

Reinventing Megaproject Delivery Models

The Rise of the Capable Client—The
Supply Chain Architect

Juliano Denicol, PhD

*Assistant Professor in Project Management
School of Construction and Project Management
The Bartlett Faculty of Built Environment
University College London*

Table of Contents

Acknowledgments 2

Executive Summary 3

1 Introduction 4

- 1.1 Research Aims and Objectives 4
- 1.2 Research Overview 5

2 Theoretical Framework 6

- 2.1 Why Are Megaprojects so Important? 6
- 2.2 From Projects to Supply Chains 7
- 2.3 Supply Chain Management 11
- 2.4 Construction Supply Chain Management 12
- 2.5 Summary 15

3 Research Methodology 16

- 3.1 Research Design 16
- 3.2 Data Collection 16
- 3.3 Data Analysis 17
 - 3.3.1 The Retrospective Cases 17
 - 3.3.2 The Real-Time Cases 17

4 Results and Discussion 19

- 4.1 Designing Client Organizations 19
- 4.2 The Client-Sponsor Relationship 20
- 4.3 The Client-Delivery Partner Relationship 21
- 4.4 The Client-Supply Chain Relationship 22

5 Conclusion 23

- 5.1 Limitations 23
- 5.2 Future Research 23

References 25

Biography 34

Acknowledgments

This journey was a challenging and rewarding one, to which some people contributed to make it remarkable. My thanks and gratitude go to:

Professor Andrew Davies and Professor Stephen Pryke for their continuous support and insightful research discussions throughout the stages of this megaproject.

The academics of the Bartlett School of Construction and Project Management for creating a thought provoking environment.

The more than 300 megaproject practitioners who expressed an interest in this research, volunteered their time, and shared critical and insightful views on the world of megaproject management.

The Project Management Institute for awarding the research with their prestigious Thesis Research Grant.

The Major Projects Association for awarding their influential PhD Long-Term Grant to the research.

The International Project Management Association for awarding their 2019 Global Young Researcher Award.

The Brazilian research agency CNPq (National Council for Scientific and Technological Development) for funding and supporting this research.

Juliano Denicol, PhD

London, 2020

Executive Summary

Megaprojects are usually proposed by the public sector as a reflection of the government delivering a new physical asset to address a necessity of the society, improve living conditions, foster business relationships, and impact the economic performance. The large amount of capital for infrastructure projects is tightly aligned with the fast and exponential global population growth, which, according to the United Nations, will reach 8 billion by 2030 and 9.7 billion by 2050 (United Nations, 2019). Considering the high rate of budget overruns and delays in megaprojects, it is important to explore in depth the potential of innovative client models to deliver megaprojects.

Considering the global infrastructure pipeline forecasted for the next decades, this research explores the formation of megaproject client organizations, which are new, dedicated, and often temporary entities created to deliver the project on behalf of the sponsor. The research is novel as it investigates three megaprojects in real time and adopts a supply chain management lens to conceptualize the formation and evolution of inter-organizational relationships. It contributes to two literatures, construction supply chain management and project delivery models, by exploring the megaproject client organization as the focal firm and its strategies to design the supply chain architecture. It builds upon previous research by exploring a different challenge to manage the supply chain in one-off settings, exploring the concurrent formation of a new entity and its supply chain strategies. Six megaprojects that at the time represented a combined investment of £93.93 billion have been analyzed in the United Kingdom: High Speed 1 (£6.16 billion), Heathrow Airport Terminal 5 (£4.3 billion),

London 2012 Olympics (£8.77 billion), Crossrail (£14.8 billion), Thames Tideway Tunnel (£4.2 billion), and High Speed 2 (£55.7 billion). The empirical data were collected through 210 semistructured interviews with senior megaproject leaders. Key research findings include: (i) the identification of the megaproject multilayer and multilevel organizational structure, identifying multiple organizational roles and responsibilities; (ii) understanding of the terminologies of owners, sponsors, clients, and operators in megaprojects, as well as the dynamics of its nonstatic and evolutionary nature throughout the project life cycle, unpacking who does what, when, how, and why; (iii) the process of the formation of temporary client organizations and the dimensions of the rationale behind the strategic decisions over time, in light of the plurality of potential integration methods between client and delivery partners; (iv) the importance of a clearly defined governance structure and recommendations to organize the inter-organizational relationships between sponsors, clients, delivery partners, and the supply chain.

This research improves the understanding of the formation and evolution of megaproject client organizations, illustrating how the emerging temporary organizations design the supply chain architecture and the dynamics of the associated inter-organizational relationships. The research contributes toward a more informed, systemic strategic decision making by the client organization, impacting the inter-organizational relationships with the supply chain to improve megaproject delivery. Considering the sequential development of these projects, there is an opportunity to understand the evolution of the U.K. market as a client in delivering megaprojects, exploring the similarities and differences of the inter-organizational structures created over time. The aim is to provide guidance for megaproject promoters, policy makers, and practitioners in their strategic decisions in the front-end of those projects, increasing the knowledge of innovative structures to address the increasing global investment in megaprojects.

