The Organisational Architecture of Megaprojects

Juliano Denicol, Andrew Davies, and Stephen Pryke

Abstract

This research explores the formation and evolution of the organisational architecture in megaprojects. We introduce the Project System Organisation (PSO) conceptual framework, which charts the architecture of megaproject organising, from intra- to inter-organisational design, and ultimately to system-level design. The PSO identifies the multiple and evolving actors across the multi-level and multi-layer megaproject system and defines four roles often used to label the client in megaprojects: owner, sponsor, client, and partner. Six megaprojects that currently represent a combined investment of more than £100 Bn have been analysed through 171 interviews in the United Kingdom: High Speed One, Heathrow Airport Terminal 5, London 2012 Olympics, Crossrail, Thames Tideway Tunnel, and High Speed Two. The PSO provides a structure to design megaproject delivery models and prototype the configuration of inter-organisational relationships. We suggest designing megaprojects as dynamic production systems, decomposing and integrating the organisational boundaries of the system in the evolving architecture.

Keywords: Megaproject Management, Organisation Design, Organisational Architecture, Inter-organisational Relationships, Client Organisations, Governance.

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1. Introduction

A megaproject is defined as a transformational project of over US$ 1 billion cost proposed by public or private sectors, providing assets that will last for decades and have large impact on societies (Flyvbjerg et al., 2003; Priemus and Van Wee, 2013; Flyvbjerg, 2014; 2017). Megaprojects are commonly associated with the delivery of major infrastructure projects in several industrial sectors, which often face significant cost overruns and delays due to multiple factors (Morris and Hough, 1987; Priemus, Flyvbjerg, and Van Wee, 2008; Merrow, 2011). The megaproject management literature has been consolidated in one of the largest systematic reviews to date, revealing 18 causes and 54 solutions to improve megaproject performance (Denicol et al., 2020). The solutions emphasise the importance of exploring the organisational elements of megaprojects through a systems lens.

Megaprojects are delivered through a combination of relationships between multiple organisations, creating a complex organisational challenge that is often underexplored in light of the technical specifications. Prior research has focused on individual actors in megaprojects, using a variety of interchangeable and often confusing terms to describe the focal organisation responsible for leading a megaproject such as the owner (Morris and Hough, 1987; Merrow, 2011), owner and operator (Winch, 2014), sponsor (Miller and Lessard, 2000; Morris, 2013) and client (Airtua et al., 2009). However, little is known about how the organisational architecture is formed and evolves in megaprojects, where the intra-organisational structure is developed influencing the emergence of inter-organisational strategies.

This study explores the organisational architecture of megaprojects and started with one of the most frequent questions from the community involved in megaproject delivery: Who is the client in megaprojects? In recent years clients have been moving away from the traditional approach of distant investors towards new frameworks of engagement with stakeholders to foster integration, coordination, and innovation, therefore it is important to understand in detail the terminology, various organisational configurations and behaviour of each actor over the life-cycle.

This research introduces the Project System Organisation (PSO) conceptual framework to identify the multiple actors in the megaproject structure, provide clear terminology, and unpack the roles and responsibilities of those entities in the megaproject delivery model. The framework was developed based on 171 interviews with the senior leadership of London's megaprojects. Six megaprojects have been analysed: High Speed One, Heathrow Airport Terminal 5, London 2012 Olympics, Crossrail, Thames Tideway Tunnel, and High Speed Two.

We conceptualise megaprojects as a system of organisations that need to be designed, coordinated, and collectively organised at intra-, inter- and system-level to deliver the asset and unlock value. This research argues that the client is the key organisation in megaproject delivery and is responsible for configuring how the system is organised, coordinating the multiple parties involved during different phases of project.

The PSO charts the architecture of megaproject organising, from intra- to inter-organisational design, and ultimately to system-level design. The PSO provides a structure to design, decompose and integrate the relationships between the main actors of the megaproject organisational system. The PSO offers an inter-organisational canvas for organisation designers, system of systems architects, meta-system integrators, meta-organisation architects, network orchestrators, enterprise and supply chain architects, and delivery model designers.

2. Theoretical framework

This section provides a review of the literature, problematising and identifying unresolved questions neglected in prior research, in order to develop a theoretical framework to understand the organisational architecture of megaprojects, different roles and configurations.

2.1 Megaproject delivery models

Megaprojects are complex system of systems projects used as the delivery model to build large sport events such as the Olympic Games (Flyvbjerg and Stewart, 2012; Davies and Mackenzie, 2014) and the Football World Cup or major defence programmes (National Audit Office [NAO], 2004) including weapons systems, submarines and aircraft programmes like the Joint Strike Fighter. Megaprojects are often used to deliver major infrastructure assets, including nuclear power plants (Morris and Hough, 1987), oil and gas factories and platforms (Merrow, 2011), mining, telecom facilities (National Audit Office [NAO], 2004a), hydroelectric plants (Ansar, Flyvbjerg, Budzier, and Lunn, 2014), seaports, airports (Davies, Gann, and Douglas, 2009), railways (Davies, MacAulay, DeBarro, and Thurston, 2014), bridges (Van Marrewijk, 2015), tunnels (Greiman, 2013) and highways (Altshuler and Luberoff, 2003).

'Project Delivery Model' is a concept that was recently explored in light of the business model literature (Davies et al., 2019). However, the word delivery can be associated with the construction phase of the project and sometimes 'delivery model' can be mistakenly understood as just the execution strategy, which is only a part of the delivery model and reflects partially the strategy to engage with the supply chain (Davies et al., 2019). Therefore, it is relevant to emphasise that the 'project delivery model' represents not only the construction phase but the whole life-cycle, where several organisations act and add value. A megaproject delivery model is defined here as the overall strategy that a public or private entity (often the owner or sponsor) adopts to engage with organisations from the public or private sector that will 'deliver' (design/deliver/operate) the physical asset throughout different phases of the project, from development, through delivery, to operations.

Megaprojects are characterized as extremely complex endeavours, comprising a range of different platforms of systems to be integrated, the so-called systems of systems or array project (Shenhar and Dvir, 2007). In terms of organisational structure, a megaproject comprises a large network of enterprises distributed in several supply chain tiers, which are requested to contribute according to their expertise in specific aspects of the project (Denicol, 2020). This temporary multi-organisation coalition is frequently composed of an owner who usually is the sponsor and operator, a delivery partner who performs the role of programme manager, Tier 1 prime contractors that act as systems integrators, Tier 2 subcontractors that supply sub-systems, Tier 3 suppliers that provide components, and subsequent tiers that contribute with sub-components until raw materials (Pryke, 2009; Mead and Gruneberg, 2013; Pryke 2017).

