Designing the inter-organisational system of megaprojects: Strategies from six infrastructure projects in London

Abstract

Megaprojects are transformational endeavours that enable the emergence of more complex and sophisticated inter-organisational structures. However, little is known about the dynamics and temporal evolution of such multi-level structures over the project life-cycle. This research examines how megaprojects design the inter-organisational relationships and configured their system architectures, contributing to unfold the inter-organisational dynamics over time. This research innovates by analysing multiple case-studies to explore the challenges of inter-organisational design. Six megaprojects that represent a combined estimated investment of more than £100 Bn have been analysed in the United Kingdom: High Speed One, Heathrow Airport Terminal 5, London 2012 Olympics, Crossrail, Thames Tideway Tunnel, and High Speed Two. The architectures emerging from the six cases reveal the need for a more systemic analysis, not centred in individual organisations. Strategists designing the megaproject system might find useful to map the vertical and horizontal interdependencies between different actors distributed across the multi-levels and layers of the system. Informed by one of the largest comparative studies of megaprojects in the UK, the findings of this research might be relevant to other geographies since the epistemic community of London's megaprojects is constantly contributing to export practices and inform megaprojects around the world.

Keywords: Megaproject Management, Organisation Design, Inter-organisational Strategies, Organisational Architecture, System Architecture.

1. Introduction

Megaprojects are large endeavours that cost over US$ 1 billion (Flyvbjerg et al., 2003), often connected with transformational infrastructure to address society's needs (Morris and Hough, 1987; Altshuler & Luberoff, 2003; Merrow, 2011). Although the benefits of those assets are captured by several generations, megaprojects tend to have a poor track of record regarding several aspects of its delivery, which is well illustrated by the expression 'over and over again' (Flyvbjerg et al., 2002; Flyvbjerg, 2011).

The understanding the managerial structures of megaprojects is particularly relevant given their increasing numbers (McKinsey Global Institute, 2013; OECD, 2013; KPMG, 2013; PricewaterhouseCoopers, 2016), as a reflection of a powerful combination of the increasing movement of rural communities to urban centres (United Nations, 2018), with the populational growth forecasted for the next decades (United Nations, 2015). Extant literature only recently started to allocate efforts to map the state of the art in megaproject management (Flyvbjerg, 2014; Flyvbjerg, 2017; Li et al., 2017; Söderlund et al., 2017), and systematically explore in depth the causes and solutions of poor performance (Denicol et al., 2020)

In light of their intrinsic features, megaproject promoters build more complex and sophisticated inter-organisational structures to deliver the asset. This research contributes to unfold the inter-organisational dynamics of megaprojects over time, emphasising the importance of organising the system by design building upon the expertise of inter-organisational architects. The research is conducted in one of the world's largest megaproject clusters and investigates six case-studies in London's rich megaproject ecology (Grabher and Thiel, 2015; Davies, 2017), namely: High Speed 1, Heathrow Terminal 5, London 2012 Olympics, Crossrail, Thames Tideway Tunnel, and High Speed 2. The exploration of multiple cases with a combined investment of more than £ 130 billion might contribute to expand our understanding with insights from one of the most comprehensive comparative studies in the megaproject management literature.

The paper is organised following a structure of five sections beyond this introduction. First, the research is theoretically framed by engaging with the literature on inter-organisational structures and organisational design. Second, the research methodology is presented, theoretically justifying the sample and emphasising the richness of multiple case-study research. Third, the results are presented where the six inter-organisaitonal maps are revealed, enabling a comparative discussion

of the dynamics between the six cases analysed in the fourth section. Fifth, the conclusions are presented emphasising the contributions of the research, managerial implications to practice, and suggestion of future research avenues.

2. Literature review

March and Simon's (1958) work inspired research on organisational studies by exploring traditional organisations composed by individuals, which might be decomposed in functions, teams, and individuals. Traditionally, the studies that built and developed such thinking (Lawrence and Lorsch, 1967) explored the boundaries with the environment, and were guided by the context, challenges and structures of its time, emphasising large and focal organisations, exemplified by Original Equipment Manufacturers (OEMs). The organisational design literature has been driven primarily by the exploration of the provision of structure to inform broader actions such as coordination, collaboration, and integration (Galbraith, 1973).

Currently, a globalised environment and the emergence of more sophisticated structures moved the focus from intra- to inter-firm relationships across different geographies (e.g. joint ventures (JVs) (Bing et al., 1999; Shen et al., 2001; Ozorhon et al., 2007), hybrids (Quélin et al., 2017; Akintoye et al., 2003; Li et al., 2005) and mergers and acquisitions (Choi and Russell, 2004; Delaney and Wamuziri, 2004). The literature on inter-organisational relations has been explored across several industrial sectors (Cropper et al., 2008; Sydow et al., 2016), as well as in the temporary environment of projects (Jones, and Lichtenstein 2008).

Other contemporary streams such as systems integration (Prencipe et al., 2003), and supply chain management (Cooper et al., 1997; Lambert and Enz, 2017) have embraced the global context and focused on the integration and coordination aspects of managing fragmented and often dispersed production networks (Christopher, 1992). Although the context is fully represented by several studies in those domains, there is less attention to the design of such inter-organisational arrangements (Simchi-Levi et al., 2007).

Megaprojects follow some of the characteristics of such traditional production chains, as it has an extensive and fragmented pool of suppliers that operate under conditions of complexity and uncertainty, therefore with less stability than traditional settings (Denicol, 2020). Considering that megaprojects are the largest category of projects, often labelled as systems of systems (Davies et

al., 2009) or array project (Shenhar and Dvir, 2007), such endeavours can be considered the richest and most complex inter-organisational context in the construction industry. Organisations working at different levels of the megaproject structure need to procure products and services from a fragmented supply chain, inevitably creating an exponential number of technical and organisational interfaces (Cornelius et al., 2011; Hone et al., 2011; Lloyd-Davies and Rowark, 2017).

In the specific context of megaprojects, the inter-organisational challenge was previously explored through several lenses, such as systems integration (Davies et al., 2009), meta-systems integration (Davies and Mackenzie, 2014), meta-organisations (Gil et al., 2017), project capabilities (Davies and Brady, 2016), dynamic capabilities (Davies et al., 2016). Previous research also approached the challenged through focal organisations, dedicating attention to explore the concepts of strong owner (Morris and Hough, 1987; Merrow, 2011; Winch and Leiringer, 2016) and intelligent client (Aritua et al., 2009; Aritua et al., 2011). However, little is known beyond the guiding and static principle of how those organisations operate, leading to potential research to unpack the rationale behind the behaviour of those entities over the megaproject life-cycle.

The systems integration literature (Whyte, 2016) is highly associated with the complexity literature, where Davies and Mackenzie (2014) provide an example of this association through their study of complexity and systems integration in the London 2012 Olympics. This piece of work is strongly relevant since the authors explore a project inserted in London's megaproject ecology (Davies, 2017) as the unit of analysis. However, although it is an insightful piece with recognised implications to practice regarding coordination, the study is an illustrative and summative example of the literature, which does not explore the megaproject as a dynamic system throughout different phases of the life-cycle. In addition, the literature focus is not related to the inter-organisational system and its rationale for designing the relationships beyond the delivery partner, considering holistically its decision-making from the outset. This study builds upon their study and contributes with insights about the formation of the temporary and evolving inter-organisational configuration, revealing the main players and the rationale that led the decision makers to select such structures.