1. Introduction

Considering the global infrastructure pipeline forecasted until 2030, US\$57 trillion (McKinsey Global Institute, 2013), and the high rate of budget overruns and delays in megaprojects, it is important to explore in depth the client-based delivery model framework. This research helps to identify some of the factors leading to the unsuccessful delivery of megaprojects (e.g., Denver Airport, Boston Big Dig, Wembley Stadium, Channel Tunnel, and Berlin Airport), and provides some guidance to overcome them. It is essential to address those failures, which are associated with environmental and economic impacts, since continuing with unsuccessful practices at this level of investment (and overbudgets) is associated with massive resource extractions. This research conducted case studies in the next generation of U.K. megaprojects: Crossrail, (£14.8 billion), Thames Tideway Tunnel (£4.2 billion), and High Speed 2 (£55.7 billion).

Therefore, this research about the management of megaprojects is informed by several different perspectives: (i) the need to expand knowledge about the new cures for the management of large-scale projects; (ii) the global scenario for the next two decades of high-infrastructure investments is pressing for managerial alternatives, either in the developed world such as western Europe, the United States, and Canada, or developing countries like China, India, and Brazil; (iii) the United Kingdom is consolidating an innovative framework for megaproject delivery and there is a pipeline of projects to validate and expand the framework in the next generation of U.K. megaprojects.

In this context, there is a necessity and an opportunity to analyze megaprojects embedded in London's rich ecology, aiming to understand how client organizations are structured and how the roles of owners, sponsors, clients, and delivery partners evolve over the project life cycle to design and shape strategies to engage with the supply chain.

1.1 Research Aims and Objectives

The question examined by this research is: How are client organizations formed and supply chain strategies designed to deliver megaprojects? The research aims to improve the understanding of how temporary client

organizations (the one-project organizations) are structured and make strategic decisions to engage with the supply chain. Little is known about the dynamics of those new entities performing the role of the client in the development phase of megaprojects. This research seeks to illuminate how the emerging temporary organizations design the supply chain architecture and the dynamics of the associated inter-organizational relationships. Ultimately, this study aims to contribute toward a more informed, systemic strategic decision making by the client organization, impacting the inter-organizational relationships with the supply chain to improve megaproject delivery. There is practical relevance and an academic gap to explore the role of the client organization and its interface with the delivery partner, contributing to the construction supply chain management literature by understanding that this client should become strong and intelligent rather than just an investor (sponsor) and asset manager (operator). To achieve this aim, the objectives are to examine how client organizations are:

- Understanding the roles, responsibilities, and terminologies of owners, sponsors, clients, delivery partners, and operators;
 - This research identified four main upstream supply chain players: owner, sponsor, client, and operator (Denicol et al., 2019). The sponsor can be the owner, the sponsor can be the owner and accumulate the operator function, or the sponsor can be just the sponsor. The ownership might lie with another party, similarly to the operations, which may be connected to another partner through a different contracting arrangement.
- Designing the relationships between owner, sponsor, client, delivery partner, tier-one contractors, and external stakeholders in light of the private versus public, and temporary versus permanent dynamics;
 - The clarification of these roles provides visibility of what each entity is responsible for at the beginning of the project, avoiding the late establishment and engagement of other organizations, such as the operator, which is one of the biggest sources of problems, as previously seen in the Channel Tunnel project. The ownership and operation might vary considerably, therefore this study considers primarily the organizations more actively involved during the project life cycle: sponsor and client (temporary vehicle composed of client and development and delivery partners).

The client is responsible to act as the supply chain architect, designing the strategies to engage with tier-one contractors that often are organized in joint ventures.

- Understanding the dynamics between client and delivery partners and how these organizations are designing strategies to engage and coordinate the large network of suppliers, identifying levels of systems integration.
- The configuration of a client organization during the development stage is different from the structure needed for a delivery organization. The client organization needs to be designed from the outset to account for the transition from development to delivery, establishing clearer boundaries and managing expectations of the people involved, otherwise the organizational format might start the delivery phase in a suboptimal manner. This study contributes to advancing the understanding of intra-organizational decisions in megaproject client organizations, and argues that the organizational design of those entities should shift toward a supply chain design from the outset. This systemic perspective of designing not only the optimal version of one firm, but also the supply chain architecture in which that entity is inserted will largely benefit the client to avoid lock-in situations. The design of the megaproject supply chain architecture, as well as the consideration of its evolution and future configurations over the project life cycle, might assist clients to expand their understanding and ability to manage and integrate the inter-organizational interfaces.