The traditional way of delivering megaprojects is the owner/operator acting as the sponsor and empowering other supply chain actors to act on their behalf to deliver the physical asset. Therefore, the owner might appoint a prime contractor (single organisation) or delivery partner (single entity or consortium of enterprises) to manage the project and establish relationships with the rest of the supply chain. An owner-driven delivery model is a more recent and innovative way of organising the megaproject structure (Gil, 2009; Gil and Beckman, 2009), where the owner can either vertically integrate the project management skills, trusting entirely in his own project management team (Davies et al., 2009; Gil, Miozzo, and Massini, 2012), or establish a temporary client organisation which will be augmented in capacity and capability by delivery partners, developing a governance structure to proactively contribute in strategic, tactical and operational decisions (Davies and Mackenzie, 2014; Davies et al., 2014). Previous megaprojects suggest that the building blocks that enabled their successful performance (Denicol et al., 2020) was the appropriate management of the front-end, where the owner had a deep involvement proactively defining strategies of governance, programme procurement and supply chain management, either through the in-house project team (Heathrow Terminal 5 – British Airports Authority, BAA) or temporary client organisation (London 2012 Olympics – Olympic Delivery Authority, ODA and Crossrail – Crossrail Limited, CRL Ltd) (Davies, Dodgson, and Gann, 2017).

2.2 Clients, Owners, or Sponsors?

Morris and Hough (1987) conceptualised the role of the owner, exploring cases across several industrial sectors (e.g. civil construction, aerospace, energy, oil and gas, ICT), arguing that some of the characteristics of the owner are associated with the practices of each industrial sector, such as the in-house development, outsourcing and contracting policies. The level of engagement of the owner with the supply chain throughout the project life-cycle (design, construction, operations) was classified across the cases in the following categories: no owner (Channel Tunnel – Civil/Mechanical), weak to almost non-existent owner (Concord – Aerospace), muddled owner (APT – In-company product development), weak owner (The Thames Barrier – Civil construction), learning owner (Heysham 2 – Power station), strong but still learning owner (Fulmar – North Sea oil and gas), strong owner (COP – Computerisation), and strong participatory owner (Giotto – Aerospace). The classification ranging from weak to strong owners is associated with whether they are experienced or not, which is partially a reflection of the industrial dynamics that occur in each sector, which in turn might be analysed both structurally and in terms of the product and its complexities. Winch (2014) explores this domain by the lens of the owner operators, as an alternative to clients, and Winch and Leiringer (2016) do so through the strong owner concept, building upon Morris and Hough's (1987) research. Winch and Leiringer (2016) argue that an emphasis on the 'owner' would move the focus towards long-term decisions associated with the operations and provision of services, rather than short-term transactional ones driven by a 'client'.

Morris (2013) emphasised the role of the sponsor rather than the owner, as previously identified in Morris and Hough's (1987) work. However, the differentiation and connections between both terms could have been explored in more depth, as exemplified by instances where the terms owner and sponsor are used as synonyms at the organisational level. Miller and Lessard's (2000) research provides a comprehensive reflection of large engineering projects, drawing upon 60 projects. The authors emphasise the concept of 'project shaping' in the front-end, where 'persistent sponsors' would shape and reshape projects in the front-end. The authors highlight that one of the key competencies of sponsors is 'ownership', where the sponsor would take into consideration its future operator role, informing its decisions as 'a responsible owner' throughout the project life-cycle. Previously, Genus (1997) highlighted a similar challenge (i.e. 'missing operator') in the Channel Tunnel project.

Similar to Morris and Hough's (1987) exploration of the owner, Miller and Lessard (2000) labelled sponsors as 'strong' and 'competent' to identify those organisations with previous involvement and experience, whereas 'inexperienced ones were given the label 'weak'. The authors distinguish between public and private sponsors, the latter represented by a firm or consortium appointed when governments opt for a concession (e.g. Build Operate Transfer (BOT)). Brealey et al. (2000) recognise that one of the first choices of the sponsor is associated with the organisation responsible for delivering the project, such as a Special Purpose Vehicle (SPV), or through a company owned by the sponsor and functioning as its extension.

Miller and Lessard (2000) represent the term 'sponsors' recognising both the organisational (e.g. sponsoring organisations) and individual levels (e.g. project sponsor executives within the sponsoring organisation); however, sometimes sponsors and owners are used interchangeably. As it is argued in this research, they might be the same organisation, but not necessarily. In other instances, the relationship mentioned is owner-contractor, which is covered in the literature through different streams, mainly at the individual level (e.g. project owners and project sponsors as representatives interfacing with the project manager), with the governance and procurement streams (e.g. project delivery methods and systems) emphasising more the organisational level. Illustrative literature streams include: project delivery methods (Gordon, 1991; Miller, 1997; Miller and Evje, 1999; Pietroforte and Miller, 2002), project delivery systems (Miller et al., 2000; Garvin, 2003; Ibbs et al., 2003; El Asmar et al., 2013; Liu et al., 2014, 2015, 2016), project champion (Bryde, 2008), agency (Andersen, 2008; Turner and Müller, 2004; Müller and Turner 2005; Szentes and Eriksson, 2016), behaviours (Helm and Remington, 2005; Kloppenborg et al., 2006), trust (Zwikael and Smyrk, 2011), relationship (Larson, 1995; Andersen, 2012; Drexler and Larson, 2000; Harmon, 2003; Suprapto et al., 2015), governance (Crawford et al., 2008; Zwikael and Smyrk, 2015).

2.3 Capable owner model

The owner can drive the multi-organisation supply chain performing the role of supply chain manager or systems integrator, establishing relationships with construction companies at several tiers to integrate the procured work-packages (Prencipe, Davies, and Hobday, 2003; Pryke, 2009). In this organisational structure, the supply chain actors are independent entities operating under separate contractual agreements with the owner (e.g. architects, tier 1 main contractors, cost consultants) (Rolstadås et al., 2011; Hart, 2015). The owner aiming to influence the governance of the supply chain and act as a systems integrator should look into its organisation and analyse if there is enough in-house project management capabilities to fit together all the systems and sub-systems and complete the mission (Hobday, Davies, and Prencipe, 2005). The owner that assumes the risk and trusts its own project management team, or develops it through an insource process of this knowledge, is rare, mostly because of the temporal characteristic of the construction industry and the lack of guarantee of future projects. This type of owner therefore is no longer a mere sponsor just providing the capital at the beginning with no control, or interest, in strategic decisions at the front-end of the project or in the dynamics of the construction phase at enterprise and project level (Winch, 2014). It expands the usual characteristics of owners as sponsor and operator, by exerting the ownership of the project through involvement in strategic and tactical decisions in order to guarantee a successful delivery (Winch and Leiringer, 2016). In general, these owners are permanent organisations that have operational capabilities to run their business, an extensive knowledge of the supply chain as well as buyer power, which allow economies of scale and supplier interest to access the given market (Davies and Brady, 2016). Thus, these organisations are well positioned to conduct sporadic capital projects, either to expand their business or to improve the current portfolio of assets in order to provide better service for their customers (Merrow, 2011).

A well-known case of owner enterprise with these characteristics was the British Airports Authority (BAA), which was a case of best practices in supply chain management by the time of Heathrow T5 construction (Potts, 2009; Denicol, 2020). In the case of Heathrow T5, the owner (BAA) developed a strategic programme to deliver megaprojects that is considered an innovation in project management, redefining the way of delivering systems of systems projects (Gil et al., 2012; Davies et al., 2016). BAA took advantage of its in-house capabilities, supply chain knowledge and buyer power, and acted as a strong and intelligent client, in a rare case where the owner internalised the project management function and performed the roles of owner, sponsor, client, and operator (Davies et al., 2009). In this context, BAA created a delivery model innovation internalizing the risk and not dumping it on the contractors, creating an environment where the supply chain would have their profit margin guaranteed and would be free to focus their attention to innovations, to impact the project and reduce its costs (Michaud and Lessard, 2000; National Audit Office [NAO], 2005). In this agreement, every supply chain member was able to propose innovations having the possibility to increase their profit, since this saved margin would be shared by a contract between BAA and the supply chain partners (Brady and Davies, 2011).

