in the network: six Turnover range (in $ million): <2–400	Number of organizations in the network: six Turnover range (in $ millions): <2–4	Number of organizations in the network: four (referred to as Sigma, the lead organization that left, Omega, the new lead organization, and Iota and Zeta, the SME members). Turnover range (in $ millions): 14–700	Number of organizations in the network: three (referred to as Alpha, the lead organization, and Beta and Gamma, the SME members). Turnover range (in $ millions): <2–2000
Performance	**Low** performance on quality, time, and relationship satisfaction metrics. "*There is a real tension between some of the companies in the network and the managing director of Reprographics Network and it is not good, not healthy, and we as the client are not getting good service. The productivity is poor. The cost is not good*" (Head of Stakeholder Engagement, Atom).	**High** performance on cost, quality, time, and relationship satisfaction metrics. "*It is a small group of contractors, yet two years ago they were doing 400 sandwiches a week in a couple of little outlets and now they are feeding 10,000 people. They have never failed, 99.5%, to get good feedback on catering here*" (Service Manager, Atom).	**Low** performance on cost, time, and relationship satisfaction metrics. Maintaining stability of network incurred additional costs. "*They are struggling with quality again, and that is the function of how it (the network) has been structured—a joint venture that is gearing up and trying to scale up. [...] It is a culture thing. They need to make an investment and effort to fix this. It can be done, but it needs to be a forced pace. You can do*	**High** performance on cost, quality, time, and relationship satisfaction metrics. "*With the Site Infrastructure Network, if you picked somebody up and said, 'Can you help?' you would not get the normal contractor response of, [sharp intake of breath], 99% of the time you would get, 'Yeah, not a problem at all. We will solve it for you,' and they really are growing from their 'can do' attitude. The Site Infrastructure Network is likely to get maybe another*

(Continues)

TABLE 1 (Continued)

Networks/key characteristics	Reprographics	Catering	Facilities management (FM)	Site infrastructure
			it over 20–30 years, but we have not got 20–30 years. They need to do it in 20 weeks. There are all sorts of ways you can do it, but you need to invest and it will cost them. [...] I see the results when it goes wrong because I receive all the complaints from the community, I have all the emails, the telephone calls, and the angry meetings" (Senior Site Manager, Atom).	*20 or 30 million dollars worth of work in, and they are taking over work from big tier one contractors*" (Senior Commercial Manager, Atom).

Although the data were collected iteratively, we delineated three stages for clarity. First, we performed initial observations (Appendix B), and five pilot interviews with Atom's senior commercial team. We also collected secondary data dating back as far as 2008 to trace the key decisions taken by the government and Atom, leading to it being granted the planning permission to build the nuclear power plant. This analysis helped us in understanding the motivation and challenges of integrating regional SMEs in the project (regional to the project's construction site). We also constructed a timeline of the key events leading up to the government's project approval.

In the second stage, we traced the development of four networks, conducted 30 additional semi-structured, face-to-face interviews with different key stakeholders, including project directors and managers of the network orchestrator and members (Appendix C). We first approached the commercial director of the project, who provided us with a broad overview of the supply chain and contracting strategy, and the work undertaken to integrate regional SMEs in the project.

The two lead authors continued to interview project and site managers, the local Chamber of Commerce and network members including the firms' directors and project managers. Data collection was guided by an interview guide (Appendix D) including questions pertaining to the process and key decisions taken during the development and the ongoing management of the networks. To address validity and reliability issues, several techniques were deployed that helped to overcome bias (for retrospective data) introduced by the respondents' memory lapse and distortion (Appendix E; Gibbert et al., 2008). We developed the narrative from the account of diverse interviewees from the network orchestrator and members, different organizational hierarchy levels, multiple functional areas, and across the networks' relationship history.

In the third step, we triangulated the data gathered from interviews with observations from site visits, and archival data such as company and policy documents, process documents, and videos. These helped us understand the nature of communication and actions within and outside Atom. Due to the public nature of the project, we were also able to access secondary data such as public consultation documents, news reports, and briefs from professional associations. For instance, collecting and analyzing archival data helped us in constructing a timeline of key decision points from the beginning of the project (2008) until the end of data collection (2019), and gaining an understanding of the various stakeholder pressures on Atom and the project.

3.3 | Data analysis

The data analysis strategy combined three iterative steps.

3.3.1 | Step-1: Open coding and developing a timeline of events

We began by developing a timeline of events from the perspective of the network orchestrator and members