The configurational level that needs to be explored and analysed in megaprojects is the system, which is composed by different organisations and their dynamics to engage with the plurality of stakeholders. This research embraces a supply chain management lens (London, 2007; Simchi-

Levi et al., 2007; Pryke, 2009; 2020) to conceptualise the architecture of the megaproject production system (Denicol, 2020).

An important aspect emerging from supply chain studies is the degree of visibility of the value chain, which will inform the managerial activities of the focal firm (Gosling and Naim, 2009). In megaprojects, inter-organisational architects might need to design the system architecture in light of the players' appetite to produce certain activities in-house or outsource, which emphasises the capability and capacity dilemma that affects megaprojects (Denicol, 2020). The consideration of internal capabilities is critical to design a structure that incentivises the flow of value from a bottom-up approach, where there is a large pool of organisations working on the production of the asset. It is equally important that the upstream players have the structures in place to capture and translate such flow of value into benefits. Designers thinking critically about the architecture of the system might conceptualise it as a combination of permanent and temporary structures and entities (Sahlin-Andersson and Söderholm, 2002), which will evolve through a variety of forms in the (designed) engagement between institutions and markets.

Although there is a consistent (static) picture of the supply chain tiers and main players operating in megaprojects (Mead and Gruneberg, 2013), less is known about the dynamics that affect the multi-level structure of the system. Given the fragmentation and asset specificity of such projects, there will be integration challenged (of products and process) at different levels, organised by rules and an inter-organisational structure, rationally designed or organically emergent. Recognising the challenges of researching settings with such longevity, even less is known about the dynamics and temporal evolution of such structures over the megaproject life-cycle.

The Project System Organisation (PSO) is a conceptual framework previously derived from the analysis of the cases in light of the inter-organisational literature (Denicol et al., 2021), which sheds light on and assists in clarifying the multi-level and multi-layer structure of megaproject production systems. As illustrated by Figure 1, 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/Planning, Delivery/Execution, and Operations).

The PSO explores the dynamics of how permanent and temporary organisations configure and reconfigure themselves to support different megaproject phases (Sahlin-Andersson and Söderholm, 2002), 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.

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 – project-based firms). 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 network organisations are likely to play a different role for each phase, as well as for each stage of their production process to deliver a particular product/service within a particular phase.

The PSO is structured around four terms, namely: owner, sponsor, client, and partner. Such terms are often used as synonyms by researchers, creating a scenario that is not helpful to move the conversation forward about the inter-organisational structure of megaprojects. It is important to understand and clarify the terminology, as the design of the megaproject system architecture is informed by the understanding of the roles and responsibilities performed by different organisations. As previously revealed by Denicol et al. (2021), those four entities are primarily different, however one or more functions might be consolidated into one entity (e.g. the client). This consolidation might happen by design from the start of the megaproject, however the longevity of such endeavours offers the platform that often encourage dynamic reconfigurations throughout different stages of the project.

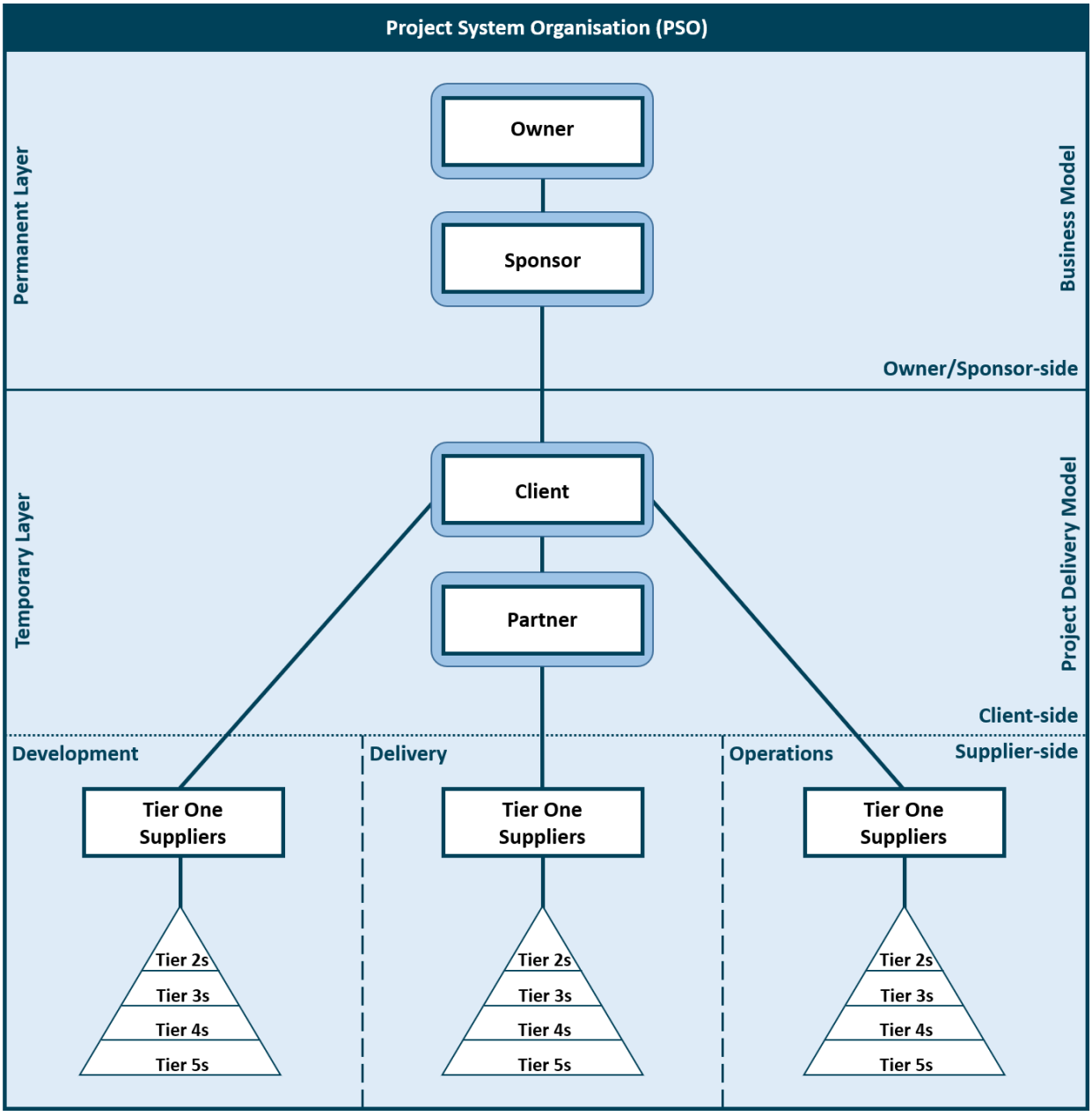

Figure 1: The Project System Organisation (PSO) conceptual framework (Denicol et al., 2021).

3. Research Methods

Megaprojects are known for its close association with dimensions that are attractive to the curiosity of researchers from several fields (e.g. organisation studies, general management, project studies). Several sources suggest that megaprojects will increase their protagonism in the near future, as the mechanism to address society's challenges via new and aging infrastructure across the world (OECD, 2013; World Economic Forum, 2014). In light of the challenges associated with access and the spatial distribution of those endeavours, previous research often explored a range of topics using one megaproject as a single case-study (Davies et al., 2009; Davies and Mackenzie, 2014; Zerjav et al., 2018). This approach is often criticised following an argumentative line of lack of generalisability, transferability power of findings across projects, and strong contextual embeddedness.