Davies et al. (2017) present further examples from several industry sectors of enduring owners, organisations that act in a similar fashion to BAA for operations and capital projects: British Petroleum (BP), Shell, Network Rail, Highways England and London Underground. This concept can be expanded to some major public owners, like the National Health Service (NHS) and even the government for strategic projects, which should become strong owners and participate actively throughout the delivery process to guarantee its own interest and decrease the number of unsuccessful projects. The literature presents several names to classify this type of owner, which is often still called by the term ‘client’: strong owner (Morris and Hough, 1987; Porter, 1998; Swarup, Korkmaz, and Riley, 2012; Winch and Leiringer, 2016), sophisticated owner (Lovejoy and Mortensen, 1989), influential owner (Cox and Ireland, 2006), capable owner (Long, Ogunlana, Quang, and Lam, 2004; Merrow, 2011) , intelligent client (Airtua, Male, and Bower, 2009; Airtua, Male, Bower, and Madter, 2011; Emuze and Smallwood, 2011; Madter and Bower, 2015; Laryea and Watermeyer, 2016), sophisticated client (Higgin and Jessop, 1965; Loosemore and Richard, 2015), pluralistic client (Cherns and Bryant, 1984; Green, 1996; Thompson, 2011), continuing client (Hillebarndt, 1984; Wu, Kumaraswamy, and Soo, 2011), informed client (Elston, 1992;

Smith, 1994), experienced client (Masterman and Gameson, 1994), large ongoing portfolio client (Blismas, Sher, Thorpe, and Baldwin, 2004), progressive client (Tah, 2005), active client (Sturdy and Wright, 2011), and capable client (Denicol, 2020a).

2.4 Temporary client organisation model

In one-off projects, if the project is not related to the core business of the owner, there is a high probability of hiring a delivery partner that has the knowledge and expertise to manage complex projects and programmes (Grabher and Thiel, 2015). The argument is that the delivery partner will do it better and more competitively than the owner, since they are working on their core business (Davies and Brady, 2000). However, it is critical for the owner to have its own project team, which will be part of a temporary client organisation that will be established to manage the interface with the delivery partner (one company or joint venture) (Davies and Mackenzie, 2014). The temporary client organisation should report to the owner and act as the supply chain architect (Denicol, 2020a), coordinating together with the contracted delivery partner and leading the integration of the supply chain (Denicol, 2020). In the management of megaprojects, the front-end should be emphasized, in order to create the governance structure that will enable a successful achievement of the goals (Artto, Ahola, and Vartiainen, 2016).

The Temporary client organisation model is suitable for owners that do not have in-house project management capability or are not strategically interested in conducting capital projects in parallel to their business operation (Söderlund and Tell, 2009). After Heathrow Airport Terminal 5, a legacy of lessons was available and the following UK megaprojects adopted a different strategy, London 2012 Olympics (Brady and Davies, 2014), Crossrail, Thames Tideway Tunnel and High Speed Two. Crossrail is a 118-km, west-east, interurban railway that provides 10% extra capacity to London's rail network. Thames Tideway Tunnel is a 7.2-meter-wide sewer tunnel with 25 kilometres of extension underneath the River Thames, running west-east from Acton to Abbey Mills. Tideway is the largest water and sewerage project since the sector privatization in 1989, and also known as London's super sewer. High Speed 2 (HS2) is a railway that will connect London with the north of England and is divided into three phases: (i) Phase 1 (London to Birmingham), (ii) Phase 2a (Birmingham to Crewe), and (iii) Phase 2b (Crewe to Manchester, and Birmingham to Leeds). HS2 is currently the largest infrastructure project in Europe.

The next generation of megaprojects opted to buy the necessary knowledge from the market because they were not experienced owners like BAA and most did not have the time to develop the capabilities to run the project (Davies and Brady, 2016). In this model, the temporary client organisation might act as the integrator of external stakeholders, creating a shield from the external environment for the delivery partner, which is responsible for the systems integration of all Tier 1 contractors, managing the interfaces between each Tier 1 contractor. On the London 2012 Olympics programme, a temporary client organisation was created, (Olympic Delivery Authority – ODA) and three companies with recognised experience in megaproject deliveries (CH2M Hill, Laing O'Rourke and Mace) were hired to act as Delivery-Partner (CLM), performing the role of programme and project manager (Davies and Mackenzie, 2014). In Crossrail, the strategy was to divide into two partners the programme and project manager functions, both with interfaces with the temporary client organisation (Crossrail Limited – CRL) (Dodgson et al., 2015). This model allows visibility and assurance to the temporary client organisation and the delivery partners, which are the only ones that have the visibility of the whole supply chain to manage it systemically. Tier 1 contractors often can only manage their own supply chain, their own independent island, not having the scope and time to understand what is happening in other Tier 1 islands, and therefore there is no visibility to manage the interfaces, where the risks and problems are often hidden.

2.5 Summary

Owners with ongoing operations and previous organisational experience in major capital projects might select to internalise the coordination and act as the system of systems integrator, while if the project is not strategic they can still appoint an external agent as a partner to deliver on their behalf. However, owners without the prior knowledge of and exposure to major projects would not be able to consider internalising the systems integration role, finding it necessary to appoint a delivery agent. Strategically, even when owners have in-house project capabilities to deliver projects, often megaprojects are risky endeavours that do not fit the corporate profile and appetite of shareholders. However, what is distinctive is that owners are creating their own standalone entities to be solely responsible for that project, a temporary organisation that often closes at the end of the project, aiming to have a closer interface with the delivery partner, enhancing integration, coordination and control through several forms, as illustrated by Figure 1.

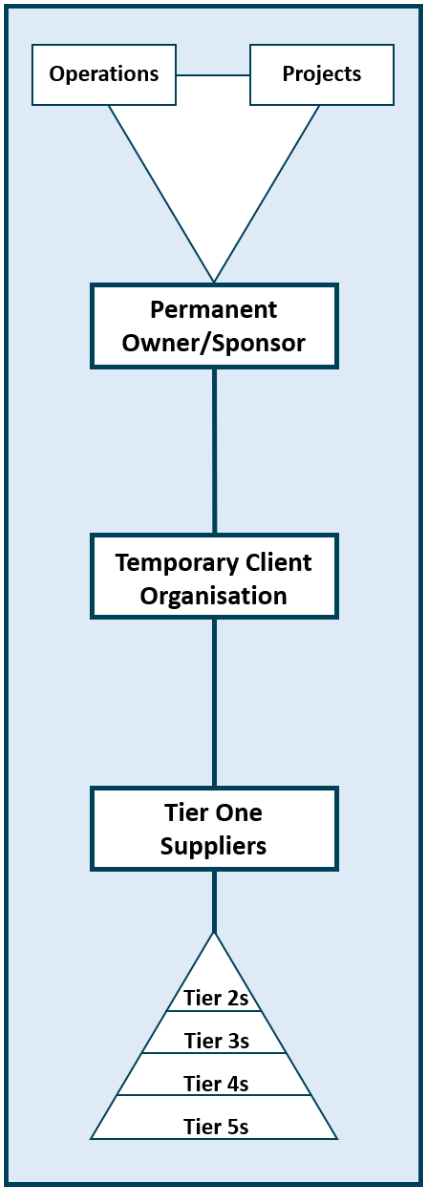

Figure 1: The inclusion of the temporary client organisation in the temporary-permanent interface.