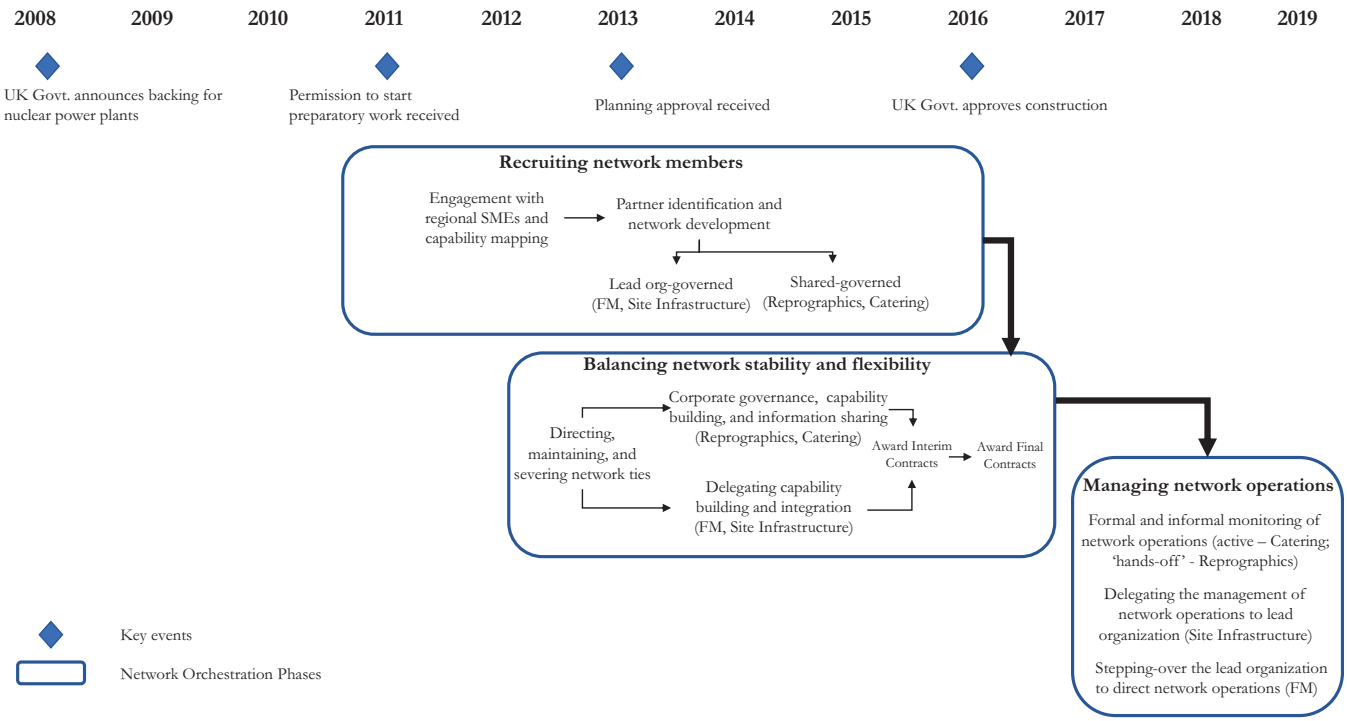

FIGURE 2 Network orchestration process.

informed by the analysis of secondary data and interviews with the commercial manager, project managers, and legal team at Atom and network members. We investigated how the network orchestrator selected governance forms, and managed subsequent coordination of four inter-organizational networks established to provide the project with a range of ancillary services. In doing so, our analysis unpacked how these governance challenges unfolded over time and supported the development of causal accounts of the underlying processes. Our research approach was characterized by conducting data collection, analysis, and theory building in tandem, coding our data in parallel with further data collection.

Data from interviews, observations, and secondary sources were coded to arrive at a timeline of events (Figure 2; Appendix G for a more detailed figure). Boxes represent key events with rectangular boxes showing events in terms of the networks, while the octagonal boxes represent external events that indirectly influenced the networks and large project. The arrows connecting one box to another indicate the sequence of the events, and how these events were connected over time. The years in the timeline (2008–2019) were kept equidistant, which allowed us to evaluate how much time had passed from one event to another. This illustration provided us we a "first cut" through the data, guiding further data analysis efforts. Following Gioia et al. (2012), we first relied on "open coding" by adhering closely to informants' terms. We grouped similar remarks together to arrive at our first-order codes.

3.3.2 | Step-2: Axial coding

Next, we compared the open codes with the literature on network orchestration (e.g., Paquin & Howard-Grenville, 2013), governance forms (e.g., Provan & Kenis, 2008), and coordination (e.g., Oliveira & Lumineau, 2017). We proceeded to substantive coding of our data into aggregate dimensions, using concepts from the network, governance, and coordination literature as a point of reference. These streams of literature provided concepts used to perform axial coding and identify patterns in and relationships between codes. Informed by this iterative process of the analysis of empirical data and theory (Strauss & Corbin, 1990), thick descriptions of the processes were produced to describe how the network orchestrator integrated SMEs into four networks. These descriptions were further validated by interviewees from the network orchestrator and members as well as by the local Chamber of Commerce. A large set of codes were generated and grouped into first and second order categories, and we also ensured to emphasize transparency with regards to the "trail of evidence" by showing how concepts and themes are interrelated (Gioia et al., 2012; Appendix F).

3.3.3 | Step-3: Explicating the relationship between task complexity, coordination activities, and network performance

We followed-up our data analysis in step 2 with another round of interviews with key managers in the network orchestrator and its members. Interviews focused on the performance of the investigated networks, and coordination activities undertaken by the network orchestrator. Data were collected from ten organizations: the network orchestrator, the Chamber of Commerce, and eight organizations participating in various networks organized around the complexity of the task they needed to perform. We examined the initial and final service requirements, and the number and interdependency between the tasks entailed in delivering the service (Handley & Benton, 2013; Shostack, 1987). Complexity of the task increases the information load and the uncertainty of service process and outcome (Handley & Benton, 2013). Since organizations and managers have limited cognitive and information processing capacity, the complexity of the service increases the need for coordination between the tasks (Zhou, 2012). Data from the interviews helped us identify the linkages between service complexity, coordination activities performed, the actors performing the activity (network orchestrator/members), and the performance of the networks. This approach to identifying the linkages between these codes and concepts was replicated across the four cases to identify relationship patterns.

4 | FINDINGS

Our analysis identified three inter-related phases of network orchestration: (1) recruiting network members; (2) balancing network stability and flexibility; and (3) managing network operations.