1.2 Research Overview

This research is composed of five sections. After the present section, Section 2 presents the theoretical framework covering the exploration of several topics

aiming to support the research question. The first subsection, 2.1 Why Are Megaprojects so Important?, introduces and frames the setting considering their relevance as a vehicle to provide infrastructure to a growing global population. The second subsection, 2.2 From Projects to Supply Chains, covers the interface between project management and supply chain management literatures, exploring concepts from mainstream supply chain management and the specific dilemmas of application in the construction industry. The third subsection, 2.3 Supply Chain Management, explores the origins of supply chain management in manufacturing environments, which leads to the fourth subsection, 2.4 Construction Supply Chain Management, that narrows supply chain management to the construction industry context, exploring the differences between permanent and temporary supply chains, drawing upon production strategies from high-volume and project-based environments. The fifth subsection, 2.5 Summary, provides a critical analysis of the literature and leads to the selection of megaprojects as an innovative setting to explore construction supply chain management studies.

Section 3 presents the research methodology with critical reflections about the tensions between theory and practice in the academic and industrial domains. The section introduces and builds a rationale for the adopted qualitative approach, data collection, and data analysis. Section 4 presents the results and discussion, following a structure of four subsections that cover the design and interfaces of the client organization with the sponsor, delivery partner, and supply chain, namely: 4.1 Designing Client Organizations, 4.2 The Client-Sponsor Relationship, 4.3 The Client-Delivery Partner Relationship, and 4.4 The Client-Supply Chain Relationship. Section 5 presents the conclusion, which summarizes the theoretical and empirical contributions in light of the research question and objectives, clarifies the boundaries of the research through its limitations, and provides recommendations for future research.

2. Theoretical Framework

2.1 Why Are Megaprojects so Important?

Megaprojects are usually proposed by the public sector as a reflection of the government delivering a new physical asset to address a necessity of a particular society and improve that society's living conditions. From an economic perspective, the environment created by an improved infrastructure system will be more likely to foster business relationships and impact the economic performance of that region, reflecting on the national gross domestic product (GDP). In the context of the public sector playing the role of the state and providing infrastructure as a driver to change and improve societies, megaprojects usually have a public sponsor, which can assume different forms and configurations of hybrid models with the private sector. Megaprojects are also referred to as major programs, which is a natural terminology given the intrinsic characteristic of scale and complexity of these projects and their division of the whole project (program) into work packages (projects). The individual projects are interdependent and part of the same program, therefore sharing the same ultimate system goal.

It is a consensus that a well-established infrastructure network can enable a country to achieve a prominent global position in terms of productivity and boost its growth. This assumption is supported by the perspective that every product or service made or distributed in that nation, from business to business in all industrial sectors to business to customer, will utilize the available infrastructure to achieve the purpose designed by several supply chain actors. These are the benefits of the constructed infrastructure, but there is a major interest from politicians and economists in the previous stages, where all the design and construction are conducted. Investments in infrastructure can provide an increase in the economic activity, engaging multiple supply chains during the initial phases: generating jobs; developing industrial sectors, regions, cities, production, and knowledge clusters; and a skilled professional workforce. This type of project attracts public attention

and is highly publicized by the media, characteristics that put such projects into the politicians' dream for either a campaign promise of creating a large number of jobs to stimulate the economy of a particular region, or just to feed their names (and egos) into the legacy in cutting the ribbon at the opening ceremony. Conversely, on the negative side, there are several sources reporting a large amount of corruption related to megaprojects, especially in developing countries, which do not have a strong institutional context or governmental structures, or even a population that is able to draw attention to the frauds.

In 2013, the McKinsey Global Institute launched an influential report predicting the need for US\$57 trillion for infrastructure investments until 2030 (McKinsey Global Institute, 2013). This necessity is hugely driven by emerging countries, especially Asian ones, since China corresponds to 24% of the required investment, which is 45% for Asia as a whole. The report divides the infrastructure sector into seven subsectors among transportation and utilities, allocating the investments for each category, such as ports (US\$0.7 trillion), airports (US\$2 trillion), rail (US\$4.5 trillion), telecom (US\$9.5 trillion), water (US\$11.7 trillion), power (US\$12.2 trillion), and roads (US\$16.6 trillion). This research considers six megaprojects in London's ecology and the majority of them (except the 2012 London Olympic Park) represent some of the suggested categories (High Speed 1 – Rail, Heathrow Terminal 5 – Airport, Crossrail – Rail, Thames Tideway Tunnel – Water, High Speed 2 – Rail).

In addition to McKinsey's report, PricewaterhouseCoopers (PwC) estimates that the necessary global investment between 2014 and 2025 is US\$78 trillion, with US\$1.5 trillion designated for the UK (PwC, 2014). This amount of capital will be able to increase the global infrastructure annual spending from US\$4 trillion in 2012 to US\$9 trillion by 2025, sustaining the global economic growth. PwC's report provides conclusions relying on an extensive analysis of five infrastructure sectors (extraction, utilities, manufacturing, transport, social) from 49 countries on all continents, which are responsible for 90% of global economic output. PwC's report presents evidence that the investments are concentrated in the Asian market, which has China as the large locomotive, and will account for 60% of the forecasted investment, while Western Europe will be responsible for less than 10%, mainly focusing on the maintenance and improvement of the established infrastructure.