The owner terminology is helpful when dealing with permanent organisations with a clear intention of integrating that asset in their structure. However, the boundaries of ownership become blurred as megaprojects are funded by a variety of sources, particularly in light of the large sums involved and their longevity. In addition, the long timeframe of megaprojects offers the space for changes in the ownership over time, influenced by a variety of factors. The client terminology is ideally suited for the management of projects, as opposed to owners associated with operations, categorising them into public/private and permanent/temporary, as well as highlighting their potential relationship with the supply chain. When public or private clients are establishing a dedicated organisation to deliver (through several forms) a single project, one of the most strategic interfaces is between the temporary client organisation and its delivery partners. As a principle, the client will primarily be responsible for managing the external stakeholders, creating a safe environment and shielding the production from turbulences, where delivery partners and contractors can focus on their areas of expertise.

3. Research methodology

This research is inspired by Langley's (1999) call for qualitative research following a combination of theory and data-driven research methods (Eisenhardt, 1989; Langley, 1999; Van de Ven, 2007), reconciling the deductive (theory-driven) and inductive (data-driven) approaches in iterative loops to generate and advance theory and practical recommendations. The abductive study conducted multiple case-studies to develop theory (Eisenhardt, 1989). A megaproject is composed of several firms organised in a temporary coalition to deliver the project across its life-cycle. Therefore, megaprojects were selected as the setting for this research due to their intrinsic complex multi-layer and multi-level organisational structures, which provide the opportunity to shed light in the research problem regarding organisational roles and their inter-organisational dynamic in the system (Alvesson and Sandberg, 2011).

The process of selecting empirical settings to use as a case in a research project is part of the process called "casing", which also addresses the limitations and boundaries of the single case (Ragin, 1992). This process needs to be thoroughly conducted by justifying the sample with rigour and clear logic. The theoretical sampling is aligned with Pettigrew's (1990) four rules to orient the selection of cases:

> "(a) Go for extreme situations, critical incidents and social dramas;
> (b) Go for polar types;
> (c) Go for high experience levels of the phenomena under study; and
> (d) Go for more informed choice of sites and increase the probabilities of renegotiating access." (Pettigrew, 1990, p. 275)

Given the rich megaproject environment in London, a strategy was conceived to build, develop and nurture relationships with practitioners (Van de Ven, 2007) over two years to enable access to three ongoing megaprojects: Crossrail, Thames Tideway Tunnel and High Speed 2. In total, six megaprojects that currently represent a combined investment of more than £100 Bn have been analysed in the United Kingdom: High Speed One (HS1), T5, London Olympics, Crossrail (CRL), Thames Tideway Tunnel (TTT), and High Speed Two (HS2). Three projects were analysed retrospectively (HS1, T5 and London Olympics) and three projects in real time (CRL, TTT and HS2).

In terms of configurational aspects (Yin, 2003), this research is a multi-case (six megaprojects), single type of evidence (qualitative), using multiple data collection methods (predominantly interviews as primary data, and publicly available documents and reports about the projects as secondary). The empirical data was collected through 171 semi-structured interviews with the senior leadership from CRL, TTT and HS2, who in several cases had worked in leading positions in the three projects analysed retrospectively. The majority of interviews lasted one hour (as scheduled), with eventual variations to 45 and 120 minutes. The megaproject ecology in London theoretically informs the sampling of cases (Davies, 2017), as managers moved from one megaproject to another over the last decades and anchored their responses comparing and contrasting insights from the retrospective megaprojects. The interviews explored the question of who is the client in megaprojects by presenting to practitioners the two categories deductively derived from the literature: ‘Permanent owner/sponsor’ and ‘Temporary client organisation’. The categories and terminologies were discussed in light of the evolution of the entities throughout the phases of the megaproject life-cycle. The informants’ roles are not disclosed for confidentiality purposes, given their easy identification in light of the high-profile of the projects in question and their leadership position. Therefore, the interviews shown in Table 1 are classified into three categories, namely: (i) Senior Manager (e.g. Senior Project Manager, Senior Delivery Manager; Senior Commercial Manager); (ii) Director (e.g. Head of Department, Director of Function); (iii) Senior Leader (e.g. Senior Strategy/Policy Advisor, Development Director, Programme Director, Managing Director, Chief Financial Officer, Chief Operating Officer, Chief Executive Officer).

Table 1: Distribution of interviews per megaproject.

Project	**Number of interviews**	**Senior Manager**	**Director**	**Senior Leader**
Crossrail	57	06	24	27
Tideway	43	11	15	17
HS2	71	09	38	24
Total	**171**	**26**	**77**	**68**

The research utilises data triangulation to complement, confirm and validate the primary data. Illustrative examples include dedicated learning legacy websites (e.g. London 2012 Olympics, Crossrail), publicly available presentations from firms (e.g. Crossrail, Tideway), reports from government institutions (e.g. DfT, IPA), regulators, audit organisations (e.g. NAO), strategic management consultancies (e.g. McKinsey), executive interviews, and articles published in the press. The information gathered form the interviews is the primary source, and where relevant confirmed either with the practitioners or with secondary information publicly available online.

This research follows Van de Ven's (2007) Engaged Scholarship approach, where the conceptual framework is influenced by practice and of mutual interest for both domains. Even when the literature was analysed to narrow the research focus through a deductive manner, there was a focus on considering empirically-informed research to guide and build a research mutually interested in both domains, theory and practice (Van de Ven, 2007). In a second stage, when the interviews were gradually collected, the conceptual framework was refined and kept evolving with inductive insights (Eisenhardt, 1989).

The deductive categories consisted of: (i) Permanent owner/sponsor; (ii) Temporary client organisation; and (iii) Tier one suppliers, as illustrated by Figure 1. During the iterative process of data collection and analysis, inductive categories emerged to refine the ones deducted from the theoretical framework (Eisenhardt, 1989). The empirical insights that shaped and improved the understanding of the setting and its configurations are twofold: (i) the division of the category 'Permanent owner/sponsor' into two separate categories, 'Owner' and 'Sponsor', reflecting that they are different entities within the fluid nature of megaproject inter-organisational relationships, where they might change roles throughout the project; and (ii) the division of the category 'Temporary client organisation' into two separate categories, 'Client' and 'Partners', reflecting the evolutionary nature of the project where one group, the evolving client, needs to make decisions about engaging with partners, in an effort to build complementary capability in the client organisation. The balance and combination of deductive and inductive insights through several iterations avoids the criticism that the researcher is trying to 'fit the data' to a particular theoretical angle (Miles et al., 2014). Ultimately, the concern with the inductive consideration (the voice of the data) adds another layer of insights from practice and reflects the authors' intention to produce content that is relevant to society (practical, impactful, applied, useful), (Van de Ven, 2007).