4.1 | Phase-1: Recruiting network members

4.1.1 | Engagement with regional SMEs and capability mapping

Atom initiated the process of recruitment after receiving permission to start the preparatory work on the site from the government in 2011. Intent on identifying and contracting with the regional SMEs, Atom approached the regional Chamber of Commerce to engage and devise strategies to engage with regional SMEs including supplier events, workshops, and informal chats in community centers. Atom also assembled an in-house supply chain team experienced in contracting suppliers on large projects in the UK. This team set up a steering group initially responsible for identifying site service operations' work packages (WPs), and developing WPs with the Chamber of Commerce to make them accessible for regional SMEs. These WPs were then shared with regional SMEs at supplier engagement events (observation #1, 2017). Additionally, the Chamber of Commerce and Atom created an online platform where the requirements of these WPs were provided, and the regional SMEs could register their expressions of interest against the WPs (Atom, 2021).

On analysis of the registered SMEs' capabilities, the Supply Chain Managers realized that no single SME had the capability to deliver the contract requirements by themselves. Therefore, they would need to collaborate with other SMEs to combine their capabilities:

> "We had the work packages with a brief scope. We identified whether the appropriate suppliers have the relevant capability for the scope. They were invited to the meeting and the scope was explained. It was made clear that the view from Atom was that there was not any single person in the room that could do this on their own, but together they might. We then said, 'those of you who want to collaborate you need to tell us by Friday that you are interested, and we are going to have a meeting'. We set up meeting slots and then waited for them to be filled" (Supply Chain Engagement Manager, Atom).

4.1.2 | Partner identification and network development

For routine services (reprographics and catering), SMEs were encouraged to identify potential partners themselves. While Atom and the Chamber of Commerce provided meeting rooms and networking spaces in their offices, Atom "did not want to spend a lot of time looking for SMEs and then trying to figure out who goes in what network and works with whom" (Supply Chain Engagement Manager, Atom). The objective of these informal meetings was for SMEs to identify whether they could work with each other, and develop a model by which they would deliver services to Atom (observation #2, 2017). This helped to "build up some initial trusting relationships and interactions between firms as they had never worked together before, and actually, quite often, did not know each other" (Head of Operations, Chamber of Commerce). This was confirmed by one of the network

members: "This was really helpful to learn about other smaller firms, and know more about possible work opportunities on such a large project" (Projects Director (SME), Reprographics Network). Atom shortlisted the networks for further discussions based on two criteria: the intent of the network members to collaborate with each other; and the suitability of service design with respect to the project requirement.

In contrast, for complex services (facilities management and site infrastructure), Atom played a more active role in setting up the networks (Atom, 2017). Based on their prior experience (Service Contract Specification, 2019), the supply chain team identified a lead organization that was established and experienced in working with large projects in the UK. SMEs interested in complex contracts were encouraged to meet with the selected lead organizations, identify opportunities for collaboration, and co-create an initial service delivery model. The lead organization, with approval from Atom, then selected the SMEs they wanted to partner with.

> "Effectively Alpha is responsible for all works that the site infrastructure network would deliver. We hold the contract but any element of work that Beta and Gamma deliver, for example, the ultimate responsibility from the main contract flows down to us" (Program Manager, Alpha).

In addition to owning the risk and being responsible for the delivery of the service, the lead organization was also responsible for governing the networks and developing SME capabilities.

4.2 | Phase-2: Balancing network stability and flexibility

4.2.1 | Directing, maintaining, and severing network ties

While the networks were formed, Atom was negotiating the strike price with the government. Atom would only gain formal project approval from the government after the strike price had been agreed and deemed to be financially viable for the parent company, Atom Group, which would make the final decision to invest in the project. In other words, while the networks were developed, there was some degree of uncertainty about project initiation. The lead organizations, being experienced in working on large projects, were familiar with this degree of uncertainty, and had resources in place to absorb it. SMEs, however, could not put their operations on hold while waiting for the project to be approved.

> "It was quite a difficult situation for SMEs. Them staying on and off, and never quite being sure whether the project was going ahead. [...] We needed firms to create networks, get to know each other and familiarize themselves with, or setting up different, processes to work together. But, networks also had to stay flexible enough to adjust to changing requirements for the project. [...] Two companies actually left the networks, because when the project dropped-off, they came to us and said, 'is it going to happen or not? If it is going to happen, I will go and re-mortgage my house.' That is how personal it became!" (Site Operations Manager, Atom).

Atom's commercial team understood that integrating SMEs into the project's networks would be unsuccessful if more SMEs dropped out or went bankrupt. While agreeing in principle to support SMEs (thus trying to ensure network stability), lead organizations were not responsible for keeping SMEs solvent, particularly since there was no formal agreement in place. Atom's commercial team adopted a combination of formal and informal coordination mechanisms to maintain network stability. Formal mechanisms included awarding interim contracts ("baby contracts"—Site Operations Manager, Atom), getting involved in corporate governance decisions to manage the entry and exit of network members, and providing the network with additional funding to help them break-even. Informal mechanisms included organizing training events for SMEs on, for example, NEC3 ("New Engineering Contract" version 3, which is a family of contracts used in the UK construction sector) contracting, and developing grant applications, networking events, and providing space for network members to meet.

The network orchestrator further supported the "stability of the network" by providing "interim contracts" as this helped organizations to start working together to deliver ancillary services to the overall project. Network members, and especially SMEs, considered this vital to make sure they stay solvent. For Atom (as the network orchestrator), ensuring that organizations stayed part of the network was crucial. This also helped in building-up capabilities of the individual networks by broadening the scope and increasing both quantity and quality expectations over time (as more organizations and workers joined the project's construction site). This speaks to the

flexibility needed by network members to adjust to changing service requirements (in terms of quality service delivery, but also to deliver the quantity of services needed for a large project).