The large amount of capital for infrastructure projects is tightly aligned with the fast and exponential global population growth, which, according to the United Nations, will reach 8 billion by 2030 and 9.7 billion by 2050 (United Nations, 2019). Correlated to this number and considering the increasing urbanization in emerging countries, there will be an acceleration of people moving from rural areas to the cities, spontaneously or forced by the conurbation between cities, resulting in the formation of megalopolis. The sum of these two phenomena, the rural exodus maximization and the increase of purchasing power in emerging countries, will insert 3 billion new people into the middle-class consumer market in the period between 2011 and 2030 (Ernst & Young, 2011). Considering this context, the proactive investment in infrastructure is vital to achieve global targets in several spheres, from climate change to public health. The World Economic Forum (WEF) pointed out that there is a return of between 5% and 25% for investments in infrastructure, corroborating the argument that infrastructure is the engine for growth, enabling the achievement of a chain of efficiencies in all industrial sectors (World Economic Forum, 2012).

The PwC study emphasizes the importance of the seven emerging countries (E7) (Brazil, China, India, Indonesia, Mexico, Russia, and Turkey) as global powers, as these nations continue to expand their infrastructure investment and participation in global GDP (PwC, 2014). In order to understand the size of the geopolitical shift predicted for the next decades, the report presents a GDP comparison between the seven emerging countries (E7) and the seven richest nations (G7) (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States). The comparison was conducted considering two global snapshots, 2009 and 2050, and concluded that in 2009 the E7's GDP was around 72% of the G7's GDP, while in 2050 this picture will be dramatically modified, with the E7's GDP representing two times the G7's GDP.

Considering the infrastructure investment until 2030, which has been called “the biggest investment boom in history” (The Economist, 2008), and the potential effects of “over and over again” in megaprojects (Flyvbjerg et al., 2003), a letter signed by 88 world-famous scientists was sent to the president of the G20 nations. The letter emphasized that academic research (Flyvbjerg et al., 2003) and industry reports (McKinsey

Global Institute, 2013) have proven, based on historical data, that infrastructure megaprojects have not achieved their proposed objectives, either in metrics related to the iron triangle (cost, time, quality) or regarding the attendance to clients' requirements and desired impacts on the society. The researchers suggested that there is a solid pattern of overruns and it is unlikely that this model will change to complete on budget the forecasted pipeline of projects, causing damage to the planet and requiring consequent corrective actions from governments and companies, negatively affecting the global economic growth (Foundation Earth, 2015). Denicol et al. (2020b) present the most comprehensive systematic review of megaproject performance to date. It considers an extensive list of synonyms used to describe megaprojects in the last decades (e.g., major projects, large-scale projects, infrastructure program, gigaprojects). The review analyzes 6,007 titles and abstracts and 86 full papers, identifying a total of 18 causes and 54 cures to address poor megaproject performance.

2.2 From Projects to Supply Chains

This section presents a discussion about projects and supply chains building upon some of the most influential conceptualizations within both domains. It highlights why supply chain management is important as a conceptualization and positions the research within the domain of construction supply chain management.

The project management literature is evolving and more attention is being given to the firm level, broadly including the management of large programs (Lycett et al., 2004; Pellegrinelli, 1997; Pellegrinelli et al., 2007), portfolios (Blomquist & Müller, 2006; Engwall & Jerbrant, 2003; Martinsuo, 2013), and supply chains (O'Brien et al., 2008; Pryke, 2009, 2020; Vrijhoef & Koskela, 2000). This logic implies that the unit of analysis extends from a single project toward a combination of multiple projects, organized and supplied by several structures. *Project studies* is the current terminology being employed to represent an expansion of the project as the unit of analysis, incorporating the relationship of projects and programs with the parent organizations, their corporate strategies, and interplay with the market and society (Geraldini & Söderlund, 2018).

The term *project society* brings to light the discussion of an environment transitioning toward production through projects, as opposed to mass production through stable operations. Lundin et al. (2015) argue that the increase of projects, building upon what Midler (1995) termed as *projectification*, will transform the way society operates, in particular when professionals of project studies (Gerald & Söderlund, 2018) interact with the current institutional system, which was built following the logic of an industrial society guided by mass production and high-volume operations. The term *industrial society* is associated with the transformation of a rural to urban society (United Nations, 2018), while project society is an evolution of the industrial one, reflecting societal changes that include demand for shorter life cycles, diversity, customization, and exclusiveness.

This rationale implies that projects are the next generation of operations, evolving from permanent to temporary (Sahlin-Andersson & Söderholm, 2002), static to dynamic, analog to digital (Levitt, 2011), lean to agile (Naylor et al., 1999), closed to open systems, the barriers of hierarchy into openness and approachable managers, the set of senior management offices into open-flow spaces, the political decisions (not always politically correct) into transparency (Locatelli et al., 2017), and universal access via social media—the dyadic form of relationship (individuals, contracts) into a network of connections linked through experiences and online platforms (LinkedIn, crowdsourcing). New projects and forms of organizing are challenging the old structure, where increasingly integrative arrangements are being used (e.g., national and international joint ventures) (Bing et al., 1999; Ozorhon et al., 2007; Shen et al., 2001), delivery partners (Davies & Mackenzie, 2014), alliances (Turner & Simister, 2001; Walker & Hampson, 2003; Walker & Lloyd-Walker, 2014), public-private partnerships (Roehrich et al., 2014), hybrids (Akintoye et al., 2003; Li, Akintoye et al., 2005; Quélin et al., 2017), and mergers and acquisitions (Choi & Russell, 2004; Delaney & Wamuziri, 2004). New forms of integration are being enabled and facilitated by the advancements in information exchange, which is growing exponentially through artificial intelligence in the Fourth Industrial Revolution (Schwab, 2017; World Economic Forum, 2016).