4. Findings

Our findings differentiate four terms that are commonly used as synonyms in the literature to represent the client function or a client organisation: owner, sponsor, client, and partner. Each one of these terms represent a different entity which has a different role and responsibility, impacting on the managerial function that they need to perform. Megaprojects are interesting settings to observe/study/research the differences about the role of the client considering the temporary and permanent dilemma, usually appointed as one the inhibitors of productivity in the construction industry. The temporary dimension is coupled with the fragmentation of the construction industry. The nature of a megaproject implies the necessity to engage with an extensive number of suppliers to have capacity and capability to deliver a large and complex project. Given the scale of the project, it is unlikely that a client organisation will design a strategy to hire one or a reduced number of companies to complete the work, it would be a risky decision which is most likely to be repelled by the regulators, sponsors directly or via their organisational extension which is embedded in the project, often called project representative. Considering the scale dimension of megaprojects, if there is capacity in the market through several organisations, the client will develop a strategy to spread the risk and divide the work in an optimal configuration of work packages, therefore the number of suppliers tend to increase when looking through the capacity lens.

The answer to the research question of who is the client in megaprojects is connected to a structural problem of the construction industry given its fragmented nature. Such characteristic maximises the intermediary clients throughout the supply chain tiers and creates a plurality of actors in the promoter-side. The empirical insights provided some guidance to clarify the terminology found in the literature, expanding it to four categories (owner, sponsor, client, partner), as illustrated by Table 2.

Table 2: Empirical evidence of multiple organisational actors.

Actors	Representative quotes
Owner	Regardless of whatever the ownership structure is for a programme or a project, or even a portfolio to be successful, there needs to be absolute clarity between the role of the sponsor, the role of the deliverer, and the role of the owner or the operator. I think the owner, and it will depend on the particular thing that is being done and it's not temporary obviously. Actually your sponsor is setting the requirements, providing the funding, making the business case, all that good stuff. It will either be saying to a temporary

	or permanent client organisation, "Right, you go and deliver that for me," and they could actually be the same organisation. There will be an instance where the delivery organisation, the client organisation is handing over to itself. There's something like Crossrail where it's Crossrail limited delivering the stuff and then handing over to TfL [Transport for London] for the most part, some bits handing over to Network Rail so it's not always the same person. HS2 is fundamentally different because they are going to be the owner of the High-Speed network. They're going to have maintenance, responsibility. Train services will be franchised out, you know, the operation of the railway services but the management of the assets, the operation of the asset… well the decision to be taken out will remain with HS2, they are the custodians of the asset home. Therefore, they're in a position to look at whole life costs. So, then we're left with this model where we have Thames [Water], who ultimately become the operator, and Tideway are the asset owner and maintainer. So, Thames [Water] will pay Tideway for use of their tunnel and Tideway passes that on to its investors. Then, you have the main works contractors and then in between all of that, you have [the partner].
Sponsor	Sponsors, traditionally, it's about setting the requirements about managing the scope, reporting on the budget. Ultimately moving through the benefits, benefits realisation. So, I think it's clear what they do. There's a danger that that gets muddled with a sort client role. There becomes a sort of degree of confusion between the two. Because having a budget responsibility almost drives you into the client area. I think even Crossrail, which is a different vehicle delivery mechanic again. Where it was a new delivery organisation, in terms of Crossrail Limited, that was set up to deliver that on behalf of its joint sponsors, TfL and Government, or DfT [Department for Transport]. So then within that construction of the delivery model, so you have the regulator, which is Ofwat, you have DEFRA which is effectively the government sponsor because of the support package, obviously Thames Water because they originally developed it and then you move into a more, as we create a client, a more traditional delivery model, i.e. we're the client, we have a programme manager who manages the work and then we have a series of main works contractors and a system integrator.
Client	So if you take T5, T5 was super controlling. They controlled everything. The client was all over everything. They bought, within to their client organisation, all the skills they needed and they managed everything to death. We had changed the industry by delivering Terminal 5. We did it by actually having parts of our consulting team, parts of our supply chain all forming the client role. T5 was completely collaborative and had it in-house. There's no differentiation between those people who work for a supplier and those people who work Terminal 5. Terminal 5 decided to take the risk themselves, exposed themselves to the risk but to get the best people around to actually manage that risk. Crossrail is different because it's set up just to deliver the construction project and is being handed over to TfL to operate so the organisation and the individuals will be gone by the time we get down to the maintenance and operation. We're the client [Crossrail Limited]. We are a pop-up client. Transport for London are going to be the owners. The mayor and the DfT are the sponsors, so you have sponsors, you have

	owners and operators who use it and will gain revenue from it and will be accountable for the reputation of how that thing operates. The decision was made in 2014 that HS2 Ltd would be the deliverer. The decision was also made that we would be the future infrastructure manager, and that we would be the initial shadow operator. This has now extended the life of HS2 from 2017 because that's when we get an Act for the 2017, or as a developer, we're now saying, "You will deliver it through to 2033, and you will, out of you will grow the infrastructure manager and operator for post…" Because we've got two stages, "From 2026 onwards, you will be the infrastructure manager of Phase 1, and the operator of Phase 1, and then you'll be the infrastructure manager of Phase 2. We're not just a developer. We've got to deliver this thing. This means we're not a company, a project company for, not a development company, we're not at that stage of Channel Tunnel Rail Link, HS1, or anything else, the builder, so we're not just a project to build it. We are basically now turning into a company forever. Whether that company is sold off, split up, it doesn't matter.
Partner	It's how you then, as a client, contract with the [Partner]. So the delivery partner, if you create this correctly, these guys have skin in the game. So this organisation isn't just here's some bodies and just pay me some money. It's here's some expertise. So it therefore comes down to whether this becomes a body shop or a service provider. Using our example from High Speed One [HS1] because we were a thin client and as you say that was part of the model for the ODA (Olympics), this gave rise to the delivery partner concept. The delivery partner concept recognised [the need] on the complex long-term projects, where you've got new skill requirements, to build those up from scratch for one-off projects. So, [on Crossrail] you have the client's organisation on the top, the PDP [Project Delivery Partner] would be managing the central section, Network Rail would be managing their own network works and then to complement that, they identified a Programme Partner [PP].

Beyond the terminological problem as they are different organisations, the structural understanding of the system is important given that those entities might accumulate each other's functions at different stages of the megaproject. Informed by Table 1, the following organisational structure is proposed, where each entity represent one of the six levels of the system and counts with a sphere of influence around itself:

- The owner, and often the ultimate sponsor (e.g. treasury, central banks, investors) who might be the operator;
- The sponsor, for example public departments that receive the funding and are empowered by the owner to act as the sponsor (e.g. Department for Transport – DfT);
- The client (i.e. delivery authority/vehicle/body), a single-purpose organisation (temporary or permanent) created by the sponsor to oversee the project (e.g. ODA, Crossrail Limited,

Bazalgette Tunnel Limited, HS2 Limited). This entity is empowered by the sponsor to establish contracts with the development partner, delivery partner, tier one suppliers, and the wider supply chain;

- The partner, which is composed of one or more organisations who are responsible to augment the capacity and capability of the client organisation, usually mistakenly understood as "the client" by the supply chain. It might be independent or integrated to the client organisation at different stages of the project (all integrated at T5; CLM independent of ODA at London 2012; Programme Partner and Programme Delivery Partner at Crossrail – independent and later integrated with Crossrail Limited);
- The tier one suppliers, which are responsible to deliver a substantial work package acting as systems integrators of their own supply chains (they can be organised as single entities or joint-ventures); and
- The wider supply chain (tier 2s, 3s, 4s, and so on).