4.2.2 | Corporate governance, capability building, and information sharing

For routine networks (reprographics and catering), the commercial management team at Atom assumed an active role in maintaining network stability, including, for instance, ensuring that the ties between network members were maintained. In the catering network, "commercial managers guided [the network members] through initial corporate governance decisions" (Managing Director, Catering Network). Atom further supported SMEs by openly sharing informal estimates of future demand to enable SMEs to plan capability developments, and ensure network flexibility during later project phases. Here, network flexibility, in terms of, for instance, "requirement changes, was needed alongside ensuring that the network was commercially viable" (Managing Director, Catering Network). Atom's commercial managers regularly visited the SMEs' premises to understand their issues, and frequently shared information about their ongoing negotiations with the government.

> "When I arrived on site, there were eleven of us here, so I had watched the construction site grow from eleven to 3,200 people. SMEs are part of our team, so they share the data that they have, and we communicate the data we have. They are involved in key meetings which are held three times a week, and all the data are fed to them. Prior to that, I held a weekly integration meeting, but we have had to do it more frequently now, but once a week we would get everybody together, all of our supply chain partners, and spend one hour just discussing and looking ahead at the program. [...] This was really needed to keep firms motivated, key networks together and stable, but yet explain repeatedly that project requirements are fluid and may, no, actually, will change" (Service Manager, Atom).

As network participation was not contractually mandated at this stage, the reprographic network did not engage with informal coordination mechanisms, such as bilateral information sharing, and capability building, that were deployed by the network orchestrator. Despite the shared governance arrangement, there was asymmetry between the network members in terms of the subtasks that were within each member's expertise and share of the contract, "resulting in discontent across network members" (Director, Reprographic Network), and limited internal (within network) and external (with the network orchestrator) engagement. This asymmetry mainly stemmed from the different expertise and capabilities that individual firms brought to the network.

> If the reprographics guys plan printing, document copying, all the digital stuff, it is only one pound. But the lithographic guys' work, it is a million pounds. [...] Those things will start to be, 'Oh, hang on a minute! He is getting this sort of business out of it.' And I have to keep reminding them: 'Do you remember our conversation? This was the risk.' [...] It was not actually the amount of money per se, it was the amount of money in percentage to your business. If somebody who got a million pound turnover business, gets £300,000 a year from this contract, it would be 30% uplift in their turnover. If we got three times that, it would not be a 1% uplift in our turnover. So, actually the figures relative to the effect on individuals' businesses was very different. Getting hung up about actually the money that you were getting was not the whole story. [...] We really needed to build up some more trusting relationships between participating firms [SMEs] in the network" (Director, Reprographic Network).

4.2.3 | Delegating capability building and integration

Atom delegated the responsibility of maintaining the stability of the networks to the two lead organizations responsible for complex service networks (facilities management and site infrastructure). In the case of the site infrastructure network, for example, the lead organization co-designed the service delivery model with the SME organizations. Although the lead organization would hold the full service contract and own the risk, it also organized training sessions on NEC contracting for the SMEs. There was an understanding that if the network was successful in delivering services to Atom, the lead organization would work on future contracts with the SMEs. In contrast, the facilities management network

was less stable. Initially, the two large organizations (Sigma and Omega) had "undertaken the responsibility of training and upskilling SMEs" (Business Development Manager, Facilities Management Network). However, due to the uncertainty of this phase and disagreement on the lead organization holding the contract, one of the large organizations (Sigma) exited the network. Atom, keen on ensuring that the network was not disbanded, asked Omega to take a pro-active role as a lead organization to ensure that the network was able to deliver key services to the project.

> "I think there was a lot of money spent on legal. [Director of one of the SMEs] on behalf of the four smaller players helped to bring legal advice to the table when we were discussing the contract. His legal team pointed out that actually the contract as it was fetched to us was not going to allow us any authority really. It was going to be given to the lead organization essentially, and there were 100s of pages of clauses, and the partnering agreement was not really worth the paper it was written on" (Mechanical Engineer (SME), Facilities Management Network).

4.2.4 | Awarding interim contracts

Atom adopted a formal mechanism to maintain stability of all four networks by awarding "interim contracts" to the networks, which were held by all members of the catering and reprographic networks, and the lead organizations in facilities management and site infrastructure networks. Contracts included provisions for Atom to intervene in key network decisions, formalized the service design and capability building activities being undertaken by the network members, and provided a mechanism to the network orchestrator to maintain the cash flow of the smaller organizations. They allowed Atom to demonstrate an ongoing commitment to regional development despite the uncertainty surrounding negotiations with the government. This helped to ensure stability (in terms of firms staying in their networks), and also starting to introduce firms to the flexibility needed for delivering services to the project. In terms of flexibility, all four networks understood that service requirements (e.g., quantity and timing of service delivery) could change from one delivery to the next and that the network needed to be "flexible enough to respond to these changes to satisfy project requirements" (Director, Reprographic Network).

In 2016, two significant events shaped the conclusion of this phase. In July, the parent organization, Atom Group, formally agreed to invest in the project and the UK government approved the construction of the new nuclear power plant in September. Following this, Atom issued an "invitation to tender" to each of the four networks, declaring them as preferred bidders. Following the formal submission of bids by each network, and subsequent negotiations with Atom's legal and commercial teams, the four networks were awarded formal and final contracts.