The core argument of Lundin et al. (2015) concerns the increase in production guided by projects, which emphasizes the temporary and ad hoc nature of this type of organization, rather than permanent structures

leveraging economies of repetition and scale. The emphasis on projects might be associated with the enhanced service levels demanded by clients, who want to ensure value for money through tailored and flexible solutions, contrasting with off-the-shelf products (Gann & Salter, 2000). This societal transformation illuminates the dilemma of temporary versus permanent (Sahlin-Andersson & Söderholm, 2002); although projects are temporary endeavors, they might be developed within the realm of permanent structures, being necessary to build the interfacing capabilities to navigate those contexts. The temporal nature of projects ensures different multilevel relationship dynamics, when compared with more stable structures. The rapid and evolving nature of projects stimulates managers to seek short-term results (often confused with project results), rather than considering the entire system.

Lundin et al. (2015) identify three archetypes of project-based organizations aiming to understand the interplay between projects and their contexts, namely:

(i) project-based organizations, (ii) project-supported organizations, and (iii) project networks.

Project-based organizations (PBOs) (Hobday, 2000) are also documented as project-based firms (Artto & Wikstrom, 2005; Gann & Salter, 2000; Lindkvist, 2004; Whitley, 2006), being associated with permanent firms that deliver their core capability through projects, drawing upon an intense focus on knowledge. They have an interface between a permanent structure and temporary projects being delivered, usually colocated with the client at the boundaries of the firm. PBOs are involved in multiple projects at any point in time, providing the same or different services to the same or different stages of the project (Thiry & Deguire, 2007). There is a disconnect between each project, in line with the lack of pipeline visibility, which emphasizes even more the importance of the portfolio management capability (Müller et al., 2008) for those organizations. This is particularly relevant in the underexplored context of megaprojects, which might improve their corporate profile and lead to future business, where a PBO would only be able to strategically bid low to capture a specific megaproject, with strong knowledge about their portfolio and supported by the performance of its involvement in other projects.

Project-supported organizations are permanent organizations involved in high-volume operations and supported by eventual projects, but that do not capture

value and profit primarily from projects (Lundin et al., 2015). Examples of those organizations include manufacturing firms with high-volume production that use projects to insert innovation and improve their core processes (Shenhar & Dvir, 2007). This type of organization can be understood as projects in operations-based firms, which is documented extensively in the operations management literature through several manufacturing contexts. The challenge for traditional organizations is to maintain their competitive advantage in a globalized market where geography (and its inherent contextual characteristics) plays an important role. Therefore, projects are the vehicle selected to include innovation and advance the system toward sustainable competitiveness (Frederiksen & Davies, 2008; Shenhar & Dvir, 2007). Manufacturing multinationals from the pharmaceutical sector (Müller et al., 2013) are strategically insourcing project management capabilities, creating an internal project management consultancy firm oriented to solve the problems of one single organization, the project-supported, permanent pharmaceutical organization.

Project networks recognize that projects are conducted by multiple firms that have organized themselves in a networked structure. Lundin et al. (2015) identify a wide range of uses for the term *project networks* and ultimately adopt the definition provided by Sydow and Windeler (1999), which argues for a broader focus on network coordination. In addition, this definition emphasizes past experiences and the organizational memory (Cacciatori, 2008; Kasvi et al., Prencipe & Tell, 2001; Vartiainen & Hailikari, 2003) of multiple firms working together across several projects to improve their coordination capability. This assumption may be less applicable in the construction industry, not only from a commercial stance but also through the inherent characteristics of the sector, where there is limited pipeline visibility and regularity (Ireland, 2004), in which future businesses/projects are less guaranteed, leading to the case of temporal supply chains formed project by project.

In the manufacturing domain, with increasing globalization and stronger competition, several authors have argued that firms started to maintain only their core competitive advantage in house (Barney, 1991; Porter, 1985) and outsource peripheral functions and systems, often to emerging markets, seeking low costs of labor in production (Christopher, 1992). This phenomenon transformed local, regional, and national

firms into global players that need to coordinate a wide range of business partners, organized across several supply chain tiers (Simchi-Levi et al., 2007). The operations management literature argues that the competition is not between firms anymore, but between supply chains; thus, the focal firm with the best supply chain management capability would win the battle (Cooper et al., 1997; Lambert et al., 1998; Lambert & Enz, 2017).