This research is novel and makes a contribution by adopting multiple case-studies to explore the challenges of inter-organisational design and generate theory. It mitigates the challenges faced by previous single-case research in megaprojects, increasing the external validity power by drawing upon multiple sources of evidence (cases) to inform and generate transferable knowledge (Yin, 2018). The longevity of megaprojects poses questions on how to capture information about several aspects of the project and its evolution over time. The research is informed by Langley's (1999) process research, where How and Why questions are important to reveal the evolution of different actors throughout the project life-cycle, leading to the configuration of the inter-organisational system. The research follows a hypothesis-generating approach through exploratory cases, recognising that several aspects of such endeavours are not well understood to pursue a quantitative approach, often associated with hypothesis-testing (Carden, 2009).

Fiss (2009) explored the advantages of case-studies to understand organisations and argued for different configurations at multiple levels, namely: intra-organisational, organisational, supra-organisational, and inter-organisational. Although quantitative research is valid to understand the relationships in several settings, qualitative approaches are more suitable to unpack the dynamics between the variables in less matured environments, such as megaprojects. Therefore, considering the nature of megaprojects, qualitative methods are more suitable to explore the causalities than the deterministic stance intrinsic of quantitative research.

This research is informed by Yin's (2018) approach, being characterised as multiple cases (six megaprojects), single type of evidence (qualitative), multiple data collection methods (primary through interviews and secondary via publicly available material about the projects), and a single method of analysis (narrative description of the case). It draws upon Nicolini's (2009) zooming out approach to understand the configurational changes of the multi-level inter-organisational system, following a process (research philosophy) aiming to find order and patterns to increase the generalisability power.

The volume of process data, a challenge labelled by Pettigrew (1990) of "death by data asphyxiation", is exponentialized by the rich opportunity of exploring multiple megaprojects in London. Hence, the study adopts the temporal bracketing strategy to organise the data (Langley, 1999), which is underpinned by the aim and philosophical rationale of exploring the evolution of inter-organisational systems. The strategy is associated with the definition of the megaproject phases that organise the activities in the UK megaproject ecology, namely: development, delivery, and operations.

Six megaprojects that represent a combined estimated investment of more than £130 Bn have been analysed in the United Kingdom: High Speed One (HS1), Heathrow Airport Terminal 5 (T5), London 2012 Olympics (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). The empirical data was collected through more than 250 one-hour 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. Interviews were conducted with several organisations at each level of the PSO conceptual framework, capturing detailed information aiming to chart the system architecture of each megaproject at different points in time.

The selection of cases follows the 'casing' process of Ragin (1992), who argues for a clear and rigorous logic to justify the sample. The sample selection is enabled by the rich megaproject ecology in London (Grabher and Thiel, 2015; Davies, 2017) and follows Pettigrew's (1990) four rules: "(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." The embeddedness of all

projects in London, currently the world's megaproject cluster, provides an extra layer of strength to the theoretical selection of the sample, enabling more insightful comparisons given the similarity of context, regulatory framework, movement of firms, and professionals.

4. Results

There is a theoretical and practical confusion between four terms, namely: owner, sponsor, client and operator. Sponsor and client are often used as a synonym, whereas owner and operator are used together, not often as a synonym, but lacking differentiation between them. In this environment, terminologies are critically important and might create significant problems by pre-assumptions of what that specific term means and what are the implications of its role and responsibilities. It is important to have clear definitions of each term and avoid duplications of the same word and meanings, mitigating potential communication risks.

The idea of consolidation of those terminologies into one term, for instance, into owner, intentionally or unintentionally (to express an idea or sell a concept), reduces the potential for understanding. These are different entities playing different roles in the project environment, bounded by time, subject to the inherent temporalities of projects and the evolution of scope over the project stages. It is not possible to consolidate terms in light of the plurality of the market, which might consequently cause a misleading direct comparison between permanent firms with an operational business such as Heathrow, TfL and Network Rail, with temporary client organisations such as the ones created for the Olympics, Crossrail and HS2 – which might change its nature during the project life-cycle.

The owner of a public project is often the government (the Owner), as the representative of the people that are funding the project through their taxes, who might sell to the private sector in a later stage. Within the government, the project is allocated under a department that represents a sector (e.g. Department for Transport), which is the government sponsoring agency (the Sponsor), which in turn defines the project delivery model and might create an arm's length organisation (the Client), to develop and deliver the project on their behalf (e.g. ODA, Crossrail Ltd, HS2 Ltd). Those temporary settings are also known and labelled as the 'delivery vehicle', 'delivery body', 'delivery agent', 'arm's length body', 'hybrid SPV' and 'pop-up client organisation'. The client is augmented in capacity by several entities that provide extra capacity and capability, ranging from

more generic to very niche expertise. The immediate organisations working alongside the client, integrated or not, are the development partner and delivery partners. These organisations can be single entities or organised in a joint venture with several firms forming a single entity. The rationale behind the creation of an autonomous client organisation is associated with the desire to disconnect the new megaproject from a traditional structure, either a public department or infrastructure agency. Therefore, the new independent entity would not be constrained by the policies of the permanent organisation, being possible to establish a governance structure appropriate to a megaproject and have more freedom to recruit the necessary people to key positions in the organisation. The sponsor might influence the client model that the new entity will adopt, which will reflect in their drivers to start designing the supply chain architecture and building capability.

From the suppliers' perspective, the rationale for bidding in a joint venture for a delivery partner or tier one contract includes not only sharing the risk with more organisations, but also a more systemic picture: first, reaction to a context incentivised by the client, who might be looking for a pool of more firms, believing it will bring more value to the project through combined innovation from their parent organisations' previous experiences; second, capability complementarity, where a very niche firm in railway systems might be included with 5% of the joint venture to compose a better offer to the client; and, third, capacity, where the joint venture partners are competitors in the market for smaller contracts, but would not have the financial strength to bid alone for a bigger package in a megaproject. In scenarios where they are competitors and are together only to augment capacity, there might be problems in sharing their previous experience, where the firms will be afraid of giving away too many of their industrial secrets and too much of their intellectual property, which might affect their future competitive advantage.

The PSO is enacted enabling the creation of inter-organisational maps for each megaproject, enabling a comparison of dynamics between the system architecture of the six cases analysed. The following project actors are represented across the six levels in each inter-organisational map, as illustrated by figures 2 to 7.

- The owner or the ultimate sponsor, for instance, governments, Treasury, central banks.
    - HS1: UK Government; Heathrow Terminal 5: British Airports Authority (BAA); London 2012 Olympics: UK Government; Crossrail: Transport for London (TfL);

Tideway: consortium of investors (Allianz, Amber Infrastructure, Dalmore Capital and DIF), HS2: UK Government.