In sum, in the second phase, Atom invoked a combination of formal and informal mechanisms to maintain network stability. However, the intensity of the coordination and specific activities differed across the investigated networks. While only "interim contracts" were used to maintain the stability of the reprographics network, additional formal and informal mechanisms were utilized to stabilize catering, facilities management, and site infrastructure networks. These activities also provided firms across the four networks with an introduction to the flexibility (e.g., in terms of service deliveries) required to meet changing project requirements. Atom participated in corporate governance decisions and stepped-in to make key decisions across catering and facilities management networks. Atom also collaborated in service design and delivery models, and socialized with SMEs and network members, but delegated most of the responsibility for maintaining the stability of the site infrastructure network to its lead organization, and only socialized and exchanged information with the lead organization. This phase concluded with the award of final contracts. The next section illustrates the role of the network orchestrator in managing network operations.

4.3 | Phase-3: Managing network operations

4.3.1 | Formal and informal monitoring of network operations

Atom took an active role in coordinating the day-to-day activities of the catering network, such as participating in the network's strategy and ongoing meetings and influencing key decisions taken at the outset of a developing network. Atom also helped in facilitating the transfer and sharing of knowledge within the network, and across other networks facing similar issues.

> "I have been very much involved in board meetings, and driving the businesses to achieve what we need them to achieve, to

> get them to the place where we need them to be to do business, and to deliver the service. We had a forum where we brought all these embryo businesses together, and we shared practice, experience, and knowledge deliberately" (Site Operations Manager, Atom).

Atom encouraged network members to proactively raise issues by setting up the mechanism of "early warnings" and "for us [SMEs] to be much better in starting to collaborate with each other and address any occurring issues" (Managing Director, Catering Network). Atom's service managers collected user feedback through satisfaction survey and focus groups to improve service quality. Recognizing that service requirements would change over time, Atom set up relevant performance measures while also ensuring that network members would be flexible in reacting to changing requirements.

In contrast to the catering network, Atom took a "hands-off" approach to managing day-to-day operations of the reprographics network by establishing performance measures and expecting SMEs to meet them. There were no informal monitoring and engagement activities undertaken by Atom, with the service managers' preference to keep distance from the network and using a "stick" approach. Any performance shortfalls were attributed to the network-members' inability to work together (observation #4, 2018). This "stick" approach to goal-setting was confirmed by network members, who lamented that Atom did not provide regular monitoring:

> "I think sometimes we talk a lot about the NEC3 contract, and the commercial side of it. NEC3! NEC3!! NEC3!!! [...]. We have got SLAs, KPIs, and things like quota performance and turnaround. Plus, we have monthly reporting" (Projects Director (SME), Reprographics Network).

4.3.2 | Delegating the management of network operations to lead organization

Compared with networks delivering routine services (catering and reprographics), Atom gave the lead organization in the site infrastructure network, Alpha, greater responsibility for coordination, working with the other two SME partners (Beta and Gamma) on delivering services. According to the contract, Alpha was responsible for achieving the goals, administering, and coordinating tasks of the network, as well as facilitating communication between Atom and the other network members, and ensuring that payments to Beta and Gamma would flow through Alpha. As an example, Atom tasked the network to design temporary roads leading to the construction site. Alpha received this task, and then involved one of the network members in the design. The network member was selected for its expertise in local traffic management systems and knowledge of bus routes. Then, the other network member with expertise in civil engineering surfacing was involved in the design and execution planning of constructing the roads. This is an example of how the lead organization worked collaboratively with the network members. Additionally, Alpha was responsible for scaling up the capabilities of SME network members by coordinating resource investments and enhancing SME managers' skills.

> "We then agreed between the four parties (Atom, Alpha, Beta, and Gamma) that if Alpha held the main contract, we would have a partnering agreement that would sit within the contract, stipulating that Beta and Gamma had people on the management board and they had work allocation rights. Alpha has the authority to make critical decisions and allocate work to its partners" (Projects Manager, Site Infrastructure Network).

4.3.3 | Stepping-over the lead organization to direct network operations

While Atom delegated much of the responsibility for managing the site infrastructure network's day-to-day operations to Alpha, it took a different approach once it came to managing the operations of the facilities management network. Despite being managed by a lead organization, Atom became involved in day-to-day coordination activities, such as closely monitoring the daily work sheets completed by network members. The network provided services which were often delivered by individual members who did not work together (services could be divided among members with little interdependence). This led to situations were individual network members approached Atom, rather than the lead organization, to report on their individual progress. This resulted in further work for Atom which should have been handled by the lead organization.

> "I had spoken to him [Atom's Commercial Director] on a couple of occasions, and when we met, [Atom's Commercial Director] came along. I suppose, in essence, it was nice on

TABLE 2 Summary of coordination by the network orchestrator across the orchestration phases.

Networks, complexity, governance arrangement	Recruiting network members phase	Balancing network stability and flexibility phase	Managing network operations phase
Reprographics (low complexity, Shared governance)	Informal coordination • Through networking events • Personal connections • Use of common platforms	Formal coordination • Interim contracts	Formal coordination • Monthly reviews • Distribution of rewards by contribution
Catering (low complexity, Shared governance)	Informal coordination • Through networking events • Personal connections • Use of common platforms	Formal coordination • Interim contracts • Corporate governance decisions Informal coordination • Funding opportunities • Keeping informed of negotiations with the government • Open collaborative demand planning	Formal coordination • Formal monitoring • KPI adjustment • Customized payment terms Informal coordination • New business development • Informal performance monitoring
Facilities management (high complexity, lead-organization governance)	Informal coordination • Through networking events • Personal connections • Use of common platforms	Formal coordination • Interim contracts • Stepping in to make key decisions • Keeping informed of negotiations with the government Informal coordination • Collaborative service design • Informal socialization with network members	Formal coordination • Formal monitoring • Stepping in to make key decisions • Direct line of communications with SMEs Informal coordination • Informal monitoring • Advising on service design • Conflict resolution
Site infrastructure (high complexity, lead-organization governance)	Informal coordination • Through networking events • Personal connections • Use of common platforms • Through lead organization	Formal coordination • Interim contracts • Delegated to the lead organization Informal coordination • Keeping informed of negotiations with the government	Formal coordination • Formal monitoring through lead organization's KPIs • Demand sharing Informal coordination • Socializing with lead organization • Keeping informed of external decisions