4.1 Project System Organisation (PSO)

A Project System Organisation (PSO) is defined here as the combination of permanent and temporary organisational layers, which form the megaproject organisational structure during the entire life-cycle towards a variety of temporary-permanent configurations. All projects exhibit a PSO, but it is particularly pronounced in megaprojects where the structures are more complex and easily observed. The megaproject PSO is constituted by organisational components acting across layers, levels and phases, and each entity is embedded in a permanent or temporary layer, has to deal with different levels of authority across the supply chain tiers and phases of activities from begging to end. The PSO has two layers, usually six levels and three phases (Development, Delivery, and Operations), as illustrated by Figure 2.

Given the ambiguity in nomenclatures regarding megaproject phases observed in the literature, this paper proposes terminologies that can be used in the same phase, aiming to simplify the language and unify the discussions.

- Inception, gestation: For the stage where the project is under consideration but not confirmed by policy makers;

- Development, planning, initiation, front-end: For the stage where the project is confirmed and conducting studies to get permissions;
- Delivery, execution, construction: For the construction phase;
- Operations: For the stage after construction when the asset is completed.

Between the development and delivery stages there is a transition called delivery readiness, where the organisation will go through a significant expansion challenge reorganising itself for a task of different nature. Between the delivery and operations phases there is a transition called operational readiness, where the client will coordinate and close all tier one contracts and hand the physical asset over to one or more organisations, often the sponsor, who might be the owner and operator, or not.

The permanent layer is composed of the institutional environment, which is mainly represented by the owner (usually the ultimate sponsor and might be the operator) and the sponsor (might be the operator or not). This layer relies upon established cultures from long-term state-owned structures and organisations, however it is not static and needs to reconfigure itself to play different roles at the several phases of the project. For instance, the permanent layer will function as the body responsible for the establishment of the client organisation (temporary or not) in the development phase, for the assurance processes in the delivery stage and for the operation (or interface with the operator) after the conclusion of the asset. The temporary layer is represented by the client organisation, which is set up with the single purpose of coordinating the activities of the project and by the pool of organisations that are assembled through several supply chain tiers to conduct the work (e.g. development and delivery partners, designers, consultants, tier one contractors, wider supply chain with suppliers distributed from tier two onwards).

Therefore, the PSO is organised across six vertical levels consisting of the owner, the sponsor, the client organisation, partners (e.g. development, delivery partners), tier one contractors (e.g. joint ventures, systems integrators) and the wider supply chain. The first two levels act collectively as the megaproject sponsor. The often temporary client organisation and the partners act collectively as the client, however the sponsor and client can choose to form an integrated client organisation (e.g. client + partners) or an independent one outsourcing some functions and creating a clear line between the client organisation and the partners. In general, the perception of the tier one contractors and wider supply chain is that there is only one client, regardless of how they are organised, independently or integrated. However, it is critical for the client organisation to develop a governance structure to clarify the specific authorities across organisational boundaries, which enables a more efficient reporting system.

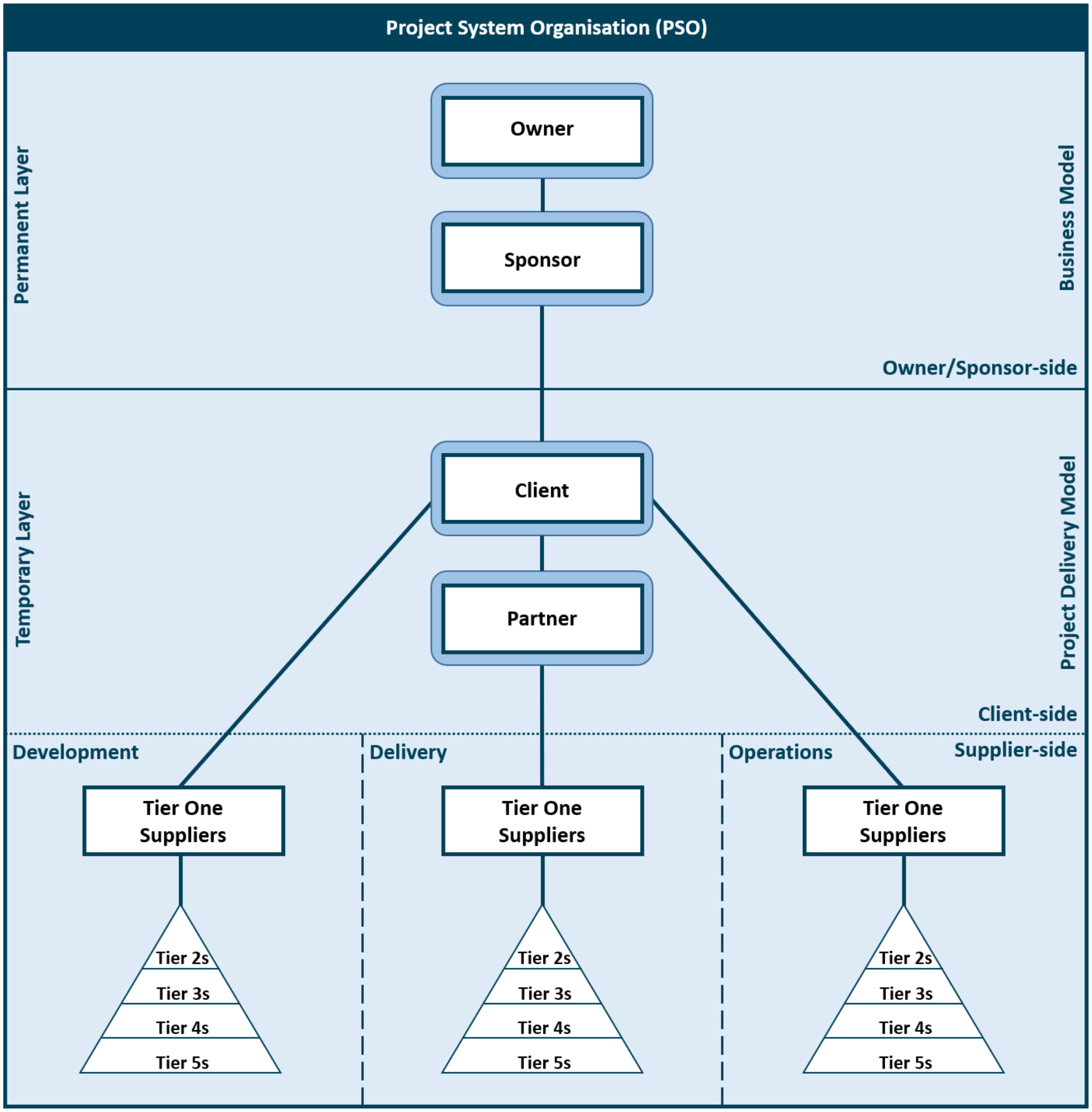

Figure 2: The Project System Organisation (PSO) conceptual framework.