With the advent of globalization, project-based organizations are transitioning to become project-network organizations, at the same pace that traditional high-volume manufacturing firms are increasing their share of projects, therefore moving toward what Lundin et al. (2015) called project-supported organizations. Project networks have been conceptualized mainly through two understandings, namely: (i) a joint collaborative effort of project organizations for complementary knowledge and capabilities, corporately or individually through their employees (Jones, 1996); (ii) the repeated collaborations between organizations in light of past experiences and the analysis of the benefits to an evolving and recurrent network (Sydow & Windeler, 1999).

The previous conceptualizations explore the network as a permanent structure, drawing upon the implications of managing temporary projects taking advantage of the relationships offered by the network. However, they do not fully explore one-off contexts, where temporary supply chains are formed and dissolved project by project. Even more surprising is the lack of commercial awareness and its implications, ignoring the market orientation of the organizations forming the network (Lundin et al., 2015). This tendency is progressively emphasizing soft aspects and neglecting contractual arrangements, which are the mechanisms that commercial organizations will be incentivized and respond, particularly in a low-margin sector such as construction. Lundin et al. (2015) suggest a second conceptualization that the continuous relationship among organizations tends to improve their efficiency of working together as a network structure (Guimerà et al., 2005; Rodan & Galunic, 2004). The project-organizing literature often does not explore the concept of regularity and overall generalizes about several project-based domains, where the concept of regularity has the potential to be analyzed in light of each project-based context. This is at the core of project management and the dilemmas of generalization to

connect with other fields, in particular general management literature. Morris (2010) highlights that project management is context sensitive; therefore, the high-level generalization contributes little to evolve the domain, understand the problems, or assist in improving practices.

Critically evaluating the construction sector through the supply chain management lens, one could argue that, in light of its inherent fragmentation (London & Kenley, 2001; Vrijhoef & Koskela, 2000) and discontinuous nature (Gosling et al., 2015), it is important to look at the entire production system rather than individual pieces (Davies et al., 2009). Exploring the argument through the lens of megaprojects, which are delivered by a coalition of entities combined and recombined across the value chain, thus inter-organizational projects (Jones & Lichtenstein, 2008), the analysis of individual firms which do not have the program-wide visibility is to some extent irrelevant and tends to create siloed, suboptimal, and dysfunctional decisions for the system (Mead & Gruneberg, 2013). This scenario suggests that a critical capability is the coordination of inter-organizational relationships, which could be conceptualized by the management of the supply chain through a focal firm, where the client organization would be the supply chain actor to explore and enact a systemic approach.

The lens of production theory, which emphasizes the elimination of waste from the activities employed to transform a range of inputs into a final product, has been less explored by the project-organizing literature (Browning, 2003; Maylor et al., 2018). One of the exceptions is the lean construction research, formed by an active group of scholars inspired by the pioneering work of Koskela (1992, 2000). This research stream is more aligned with construction management than project management, carefully addressing operational topics during the production of the asset on-site. There are avenues of research and opportunities to incorporate insights from industrial engineering, standardization, and stabilization into the temporary phenomenon explored by the mainstream project management and project-organizing conversations (Maylor et al., 2018). One of the arguments in the project management literature to justify the lack of incorporation is the need to emphasize a discussion on strategic thinking rather than hard tools and executional approach. This stream is illustrated by Morris's (1994) critique of traditional project management literature,

which argued that the focus should be shifted from the operational level to the more strategic level as defined by the management of projects. Supply chain management addresses both arenas, providing the holistic lens to understand, design, and manage the system at the organizational level, as well as the philosophical and practical guidance from the operations management stream to address the operational level (Souza, 2015).

A special issue of the *International Journal of Production and Operations Management* in 2018 examined the interface between projects and supply chain management (Maylor et al., 2018). The guiding logic is the lack of research encompassing both domains, therefore the need for a special issue consolidating the knowledge and proposing future avenues. The special issue is a timely and well-written contribution that advances the conversation by bridging the project management and operations management communities. However, there are more opportunities to expand the topic and connect with the work of supply chain scholars exploring the interface between the two domains for more than two decades. It is interesting to explore the relationships with influential studies, such as Luhtala et al. (1994) on make-to-order supply chains, Vrijhoef and Koskela's (2000) highly cited paper about the four roles of supply chain management in construction, Cox et al. (2006) on managing in construction supply chains and markets, London (2007) on construction supply chain economics, O'Brien et al. (2008) on the handbook of construction supply chain management, Pryke (2017) on networks in project-based organizations, and Pryke (2009; 2020) on construction supply chain management.

Considering the operations domain, important studies explored the interface between construction and supply chain management. In the last decade, Gosling and Naim (2009) presented a systematic literature review on engineer-to-order supply chain management in the *International Journal of Production Economics*; Segerstedt and Olofsson (2010) organized a special issue on construction supply chain management in the *Supply Chain Management: An International Journal*; Aloini et al. (2012) offered a review of construction supply chain risk management in the *Business Process Management Journal*; and Behera et al. (2015) provided a discussion to evolve the understanding of construction supply chain management through a soft systems approach in *Production Planning and Control*.