> your journey through this to get a one-to-one with [Atom's Commercial Director], and have a little chat about how it is going for you" (Owner, SME, Facilities Management Network).

Atom's overly intrusive involvement led to one of the network members dissociating themselves from the network. This was disappointing for network members, as Sigma (as lead organization) had previously invested in training and upskilling network members, and Atom's day-to-day involvement in network coordination undermined the lead organization's effort. Consequently, a new lead organization, Omega, was appointed by Atom. Omega was not a specialist in facilities management, but a large utility company operating in the region. This network arrangement stood in contrast to the "site infrastructure network" in which the lead organization (Alpha) was a specialist in all services provided. The new arrangement was disappointing for some of the network members, who were looking forward to developing their capabilities with Sigma.

> "For us, as a company, that was a real hardship because Sigma had massive ability in build, program systems, and machinery equipment. It would have been a real asset for us to grow with them" (Business Development Manager, Facilities Management Network).

This situation was reflected in the performance of the network in terms of cost overruns, and delays. As a result, network members tended to approach Atom to resolve issues, rather than communicating first with the lead organization. Atom then reacted by getting excessively involved in key decisions with regards to network activities, thereby defeating the purpose of having a lead organization in the network.

In sum, in the third phase, Atom adopted a combination of formal and informal mechanisms to coordinate network operations. In the case of the reprographics network, Atom carried over its hands-off approach from the previous phase, restricting its involvement to formal monitoring and ensuring that the incentives and payment terms were aligned with the relative contribution of the network members. In contrast, Atom was more closely involved in the management of catering and facilities management networks by monitoring the performance both formally and informally, setting-up bespoke payment terms that were more suitable for SMEs, and open and frequent demand sharing (observation #6, 2018). Atom also retained the rights to veto the decisions made by the network members and remained involved in the governance and service design meetings.

Atom maintained open communication with the SMEs and guided them on bidding for other contracts. In case of the site infrastructure network, however, Atom restricted its interaction with SMEs to formal monitoring, and maintained most of the communication and interactions through the lead organization. The decision on the mode (formal/informal) and intensity (active/passive) of coordination by the orchestrator had implications for performance. In the case of routine services, a much higher involvement of the network orchestrator in network operations (i.e., both formal and informal coordination, and both active and passive coordination) was needed to drive high network performance (catering). In contrast, in complex services, the subdued involvement of the network orchestrator in network operations (formal and informal, and *only* passive coordination) was important for high performing network operations (site infrastructure).

A complete overview of the formal and informal mechanisms adopted by Atom across the three phases of the network orchestration process are summarized in Table 2.

5 | DISCUSSION

5.1 | Theoretical contributions

Despite offering important insights into how large inter-organizational networks are coordinated and integrated in large projects (Jones & Lichtenstein, 2008; Manning, 2017; Oliveira & Lumineau, 2017; Tee et al., 2019), prior research offers surprisingly limited understanding of how their constituent service networks are purposively orchestrated (Paquin & Howard-Grenville, 2013; Perks et al., 2017). Our research contributes to formal middle-range theory (Glaser & Strauss, 1969, p. 32) by reformulating and advancing research on network orchestration in the empirical setting of inter-organizational networks embedded in a large project. Here, our study offers two distinct, yet inter-related, contributions to prior network and governance studies with a focus on within projects.

First, prior studies offer limited insights into how a network orchestrator selects the most appropriate form of network governance (Raab et al., 2015). Previous studies are either conceptual in nature (e.g., Provan & Kenis, 2008), or have examined intra-organizational networks (e.g., Zhou, 2012) Providing an empirical and contextual analysis of this gap is important given that the choice of network governance form enables, or constrains, performance. While networks governed by lead organizations may foster efficiency, external legitimacy, and stability, networks with shared governance foster collaboration, internal legitimacy, and flexibility (e.g., Provan & Kenis, 2008).

Our findings show that task complexity drives the choice of governance form, where shared governance is more appropriate for routine services, and lead organization governance is more appropriate for complex services. We theorize that the advantages of each form of network governance are analogous to those that might be realized through the introduction of an organizational hierarchy. Task complexity creates extensive interdependencies (Simon, 1962) that require hierarchical communication structures to help reduce coordination costs, manage conflicts, and resolve trade-offs (Galbraith, 1977). Appointing a lead organization to govern the network creates an inter-organizational quasi-hierarchical structure that allowed the network orchestrator to effectively delegate control, and make the lead organization responsible for goal achievement, ongoing coordination of tasks, and decision making. Task complexity creates pressure for increased specialization, coordination, and administration (e.g., Donaldson, 2001; Mintzberg, 1989), therefore favoring network governance with a lead organization. Thus, we posit the following proposition:

> **Proposition 1.** *Within an inter-organizational network there is a fit between task complexity and network governance; network governance involving a lead organization is most effective for the delivery of complex services, while shared governance is most effective for routine services.*