- The sponsor, for instance, public departments that receive the funding and are empowered by the owner.
    - HS1: Department for Transport (DfT); Heathrow Terminal 5: British Airports Authority; London 2012 Olympics: Department of Culture, Media and Sport (DCMS); Crossrail: Transport for London and Department for Transport; Tideway: Thames Water; HS2: Department for Transport.
- The temporary client, also called delivery vehicle/body, a single-purpose organisation created by the sponsor to oversee the project. This entity is empowered by the sponsor to establish contracts with the development partner, delivery partner and tier one suppliers.
    - HS1: London and Continental Railways (LCR) assisted by its subsidiary Union Railways; Heathrow Terminal 5: British Airports Authority; London 2012 Olympics: Olympic Delivery Authority (ODA); Crossrail: Cross London Rail Links Limited (CLRL Ltd) (development stage) and Crossrail Limited (CRL Ltd) (delivery stage); Tideway: Bazalgette Tunnel Limited (Tideway); HS2: High Speed Two Limited (HS2 Ltd).
- The development partner, the single or joint venture of firms advising the client during the front-end stage until the permission to build, often the approval of the hybrid bill and royal assent.
    - HS1: Rail Link Engineering (RLE) (Arup, Bechtel, Halcrow and Systra); Heathrow Terminal 5: British Airports Authority; London 2012 Olympics: CLM (CH2M, Laing O'Rourke, and MACE); Crossrail: Bechtel; Tideway: CH2M; HS2: CH2M (Phase 1); Bechtel (Phase 2).
- The delivery partner, which is composed of one or more organisations who are responsible for augmenting the capacity and capability of the client organisation (and are usually mistakenly understood as 'the client' by the supply chain), which might be independent or integrated with the temporary client organisation at different stages of the project.
    - HS1: Rail Link Engineering (Arup, Bechtel, Halcrow and Systra); Heathrow Terminal 5: British Airports Authority and suppliers through the T5 agreement; London 2012 Olympics: CLM (CH2M, Laing O'Rourke, and MACE); Crossrail:

Programme Partner (CH2M, AECOM, Nichols) and Programme Delivery Partner (Bechtel, Halcrow, Systra); Tideway: CH2M; HS2: CH2M, Atkins and SENER (Phase 1), Phase 2 to be appointed.

    - HS1: London and Continental Railways independent of Rail Link Engineering; Heathrow Terminal 5: British Airports Authority and tier ones integrated through the T5 Agreement; London 2012 Olympics: Olympic Delivery Authority independent of delivery partner; Crossrail: Crossrail Limited independent of programme partner and programme delivery partner and later integrated; Tideway: Thames Water integrated with development partner and later Tideway more independent of the programme manager; HS2: HS2 Limited integrated with development and delivery partners.

- The operator, which is responsible for the provision of services to end-users and profits through the exploitation of the asset.
    - HS1: Eurostar UK (owned by London and Continental Railways); Heathrow Terminal 5: British Airports Authority; London 2012 Olympics: during the games the London Organising Committee of the Olympic and Paralympic Games (LOCOG), and after the games several tenants; Crossrail: Mass Transit Railway (MTR); Tideway: Thames Water, with Tideway responsible for maintenance; HS2: West Coast Partnership, with HS2 Ltd as the infrastructure manager.
- The tier one contractors, organised as single entities or joint ventures, which are responsible for delivering a substantial work package acting as systems integrators of their own supply chains.
- The wider supply chain (tier two, three, four, and so on).

At High Speed 1, the UK government was the owner, allocating the responsibility to a public department (DfT) that acted as the sponsor, as shown by Figure 2. A PFI contract was awarded to London and Continental Railways (LCR), which was responsible to Design, Build, Finance and Operate (DBFO) the line. LCR appointed a partner to design and project manage the construction, Rail Link Engineering (RLE), also responsible for liaising with the tier one suppliers.

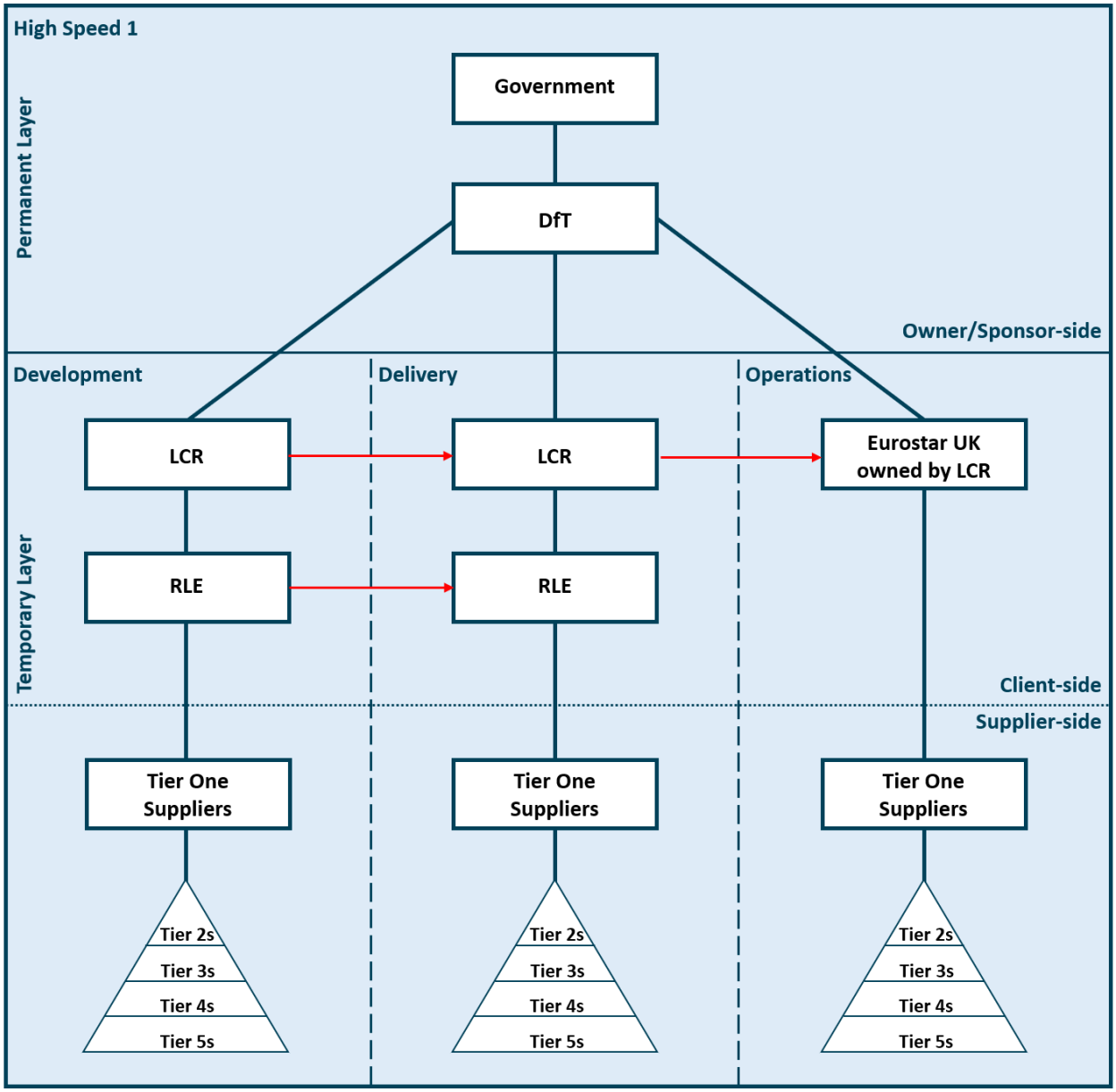

Figure 2: High Speed 1 PSO.

At Heathrow Airport Terminal 5, BAA, as an independent airport operator, had the opportunity to internalise several roles, and acted as the owner, the sponsor and the client, as illustrated by Figure 3. BAA established integrated project teams with its tier one suppliers, working in a collaborative manner guided by the principles of the T5 Agreement, where the client held the risk of failure and removed the supply chain fear of not profiting from the project.