The client organisation is responsible to develop a governance structure that will determine the rules of the game and clarify the roles, responsibilities and authorities internally (intra-organisational) and externally (inter-organisational). The creation of this governance structure is usually a joint effort between the sponsor and the client organisation. The governance structure will naturally evolve during the project life-cycle, therefore it is necessary a degree of self-awareness in the client organisation in order to re-design/shape the governance according to the requirements of the project. The refreshed structures will continuously illuminate the way the client works internally, as an entity with several departments/functions/directorates. It also provides assistance to clients in their external engagement with the supply chain and institutional environment, enabling a clear message regarding the intra-organisational structures and strategies for inter-organisational relationships.

The governance structure is important to allocate the right authority to the right level, it is a high-level conceptualisation of roles and responsibilities that provides clarity to internal and external stakeholders. The contract also plays an important coordination role, where clear and non-ambiguous language might help to create the alignment with the supply chain, supported by performance metrics. Otherwise, there is a shift in power after contracts are awarded, which makes it very difficult to reengineer the principles and influence the supply chain. As informed commercial organisations, contractors will charge an addition to the original contract to deliver the work, which is the traditional business model in the construction industry, bid low to win the contract and escalate the costs later by additions to the contract (which might be related to missing information or poor specification). They might also bid low on the expectation of selling extra services later at a much higher price than found in the market place, making use of a powerful position as part of the project (which might be a single-source scenario).

5. Discussion

The PSO explores the dynamics of how permanent and temporary organisations configure and reconfigure themselves to support different megaproject phases, understanding the permanent as the institutional players (promoters that shape the strategic context throughout the project) and the temporary as standalone (pop-up) organisations created only for the project's purpose and those assembled to provide capacity and capability acting as reservoirs of knowledge in a flexible but formal arrangement. This perspective builds upon literature of the temporary-permanent dilemma (Sahlin-Andersson and Söderholm, 2002), and on the multiple temporalities across the megaproject life-cycle (Brookes et al., 2017). The PSO explores the rationale behind the strategic decisions that contribute to form the supply chain architecture (Denicol, 2020; Denicol, 2020a) that configures an inter-organisational project. It draws upon previous research on temporary inter-organisational projects (Jones and Lichtenstein, 2008), and highlights the perspective of supply chain design and consideration of its elements as a system throughout several phases of the project life-cycle.

There are several layers of inter-organisational coordination in the PSO, each node of the system can be perceived as a client by its subordinate supply chain tier, therefore there is a need to unpack the spheres of influence of each node of the system in a megaproject. This influence will vary according to the phase of the project and the function necessary to be performed by each entity. The PSO is the conceptualisation of the ingredients of that particular megaproject system, which aims to provide a platform for identification of the several supply chain actors, clarify the terminologies, roles and responsibilities of those entities. It offers a unifying visual system to discuss and design the overall strategy to deliver the asset, the megaproject delivery model. This multi-level understanding evolves previous project management literature on megaprojects focused primarily on only one supply chain actor, such as the owner (Merrow, 2011), strong owner (Morris and Hough, 1987; Winch and Leiringer, 2016), owner and operator (Winch, 2014), client (Aritua et al., 2009; Aritua et al., 2011), and sponsor (Miller and Lessard, 2000). In addition, it contributes to the discussion about the domains of project organising proposed by Winch (2014) through the owner and operator lens, unpacking the dynamics in the context of megaprojects by offering a more elaborated inter-organisational structure with an expanded set of supply chain actors and terminologies.

The PSO differs from project-based firms (PBFs) (Gann and Salter, 2000) and project network organisations (PNOs) (Lundin, Arvidsson, Brady, Ekstedt, Midler, and Sydow, 2015; Manning, 2017; Pryke, 2017). The PSO is not conceptualising the project organisation through a focal (coordinating) firm perspective. The PSO differs from project ecology (Grabher and Ibert, 2011) in the sense that it is not concerned with the interplay of all levels (macro, meso and micro) at the same time, from institutional organisations to the individual level. Also, the PSO does not attempt to draw comparisons and influences from past performances into the current organisational structure as project or project-based learning. Therefore, the PSO is a vehicle for discussion of the macro and meso-level of relationships only, aiming to shed light on strategies dealing with problems such as coordination, interdependencies, integration (vertical vs outsourcing), governance, organisational structures, procurement and management of supply chains.

The PSO narrows the concept of project ecology and expands the PNO conceptualisation by recognising that considering the complexity and longevity of a megaproject, there are several embedded PNOs acting as clients and playing roles at a multi-layer, multi-level and multi-phase perspectives. The multi-layer perspective reflects the dynamics of permanent layer, consisting of institutions and where owners and sponsors are located, and the temporary layer, where the temporary supply chain composed of multi-coalitions is formed to attend the requirements of the project (with new organisations – temporary client organisation; and existing ones – PBFs). The multi-level perspective presents the complexity of a megaproject which tends to generate more sophisticated inter-organisational structures distributed across multiple supply chain tiers. The multi-phase perspective illustrates the long life-cycle of those endeavours, where there are sequential phases of production (development, delivery, operations) and the myriad of supply chain organisations are likely to play a different role for each phase, interacting with the organisational dynamics during that phase. Exemplifying this argument, an organisation that is developing a technical design during the development phase will have their natural and inherent production process to deliver the design, which is influenced by the stage of the megaproject they are embedded, and by the intra-organisational dynamics of the client entity during the period of engagement.

Davies et al. (2019) explored 'project delivery models' in light of the business model literature and called for further analyses of the concept. Building upon their work, the PSO defines the concept in conjunction with the life-cycle of projects, where the 'project delivery model' in question encompasses development, delivery and operations. Delivery models are associated with the route in which sponsors (public and private) procure the project they need, in other words the model in which the project will be delivered to address the project's business case based upon the sponsor's current and future needs (HM Treasury, 2008, 2013). The sponsor has a business model as a permanent organisation that might influence their appetite for particular 'project delivery models', where this decision-making process will happen during the project inception, before the development phase. However, considering the perspective of an asset owner that would later integrate the project into its network, 'project delivery model' could comprise only development and delivery, whereas operations would be conducted at the parent organisation's level (e.g. TfL, Highways England, Network Rail).

The sponsor of the project holds the business case, meaning that they need (or should) know what they want. In the UK context, the HM Treasury and the government's specific departments are often collectively the owner/sponsor representation. The Treasury provides the funding and allocates the project in their portfolio, influenced by the identification of a necessity by the National Infrastructure Commission. The specific government department (e.g. Department for Transport) is responsible to set up and empower the client organisation, liaising and managing the interface with them throughout the project phases, reconfiguring itself to play different roles accordingly.

The understanding of the PSO is fundamental to design megaproject delivery models, as the drivers for innovation regarding organisational strategy initially come from the sponsor. The sponsor is one of the most important entities regarding the project initiation and design of the PSO, which is their first role as the sponsor, where they have choices about the configuration of the client organisation (Denicol and Davies, 2020), the types of decisions that they are cascading down to the client vehicle. The owner and the sponsor should act collectively as informed and knowledgeable entities at the permanent layer, thinking systemically about the final infrastructure asset that will be handed over, in order to play the role of the intelligent and strong owner in the front-end (Morris and Hough, 1987; Merrow, 2011; Winch, 2014).