Second, prior research has shown that effective coordination depends on the fit between coordination needs and coordination mechanisms (Gulati et al., 2012; Oliveira & Lumineau, 2017), but offers limited insights into how a network orchestrator relies on formal and informal coordination to govern inter-organizational networks (Fortwengel & Sydow, 2020; Provan et al., 2007; Reypens et al., 2021). This is important given that our data showed that fit between task complexity and network governance contributes to high network performance. Across the four investigated networks, two are high performing (site infrastructure and catering), and two are low performing networks (facilities management and reprographics). Table 2 identified two types of coordination (formal and informal), provided a sense of its intensity, and indicated how it evolved over the three network phases. Our data indicate that low network performance (as measured by time, cost, quality, and relationship satisfaction) may emerge from either neglecting a type of coordination, or from a mismatch between the form of governance structure and the coordination intensity within a network. Following calls by Provan and Kenis (2008) and Raab et al. (2015) to examine the roles of management and governance, our findings suggested that outcomes are a function of both structural and relational properties of a network.

Two different approaches were used for the ongoing coordination of the shared governance networks. First, the catering network began with informal governance activities, including networking, and the use of personal connections, before migrating to a mix of formal and informal mechanisms, including formal interim contracts and monitoring, and informal socialization, and new business development. Second, the reprographics network started out with the same informal mechanisms, but then relied on formal coordination for the subsequent two network phases. The lack of informal coordination led to tensions between participants and poor performance.

Similarly, we identified different approaches to ongoing coordination within the networks governed by lead organizations. Both networks evolved from informal to the use of both formal and informal coordination, they differed in their intensity of use. In the site infrastructure network, coordination was rather passive and most of the coordination was led through the lead organization. In the facilities management network, by contrast, the network orchestrator was much more active, often circumventing the lead organization, and attempting to directly coordinate the activities of the SME network members. This is reflected in the different types of coordination activities that emerged in phases two and three (Table 2), and suggests a mismatch between the structure of the network and the coordination intensity.

We suggest that the different levels of coordination were influenced by task decomposability within the network. Task decomposability refers to the extent to which the tasks of each supplier are interdependent (cf. Zhou, 2012). Higher levels of task decomposability mean that suppliers can operate more independently through the provision of different services, or the standardization of outputs between stages of processing. Whereas previous studies have considered how task decomposability and complexity impact on internal organizational structure (Zhou, 2012), our research examined their effects at the inter-organizational level. Task decomposability is a positive feature for organizations facing complexity, allowing sub-units to specialize in their individual tasks with less coordination required between those units (Baldwin & Clark, 2000; Simon, 1962). However, our data suggested that decomposability may also be associated with negative performance outcomes when not managed properly. In the case of the reprographics network, near decomposability meant that the suppliers could operate independently (Goold & Campbell, 2002), and were insufficiently motivated to develop informal coordination mechanisms across the network. Over time, inter-organizational socialization was neglected (Cousins & Menguc, 2006), and suppliers became increasingly isolated. These feelings were exacerbated by unequal contract shares and resulted in poor service delivery to the client and cost overruns. Since the catering operation, by contrast, was not nearly decomposable, suppliers were forced to coordinate more fully on tasks across the network (Ethiraj & Levinthal, 2004). Over time, coordination led to knowledge sharing between network members, culminating in excellent service performance in the face of significant scaling challenges.

Negative outcomes associated with decomposability may also stem from a mismatch between network structure and coordination intensity between the network orchestrator and the network members. Within the facilities management network, the network orchestrator effectively disintermediated the lead organization within the network, and assumed responsibility for managing SME network members. This inadvertently created a multi-authority relationship, where network members are faced with managing more than one client (Levinthal & Workiewicz, 2018), and resulted in the relegation of the lead organization in the eyes of both the network orchestrator and SME network members. On the other hand, the network orchestrator took a complimentary approach within the high preforming lead organization network. The network orchestrator respected the position of the lead organization empowering them to coordinate activities within their network. Thus, we posit the following proposition:

Proposition 2. *Within an inter-organizational network positive network performance develops from a coordination process that utilizes both formal and informal coordination mechanisms, and compliments the structure of the network governance form.*

5.2 | Boundary conditions and further research

Although we examined a network orchestrator, and the set up and coordination of inter-organizational networks in a project in the nuclear industry, we believe that our findings have insights for network and governance in other settings. Future research should compare our findings to other industries (e.g., subject to varying degrees of urgency in delivering products and/or services as this may impact on governance forms and coordination activities), and the wider institutional and legal environment (e.g., organizations operating in countries with less mature legal systems may de-emphasize formal coordination). Moreover, given the limited number of firms in our investigated networks, we urge researchers to investigate other networks with different characteristics (e.g., such as a larger number of network members; larger organizations). Increasing the number of network members may have an impact on the choice of governance form, and how larger networks are being coordinated by a network orchestrator as coordination activities may be more time- and resource-consuming due the higher number of network members.

While our investigated networks were characterized by a stable governance form, future research should consider the impact of a changing governance form across the network lifecycle on network performance and coordination needs. The role of coordination practices to reproduce or change the network governance form originally selected, may also provide another fruitful avenue for future research. Further studies should also explore the use of relational contracts (vis-à-vis formal, written contracts enforced by courts) between parties with prior work experience (and mutual trust), or in later stages of the network lifecycle when network members had an opportunity to build up trusting relationships. The use of relational contracts may impact the nature and intensity of coordination needed to ensure high-performing networks.