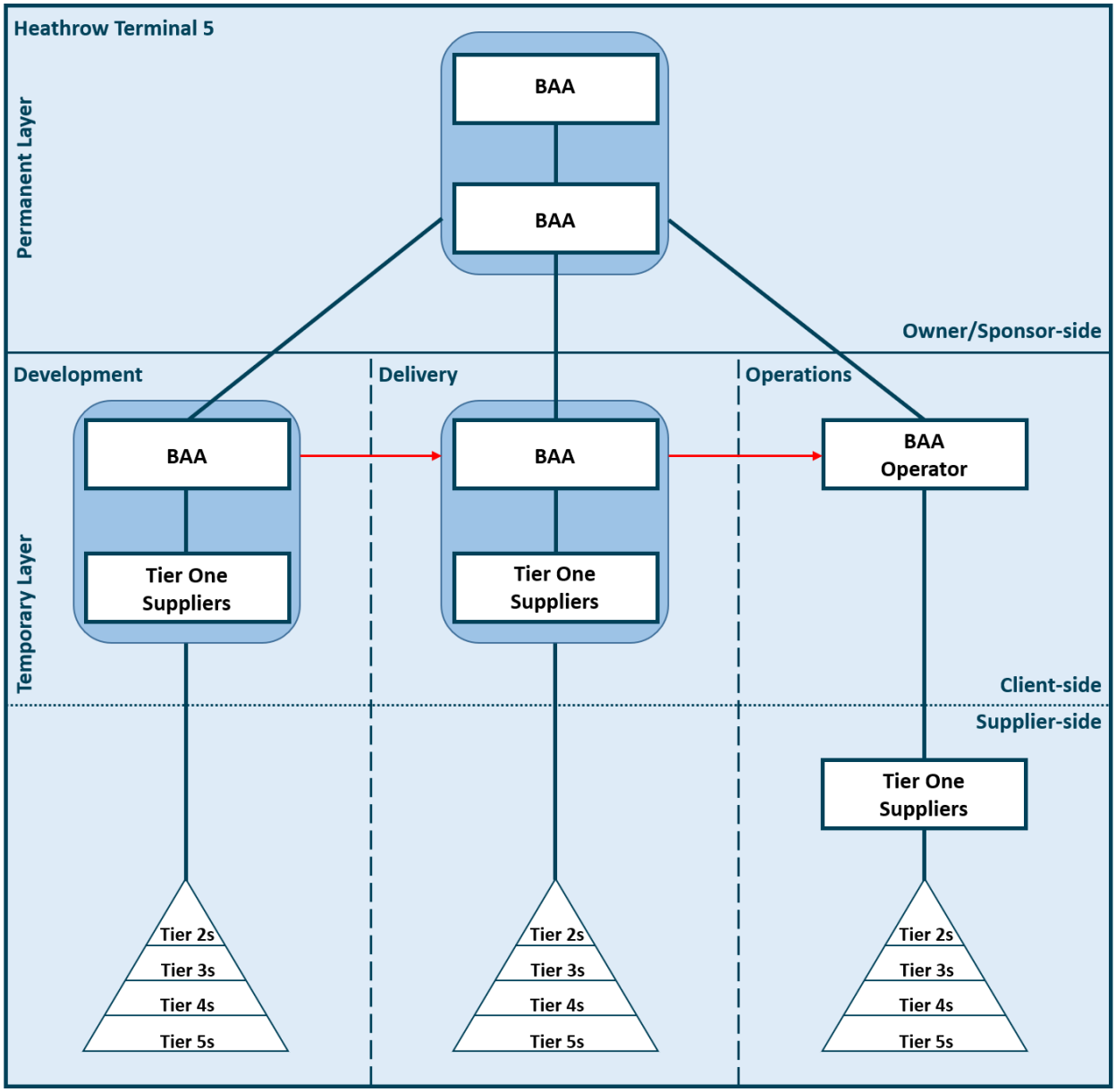

Figure 3: Heathrow Airport Terminal 5 PSO.

For the London 2012 Olympics, the UK government was the owner, allocating the responsibility to one of its departments (DCMS) that acted as the sponsor, as shown by Figure 4. A temporary client organisation (ODA) was created to be a dedicated unit in charge of the project. As an emerging client, the ODA selected a delivery partner (CLM) to provide extra capability and coordinate the tier one suppliers. The ODA and CLM worked integrated during development, but not during delivery.

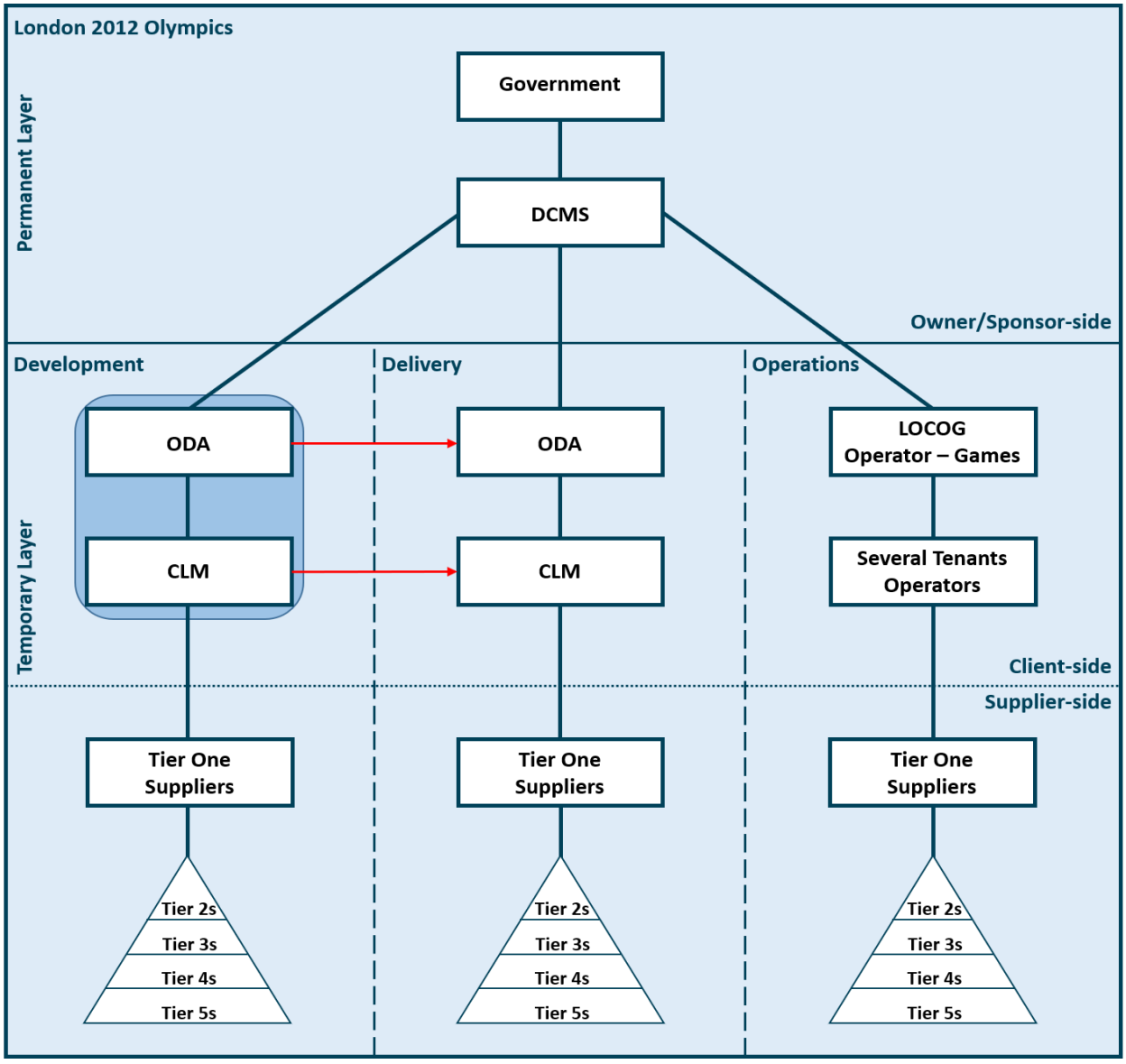

Figure 4: London 2012 Olympics PSO.