This critique sheds light on the phenomenon that both mainstream project management and operations management literatures often neglect the field of supply chain management in project-based contexts. This fact reinforces the importance and sensitiveness of the context to manage supply chains, and is particularly relevant to this research, which is contributing to knowledge on construction supply chain management, in the particular underexplored setting of megaprojects.

2.3 Supply Chain Management

After a discussion about the interface between projects and supply chains, this section introduces the main concepts of mainstream supply chain management building upon the evolution of logistics and the spectrum of strategic decisions across different production strategies. It should be highlighted that mainstream supply chain management works as a context to construction supply chain management, which is the focus of this research. The concept of supply chain management was an evolution of the traditional logistics thinking to address the boundaries of the organization with its partners, other businesses that contribute to form a given product and satisfy the demands of an intermediary or final customer (Christopher, 1992; Cooper et al., 1997). Considering the timeframe in which supply chain management evolved as a concept and started to gain momentum (1980–1990s), it was a reflection of the global context and the economic revolution that was happening (Simchi-Levi et al., 2007). The increasing globalization has driven firms to look to outsource every possible noncore function (Roehrich, 2008) to emerging markets, in order to obtain cost-driven competitive advantages. In addition to the economic environment and stimulated by the work of Porter (1985), the internal optimization of factories was expanded, and senior management leadership started to explore the concept of value chains. By the late 1990s, a large proportion of the production activities was distributed across multiple emerging markets with cheap labor and production costs; therefore, there was a real necessity for a more systemic concept to provide theoretical support for inter-organizational integration (Cooper et al., 1997). In this context, supply chain management started to have space within the business community and be one of the top priorities for organizations (Lambert et al., 1998; Lambert & Enz, 2017).

Even decades after its conceptualization, there is still a terminological dilemma across several forums regarding what is supply chain management and how it is different from logistics (Cooper et al., 1997; Mentzer et al., 2011). To summarize the tension about these interfaces and provide clarity, Larson et al. (2007) present the most frequent interpretations, namely: (i) *traditionalist* where supply chain management is seen as an area within the logistics, responsible for activities that nobody can describe when questioned; (ii) *relabeling* where supply chain management is understood as the substitute of logistics, a new term adapting to the modern business context and addressing the leadership needs; (iii) *unionists* where supply chain management is noticed as a larger area than logistics, incorporating the outputs from logistics for strategic decision making; and (iv) *intersectionist* where supply chain management and logistics are observed as different concepts that perform common activities in specific (unknowns) situations. This research adopts a unionist view of supply chain management, where it has a large and more strategic scope than logistics, responsible for the external relationships of the firm with other organizations in the supply chain, encompassing organizations across several tiers that contribute to the product, from raw material extraction, through its transformation into products and services along the value chain, until distribution to the end user.

Analogous to the project management bodies of knowledge, two best practice models were developed to address the lack of consistent supply chain management knowledge in both business and academic communities: (i) the Global Supply Chain Forum (GSCF) and (ii) the Supply Chain Operations Reference (SCOR). The GSCF was developed by the influential Ohio School of Supply Chain Management, which emphasizes that supply chain management is about integration of processes across multiple organizations considering a holistic perspective from the raw material extraction/supplier, through transformations until the selling point to the final customer (Cooper et al., 1997; Cooper & Ellram, 1993; Ellram & Cooper, 1990; Ellram & Cooper, 2014; Lambert & Cooper, 2000; Lambert et al., 1998; Lambert & Enz, 2017). The critical word here is *processes*, which provides a much wider perspective than just products (or materials); it has a focus on information, which ultimately can be understood (and sold) as services or incorporated to products to create value for clients. The GSCF model is supported by the framework

developed by Lambert et al. (1998), which adopts a focal firm perspective to explain supply chain management. This framework builds on Porter's (1985) value chain thinking, where the focal firm should map its external relationships upstream and downstream, understanding the contribution of each supply chain actor for the end goal (product or service). After mapping, the focal firm has the opportunity to classify the supply chain relationships (preferably following a robust set of criteria), in order to prioritize which relationships it will control and to what extent. Levels of involvement should be established in order to develop an intra-organizational awareness and culture, which can be expanded through capabilities and, ultimately, to routines.

The supply chain management literature conceptualizes large manufacturing firms (i.e., original equipment manufacturers – OEMs) as the head of the supply chain, which would have the scale and repeatability to design and manage their inter-organizational relationships over time. The literature regarding low-batch production is less explored in the operations management domain, and particularly underdeveloped about the role of the client in settings influenced by that production strategy.