Future research on the dynamics of inter-organizational networks in large projects might benefit from a multi-level approach that accounts for the interplay between forces "from below" and "from above" (Sydow & Braun, 2018). On a level below, inter-organizational networks involve collaborating organizations with varying degrees of capabilities and experience that must be taken into account when considering the performance of each network. On the level above, inter-organizational networks are embedded in a larger project and organizational or institutional environment (e.g., government policy and industry standards). They are often coordinated by a permanent parent organization (e.g., sponsor, client, delivery body, or prime contractor) whose experience, capabilities, and rules acquired when managing inter-organizational networks in past projects (the "shadow of the past") may contribute to the approach used to govern and coordinate, as well as the willingness to collaborate (the "shadow of the future") in inter-organizational networks on future projects (Rigtharrt et al., 2016). Conceptualized as multi-levels, it may be possible to study how the choice of governance and coordination of inter-organizational networks in large projects is enabled and constrained by forces from above and below, and by the shadows of the past and the future.

This study drew upon multiple sources of data including interviews, observations, and archival data. Future studies drawing more on (scenario-based, or field) experiments would inform the literature on the process established by a network orchestrator and members to set up and coordinate the various networks in a project. Research might study who at what level (subsidiary, business, and corporate), and in what job role (e.g., engineering, legal, and procurement) uses formal and/or informal coordination activities. Other performance measures might be considered that transcend purely economic measures, such as social value creation (Helper et al., 2021)—defined as "broad social benefits to a given population [...] minus their associated provision costs" (Lazzarini, 2020, p. 620). Identifying the role that network orchestration of large, inter-organizational projects may play in the creation of social value for a variety of different stakeholders provides a fruitful future research avenue.

5.3 | Implications for practice

Our study has important implications for orchestrating networks of SMEs to provide large complex projects, such as nuclear power plants, railways, or Olympic games, with supplies of catering, reprographics, facilities management, site infrastructure, and other ancillary services over the project life-cycle. In recent years, clients, sponsors, and governments have begun to recognize the role played by networks of SMEs in supporting and revitalizing the regions—creating "social value" or "positive externalities"—within which projects are situated. Such an approach requires network orchestrators, often large firms, to think differently about procurement and contracting, specifically by creating opportunities for local SMEs to

participate in high-performing inter-organizational networks of service provision. However, project management researchers, advisors, and practitioners focus almost exclusively on whether the core project has achieved its overall time, cost, and quality objectives, ignoring how the provision of ancillary services can be improved, and the participation of SMEs can create wider societal benefits for localities surrounding the project. Our findings have therefore immediate implications for clients and lead organizations that orchestrate networks of firms, including a range of SMEs, supplying essential services for the overall project to function smoothly.

For clients or lead organizations responsible for orchestrating networks, it is vital to understand and organize to address the complexity of service provision. Network orchestrators may benefit from designing networks that mirror the complexity of the task. Greater complexity in services creates uncertainties, conflicts, and trade-offs, challenges that a lead organization is best placed to resolve. Therefore, our findings suggest that shared-governed networks (where all organizations participate on an equal basis) are preferable for relatively routine services, and that lead-organization governed networks (where there is a more hierarchy akin to a delegated or tiered structure) are appropriate for complex services.

Recruiting network members, balancing stability and flexibility, and managing network operations are the three critical phases for successful achievement of SME network orchestration in large projects. Drawing managers' attention to the differing phases of network orchestration entails understanding the mix of formal and informal coordination at the appropriate time and aiming to foster coordination consistent with evolving requirements of service provision. Here, managers should consider formal coordination, such as interim contracts and clear corporate governance decisions, combined with informal coordination, such as collaborative future demand planning and informal socialization with network members. As shown in Table 2, the specific coordination activities will vary across the three network phases.

There are at least two possible coordination traps that network orchestrators may need to avoid. First, managers need to appreciate that contracts can be perceived to be inequitable and can lead members feeling isolated and demotivated, contributing to poor network performance. Managers need to set clear and joint goals for all network members at the outset of the network formation. Monitoring ongoing performance targets and their achievement is crucial as performance deviation should be actively addressed in a timely manner by the network orchestrator. Second, network orchestrators, however, should avoid the temptation to micro-manage networks, knowing instead how to effectively delegate responsibility to participating organizations. Micro-management undermines the legitimacy of the lead organization in a lead-organization governed network, or the roles and responsibilities of all network members in a shared-governed networks, and thus restricts opportunities for learning. When considering decomposable tasks (i.e., organizations can work more or less independently from each other), our findings demonstrated that managers may be better served with a series of dyadic contracts if the network does not deliver to the appropriate performance levels, rather than imposing a rigid network structure on a set of very discrete tasks.

Our study provides guidance to SMEs on engaging successfully in inter-organizational networks in other large projects. In the past, the mismatch between the scale of the requirements of a large inter-organizational network and the size of SMEs would discourage SMEs from bidding for contracts. Our study demonstrates that working in collaboration with other SMEs and, in some cases, a more experienced lead organization could lead to SMEs successfully winning and delivering on the contractual requirements of an inter-organizational network. However, SMEs need to be mindful of the governance form, mode of coordination, and intensity of coordination. While working with other SMEs, SMEs should actively seek to engage with other network members and the orchestrator. In contrast, while being governed by a lead organization, SMEs should refrain from circumventing the lead organization to seek a more direct relationship with the orchestrator. This could lead to network failure (i.e., low network performance), and damage the prospect of getting further business from the orchestrator. Instead, being governed by the lead organization could lead to good performance, and the award of more contracts from the lead organization working on other projects.

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