At Crossrail, TfL is the owner that will incorporate the asset into its network, where the responsibility to act as a sponsor is allocated to both TfL and a UK government department (DfT), as illustrated by Figure 5. A temporary client organisation (Crossrail Ltd) was created to be a dedicated unit in charge of the project. Crossrail Ltd hired two partners (Programme Partner – PP and Programme Delivery Partner – PDP) to provide extra capacity and capability working in an integrated manner.

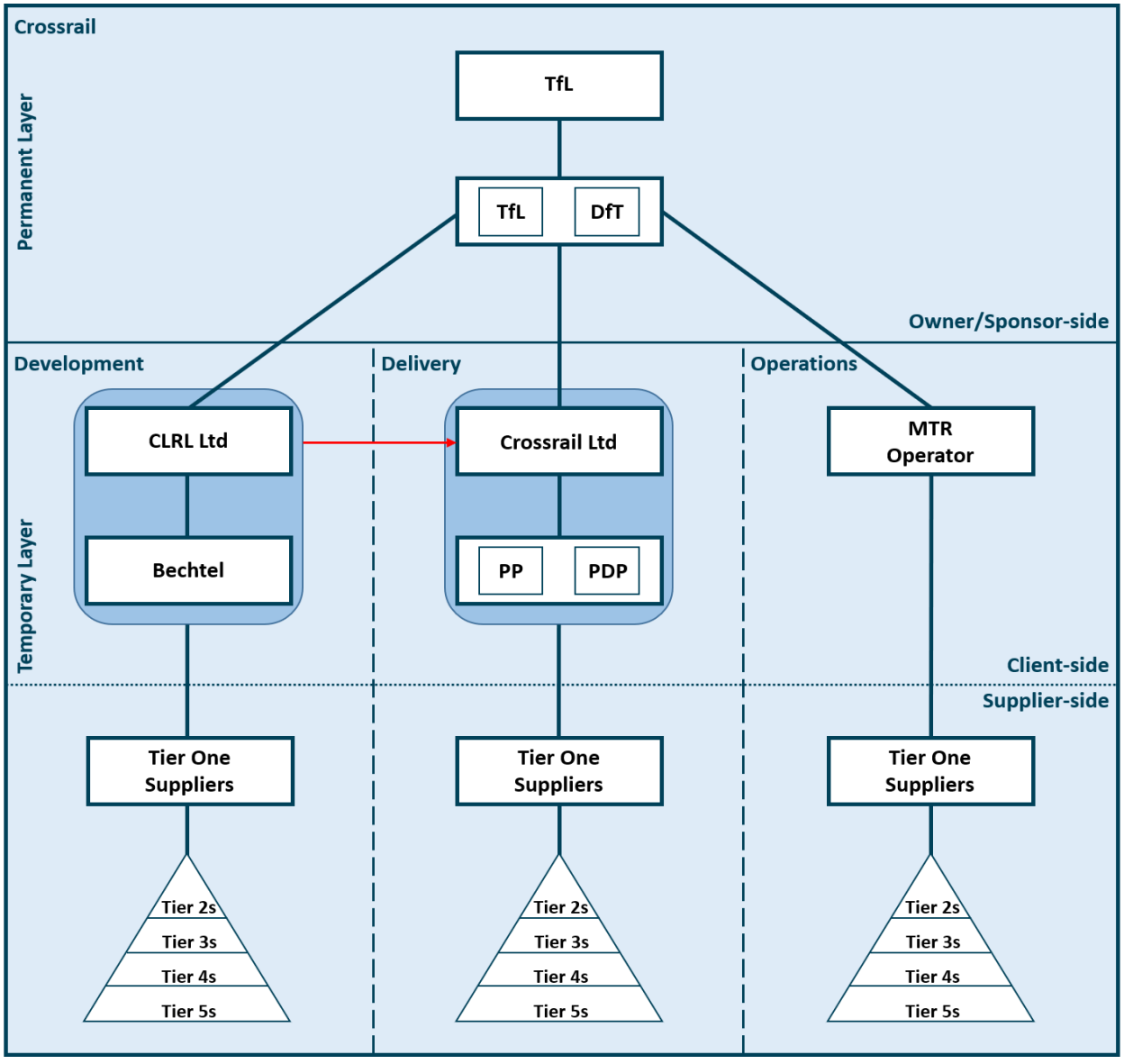

Figure 5: Crossrail PSO.

At Thames Tideway Tunnel, the project was initiated by the UK government as the owner and Thames Water as the sponsor; however, it was later sold to private investors who are now the owners, as shown by Figure 6. A client organisation (Tideway) was created to be a dedicated unit in charge of the project and CH2M was appointed as the programme partner. The relationship between them was integrated during the development the stage and more separated during delivery.