After the project creation by the sponsor and allocation of money to achieve its strategic and operational objectives (outcomes and outputs), a client organisation is set up, which is the entity created by the sponsor and progressively empowered to deliver its business case. The client vehicle is often responsible for handing over the infrastructure asset to the sponsor after construction is finished, therefore it is necessary an effort to build capabilities in the new entity drawing upon the expertise of other organisations (Denicol and Davies, 2020). The primary point of contact of the client organisation is the development and delivery partners, which would assist in coordinating the supply chain in their respective project phases. Both development and delivery partners would be working client-side, where the question posed is about integration, whether the client organisation would like to work as a completely integrated team or be a client with more defined boundaries, transferring most of the functions to the partner during delivery.

There is the intra-organisational structure of the client organisation, which is the first layer of engagement with the private sector, when the initially small client team needs to augment its capability and capacity to develop the project in the early stages; the second layer of engagement with the private sector is to plan the engagement with the contractors and the wider supply chain, where client and partner organisation(s) propose a procurement strategy to engage with the part of the supply chain that will in fact deliver a physical product, based on the transformation of raw material into a finished product.

During the development phase, there is primarily a transformation of intellectual capital (or knowledge) into documents and guidelines to build the asset, which is based on the expertise of professional service suppliers, usually consultants and designers represented conceptually by project-based firms (Gann and Salter, 2000). The literature has focused more on the procurement strategy to engage with tier one contractors, as well as the dynamics between tier ones and their supply chains (Vrijhoef and Koskela, 2000; Dainty et al., 2001; London, 2007; O'Brien et al., 2008; Pryke, 2009, 2020; Segerstedt and Olofsson, 2010; Aloini et al., 2012; Denicol et al., 2020a). This research extends the conversation by arguing that the efficiency of the procurement strategy in megaprojects is a reflection of the sophistication and capability of the client organisation. It is a function of the structures that clients build to engage and integrate with its development and delivery partners, intending to perform collectively the role of the client. The client needs to act as the supply chain architect (Denicol, 2020a), establishing a core team who will have the technical authority to deal with a pool of commercial organisations that will try to influence the project towards a range of commercial and technical mechanisms to best fit their organisational strategy. Therefore, a knowledgeable and capable client organisation assumes the responsibility as the technical authority, holistically understanding the interfaces between the components of the system and dealing with the commercial dynamics of the marketplace.

The systems integrator is usually represented by large tier one organisations that manage and integrate hundreds of suppliers in their own supply chain to deliver their work package to a client. The client may also be an integrator and can be perceived as another layer of systems integration (system of systems), with a different remit and visibility. In the particular case of London 2012 Olympics, the client established a delivery partner consortium (CLM) who was an independent organisation working as an extension of the client and responsible to coordinate the integration of several tier one organisations (acting as the programme manager), also called the meta-systems integrator (Davies and Mackenzie, 2014). The PSO provides assistance in the identification of organisations acting as systems integrators that are distributed across several tiers of the megaproject supply chain architecture, emphasising the implications for supply chain visibility, integration and control.

There is an interplay of the governance structures created by each of those organisations, considering their company as the focal firm. For an effective deployment of the systems integration function across different levels, it is essential to establish early in the front-end the overall governance structure, where the PSO might provide some clarity and assistance by unpacking the dynamics of the supply chain organisations. The knowledge of how those actors work overtime in megaprojects might help sponsors and clients in their reflection and consideration of the best model to engage with the supply chain, identifying integration mechanisms and the entities best positioned to manage risks. The wider supply chain is composed by thousands of organisations that form a pool of resources that can potentially be a part of the project, either working only to one contractor with single or multiple contracts, or to a number of contractors through single independent contracts. Each one of these entities has a degree of influence on the project at different stages, and, by mapping them, their roles and responsibilities, the PSO contributes to create a unified terminology to identify correctly the entities of the system.

6. Conclusion

This research presents the PSO framework, which provides a unified conceptualisation and definition of four roles often used to label the client in megaprojects: owner, sponsor, client, and partner (Figure 2). It recognises that megaprojects offer more elaborate structures and clarity is required to understand the different inter-organisational dynamics during their long life-cycle. The PSO highlights the complexities of megaproject inter-organisational architectures and chart the multiple and evolving actors across the multi-level and multi-layer megaproject system. It provides the building blocks for organisation designers to structure the configuration of megaproject delivery models, as well as particular phases and specific interactions between entities embedded in the system. The PSO works as a canvas to design and prototype megaproject inter-organisational relationships. It can be used to design megaprojects as dynamic inter-organisational systems, decompose and integrate boundaries in the organisational architecture. Organisational architects and strategists might use the PSO to structure and prototype a variety of configurations between the institutional and supply chain partners to deliver the megaproject.

The PSO contributes to the literature in light of the previously identified research gap about the client in megaprojects (Denicol et al., 2020). The PSO framework identifies the roles and responsibilities of the client and the inter-organisational dynamics to deliver megaprojects. It advances the discussion by providing a clear set of terms to describe the different entities and roles they perform throughout the stages of complex projects. It contributes to avoid what Genus (1997) reported as a 'missing actor' in the early stages of negotiations in the Channel Tunnel project, where the operator was absent when the project was being configured. Several intermediary clients often occupy the temporary layer of the PSO, who integrate components and systems provided by downstream supply chain tiers to deliver work packages often to the next upstream supply chain actor. An ultimate client is located in the permanent layer, which is usually represented by the sponsor and/or owner organisations, who might be the operator or have some type of involvement through an agreement in the operations.

The PSO framework defines the intra-organisational boundaries of the focal firm, and draws attention to the need to plan the evolving relationships in light of a system, which will collectively deliver the project through the interaction of its actors during the life-cycle. The keyword here is evolution, which focuses on designing a structure that will be reconfigured over time, changing the functions of the supply chain actors. The client has to ensure that the short-term decisions focused on the intra-organisational dynamics will not create an inter-organisational lock-in, constraining its ability to design new supply chain architectures.

Researchers might use the PSO to frame and prototype the inter-organisational dynamics of future megaprojects, aiming to improve our understanding of the intra- and inter-organisational dynamics across the megaproject life-cycle. In addition, future research might further explore the challenges and implications of designing and redesigning the PSO at different stages throughout the megaproject life-cycle. Megaproject practitioners and policy makers could use the PSO to inform the discussions regarding the design of the megaproject delivery model. The PSO was informed by multiple cases from London's megaprojects, which are embedded in the UK institutional environment. The PSO is a promising artefact that might be applied in other countries, however it might be limited given the structural conditions of markets and institutions in other geographies around the world.

This is particularly important because once the PSO is structured, it is frozen and will significantly influence the project from that point onwards, where reconfigurations in later stages might be challenging and inappropriate. The PSO provides practical guidance and assistance to owners, sponsors and clients to jointly leverage supply chain visibility and improve the integration capability across different levels and layers, which is critical to the intelligent client role in a megaproject. The PSO can inform the design of future organisational architectures and address the need for alignment of incentivisation mechanisms across the supply chain levels. The resulting architecture might strategically influence and stimulate the behaviour of all the organisations involved in delivering megaprojects.

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