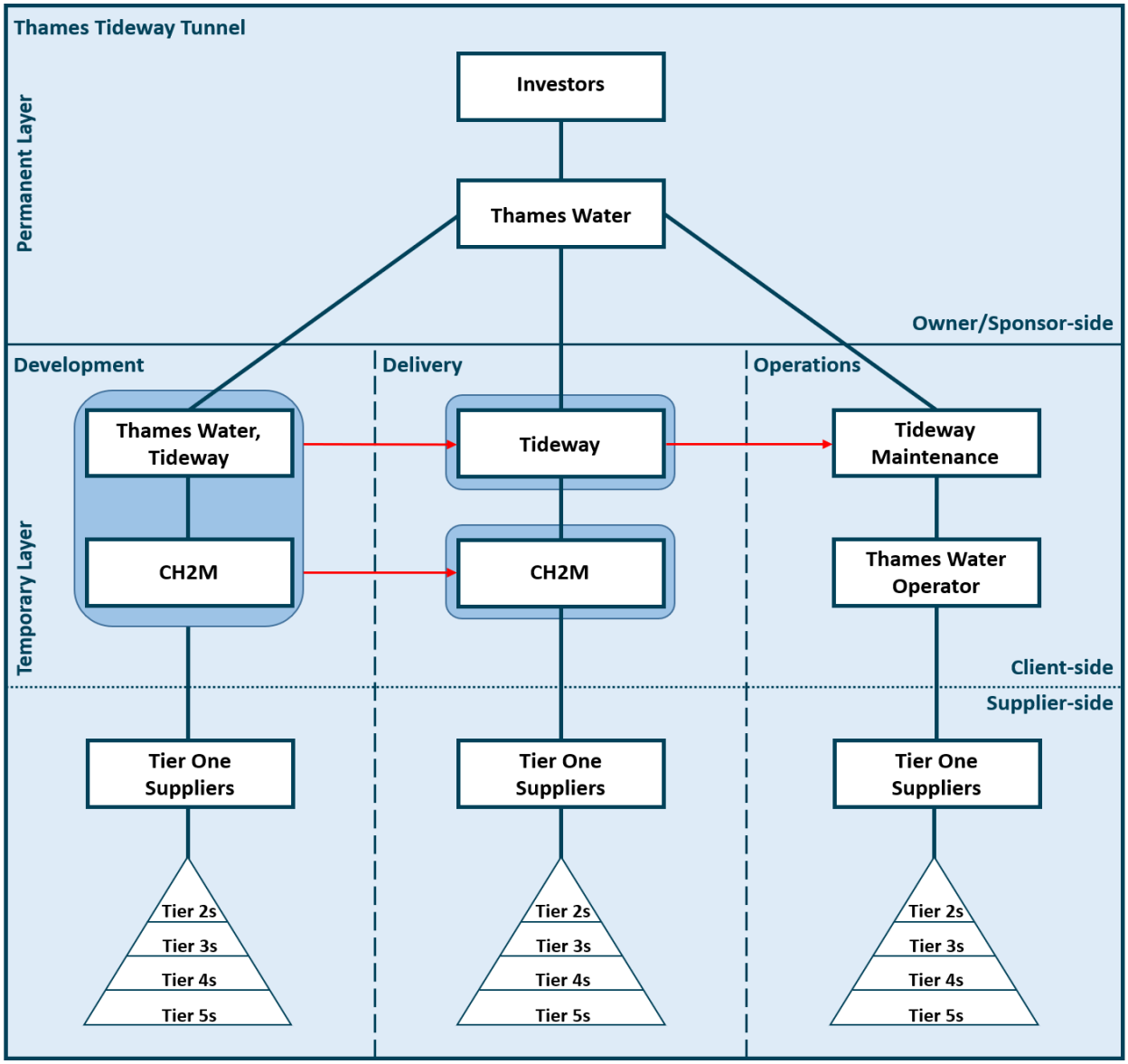

Figure 6: Thames Tideway Tunnel PSO.

At HS2, the UK government is the owner, allocating the responsibility to one of its departments (DfT) that acts as the sponsor, as illustrated by Figure 7. A client organisation (HS2 Ltd) was created to be a dedicated unit in charge of the project. The project is divided into phases 1 and 2, where different development and delivery partners were hired to work integrated with the client.

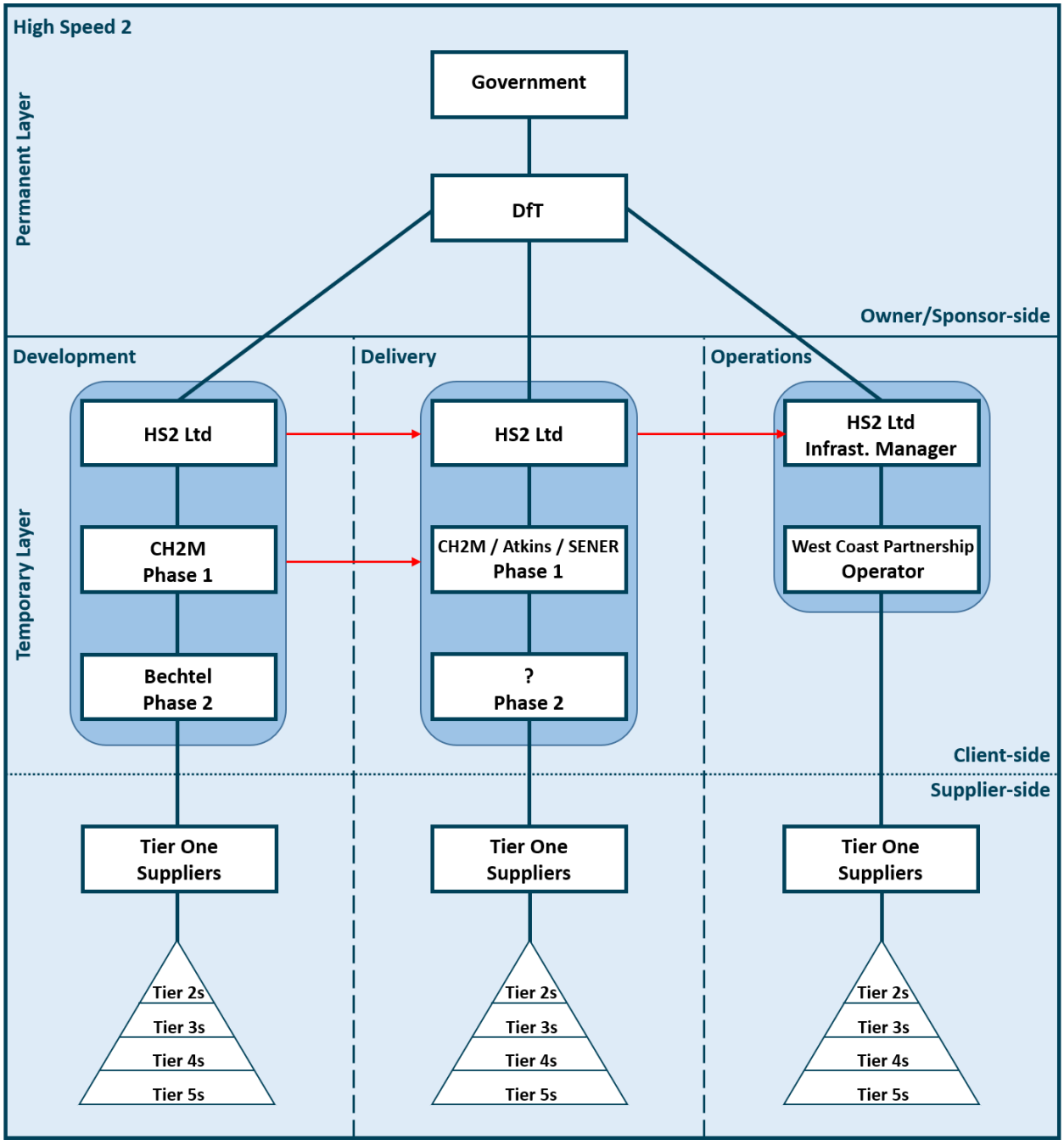

Figure 7: High Speed 2 PSO.

5. Discussion

The sponsor (Miller and Lessard, 2000) has an initial influence in the architecture of the system, progressively empowering the client organisation to deliver the project and design the inter-organisational system. Although there is a shift in power towards the client organisation, there is a constant iterative process between clients and sponsors to validate strategic decisions, as the client organisation might be temporary and the asset will be integrated in the sponsor's permanent network (Merrow, 2011). In this case, the sponsor is more connected with decisions regarding the client organisation, while the latter when empowered is building capabilities through different integration models with the supply chain. The first engagement cycle of the client organisation is associated with development and delivery partners (Davies and Mackenzie, 2014), the organisations that will provide the augmentation of capacity and capability to the client (Denicol, 2020a). Although this decision is developed primarily by the leadership of client organisations, there is a robust process in place to assess all the options with the sponsor and validate the selected approach to be adopted. The decision regarding the development and delivery partners might be perceived only as an intra-organisational decision of the client organisation, aiming to build the structures to coordinate the development and delivery of the project (Lloyd-Davies and Rowark, 2017). However, the six inter-organisational maps suggest that we need a more fluid and dynamic understanding of the system, as client organisations might create an inter-organisational form from the outset by selecting to have an external delivery partner from the start, as evidenced by the ODA-CLM at the London 2012 Olympics. Therefore, even if the development and delivery partners are intrinsically associated with intra-organisational structures (March and Simon, 1958; Galbraith, 1973) of clients, they often will perform an inter-organisational role given the longevity of megaprojects and reconfigurations needed during the life-cycle (Sydow et al., 2016).

Decisions associated with the design of the system architecture happen at a strategic level and influence the subsequent stages of the project. The interpretation of the architectures emerging from the six cases reveal that it encompasses previous conceptualisations such as meta-systems integration (Davies and Mackenzie, 2014), and meta-organisations (Gil et al., 2017), and highlights the need for a more systemic analysis, not centred in individual organisations. Therefore, strategists designing the megaproject system might find useful to map the vertical and horizontal interdependencies between different actors distributed across the multi-levels and layers of the

framework. The emerging knowledge might provide invaluable information about the temporal dynamics of the system, and inform the strategies to organise the intended behaviour of each organisation towards a collective systems-level goal.

Insights from Gosling et al.'s (2011) Research-to-Order (RTO) concept are particularly relevant to illuminate a discussion about the PSO design. Gosling et al.'s (2011) research extended the Engineer-to-Order concept (McGovern et al., 1999; Hicks et al., 2000; Hicks et al., 2001; Gosling and Naim, 2009) and provided a discussion at the factory level, where the manufacturer would start a RTO about the product after receiving the end-client's order, ensuring high levels of customisation for the client. The design of the PSO happens in another strategic layer, where the structure of the production system is being designed at intra- and inter-organisational levels, configuring the upstream supply chain actors. The RTO concept is based upon the assumption of an established production system at factory and supply chain levels, where the firm receiving the order would research about the product, drawing upon its ongoing and stable productive structure. The uniqueness of the product would be comparable to megaprojects, which also need to be researched in several of their elements. However, the key difference in megaprojects is the lack of a production system in place, where not only a new client entity is being established from scratch, therefore its intra-organisational structures need to emerge from the ground zero, but also, and more importantly, the supply chain relationships and alignments to enable the assembly of complementary capability do not exist.

Before in-depth discussions regarding the specifications of the megaproject at technical level, the client organisation is often established in light of the sponsor's business case and institutional drivers, which triggers the process of shaping, sometimes irreversibly, the system architecture (Wright et al., 2017). In a later stage, when the client organisation is established, the downstream supply chain architecture will be further designed in light of a much greater depth of technical specifications, where each category (e.g. enabling works, main works civils, railway systems) will be assessed to determine the most appropriate packaging strategies for each tier one supplier (Lloyd-Davies and Rowark, 2017). This research argues for a more integrated research and design-to-order solution for the supply chain architecture, where the client organisation would be designed in light of a wider consideration of the technical capabilities of the supply chain. As demonstrated in the six case studies, even after the careful establishment of the system architecture, there might

be instances where the architecture will have to be unfrozen and redesigned given emerging situations during the project life-cycle.

Once confidence in the project grows and there is momentum towards the hybrid bill submission, the client organisation starts to prepare to enter the delivery phase, building delivery readiness capability through recruiting an in-house team to plan the next phase. This is the second layer of engagement with the market, where the supply chain will exponentially grow, with engagements with the tier one contractors and the wider supply chain (Hone et al., 2011). The client team (client and partners) proposes a procurement strategy to engage with the part of the supply chain who will in fact deliver a physical product (Cornelius et al., 2011). The contract will be established with tier one contractors that will perform the role of systems integrators coordinating their supply chain, where the production and transformation of raw material into finished products and sub-systems occur in the lower tiers of the supply chain.

A critical point seems to be the transition from development to delivery, where there is an increasing power allocated to the client organisation that manages the progressive exponential growth of the supply network. The delivery readiness process at the end of the development phase is currently underexplored, where a delivery strategy is designed including plans to engage with tier ones and the wider supply chain. This stage is where a large amount of time was spent on Heathrow Airport Terminal 5 (Wolstenholme et al., 2008; Potts, 2009), assessing previous projects to design a different way of engaging with the supply chain, culminating in the development of the T5 Agreement (Davies et al., 2009). Once the system architecture is designed and frozen during this transition, it might be quite challenging to reengineer the desired relationships in the inter-organisational map. The identification of the delivery readiness well in advance of the delivery phase is a contribution to the literature, which is silent about the dynamics of this process in megaprojects, where the focus has been on the handover from delivery to operations (Davies et al., 2009; Zerjav et al., 2018).

There is an expanded arena to foster collaboration and take advantage of relationships between the pool of organisations involved in the project (Genus, 1997), which is little explored in the literature from the client perspective. Within the system, the individual projects are interdependent and part of the same major programme, where each project is allocated to a tier one contractor or joint venture that has visibility only of its own package, thus at project rather than programme level

(Mead and Gruneberg, 2013). However, even if these organisations share the overall vision and strategic objectives of the project, their alignment and willingness to respond and contribute might be compromised if those are not reflected in their performance indicators. In light of the scale and visibility, the client is in a unique position to explore the buyer-supplier relationship (Gil, 2009), identifying the competing priorities of each organisation and designing the supply chain architecture, strategically cascading down the alignment through a system of the contractual relationships and incentives amongst the actors. In some instances, there is a willingness to establish a collaborative approach to a particular work package, but commercially and contractually the organisation might be constrained and cannot disclose essential information (Lowe and Leiringer, 2008). In this sense, there is a gap to be addressed by the client organisation, which has a unique position regarding visibility of the project and can play the role of integrating all the information from the suppliers (maintaining their individual commercial secrets), enacting it to inform decisions at programme level and disseminating back to tier one suppliers in an anonymised format, improving the awareness and sophistication of their decisions at the project level.

6. Conclusion

In light of the unfolding and evolutionary nature of megaprojects, the owner and sponsor entities act as the initial architects of the inter-organisational system. The translation of public policies into the configuration of the megaproject system will determine not only the potential configuration of the client organisation, that might adopt different forms in the public-private spectrum, but also some of the options that clients might adopt in a later stage to engage with the supply chain. In this scenario, the owner and sponsor organisations will create conditions that will initially shape the inter-organisational map, which is later transitioned to the client organisation. The baton of being an inter-organisational architect is progressively passed to the client organisation, however there is a constant reporting line to the sponsor regarding more strategic decisions, which have the potential to significantly affect the inter-organisational system of production.

The process of making decisions between the sponsor and client to form and configure the inter-organisational structure that will deliver the megaproject is unexplored in the literature. This study addresses the gap by examining how megaprojects designed the inter-organisational relationships and configured their system architecture. The study builds upon previous project-organising

conceptualisations and evolves the conversation by unpacking and elaborating the emerging structures of project networks in megaprojects, as a temporary and complex setting. The research contributes to shed light on the process of inter-organisational formation and evolution by exploring a comprehensive sample of six of the largest European megaprojects in London. It unfolds the decision-making process of building capability in-house or outsourcing, as well as the establishment of system-wide relationships across the supply chain throughout the megaproject life-cycle. The research argues that the inter-organisational map in megaprojects is often created in an organic and evolutionary manner, while future projects would benefit of a strategic design by the architects of the system.

The research contributes to knowledge by combining two novel approaches in megaproject management research, namely: (i) the analysis of multiple megaprojects, three in real time and three retrospective; and (ii) the exploration of those settings though a process-based perspective, embracing their longevity and unpacking the temporal evolution of several actors. Informed by one of the largest comparative studies of megaprojects in the UK, the findings of this research might be considered particularly relevant to the international community since the epistemic community of London's megaprojects is currently the world's centre of gravity regarding megaproject delivery knowledge. Different players (e.g. government, firms, universities) are constantly requested to export practices and inform the development of major and megaprojects around the world.

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