The work of Olhager (2003) is one of the most cited studies of comparisons between production strategies, which draws upon a framework based on the customer order penetration point. Considering the customer perspective, in make-to-stock industries and products, the customer places the order when the product is already manufactured and stored in a warehouse waiting to be shipped to its final destination, either a selling point or directly to the end user. One of the main drivers of this production type is that customers are not willing to wait for their products; they want access to them instantly. Therefore, the immediate example of this production strategy is consumer goods products, which are available at any moment in time on supermarket shelves (Meyr, 2009; Tu et al., 2001). In the assemble-to-order strategy, the manufacturers exploit the product structure to maximize their profit; therefore, the product is decomposed into several subcomponents and those are ready to be configured in a final product according to the client's requirements in their order (Song & Zipkin, 2003). The customers may be satisfied to wait some weeks for their product while they have the freedom to customize it. However, there is a limit for this customization, otherwise it would not be profitable for

the manufacturers. The main example of this production strategy is Dell, which disrupted the computers and accessories market in the 1990s, leveraging and maximizing the concept of mass customization (Gunasekaran & Ngai, 2005).

In the make-to-order strategy, the manufacturers have options regarding the final products; however, the production starts only when the customer places the order, which avoids the problem of excessive inventory of end products (Stevenson et al., 2005). From a manufacturer's perspective, it creates implications for production planning once the demand has high variability, being necessary to create a coordination system to consolidate the demands of several sources in order to create production stability. From a client's perspective, there is more freedom for customization regarding the fabrication of the product and procurement routes, while the lead time to receive the product is longer than with assemble-to-order. In the context of the engineer-to-order production strategy, the manufacturer has the professional capability in a given industrial sector and just starts the production when the customer places the order (Hicks et al., 2000). The difference between engineer-to-order and make-to-order is the level of customer influence in the product, where in the engineer-to-order environment the manufacturer will collect the customer's requirements and design a new product, service, or solution completely tailored to their needs (Bertrand & Muntslag, 1993; Pandit & Zhu, 2007). The lead time between order confirmation and delivery of the product is considerably longer and directly proportional to the degree of influence allowed. In summary, there is a trade-off between the access to the final product and the influence on its characteristics through customization.

2.4 Construction Supply Chain Management

Following a review of the mainstream supply chain management literature, in which different production strategies were highlighted, this section explores the literature on construction supply chain management, unpacking its temporary and permanent dilemma.

Suppliers are responsible for a large portion of a construction project's total cost; therefore, the processes of supplier relationship management are

directly related to the reduction of overall project costs, being a critical area to the success of supply chain management, as well as to the organization's sustainable competitiveness (Banker & Khosla, 1995; Ho et al., 2011; Setak et al., 2012). The low individual performance of construction suppliers contributes to reducing the overall efficiency, since inefficiencies are summed along the chain, following a *theory of constraints* logic (Goldratt & Cox, 1984). For the construction industry as a whole, buying at the lowest price through competitive tendering remains the dominant practice for the acquisition of goods and services; therefore, the inter-organizational relationships are sparse and, where they exist, tend to be limited to tier-one suppliers (Elfving & Ballard, 2011; Kumaraswamy & Palaneeswaran, 2000). In this sense, it is necessary to establish a closer client-supplier relationship, which can be built on several levels, from partnerships with the proactive management of some supply chain actors, until the monitoring of lower critical suppliers. The construction supply chain management literature mainly conceptualizes the client as tier-one organizations, traditionally responsible for acting as systems integrators, being predominantly silent regarding the actor that is hiring the main contractors—the ultimate client. However, the literature is neglecting to consider the clients who influence the investment of tier-one contractors, the public or private actors that would have an enhanced visibility of the future pipeline.

Sanderson and Cox (2008) present a discussion about the dichotomy of organizing the supply chain toward a lean and agile perspective as a reflection of the product characteristics as repetitive and innovative. The authors built their rationale upon Fisher's (1997) model of supply chain strategy, highlighting the necessity of evolving the discussion from high-volume production toward project-based settings. The literature of supply chain strategies and the design of the production system is inspired by the decoupling point discussion (Olhager, 2003) in the operations management domain. This stream of literature is influenced by the control of production in a central firm (factory), expanding the alignment toward upstream and downstream supply chain actors (Lambert & Cooper, 2000). The production within the boundaries of the factory was originally influenced by lean (Ohno, 1988; Womack et al., 1990), and later agile (Christopher, 2000; Yusuf et al., 1999) thinking, which naturally progressed toward the supply chain design and management (Christopher & Towill, 2000), when firms

started to maintain their core business in house and outsource other functions (Simchi-Levi et al., 2007). This duality still exists with strong advocates on both sides; however, the literature evolved toward *leagility* (Naylor et al., 1999), a combination of lean and agile, to orient production (Hallgren & Olhager, 2009) and supply chains (Goldsby et al., 2006; Krishnamurthy & Yauch, 2007; Mason-Jones et al., 2000a; 2000b) in environments where the final customer demand has high uncertainty. This approach is organized around the product structure and decoupling point, where the factory is organized to push production following a lean strategy until the moment where products have the same structure (decoupling point), and pull production following an agile strategy when the order is confirmed. This strategy is also covered by the platform literature (Jiao et al., 2007; Ulrich & Eppinger, 1995), where products are strategically designed to have an identical structure, up to a certain point, aiming to achieve managerial benefits both internally in the production line and externally with the supply chain. As highlighted earlier, this internal production reflects upon the strategies adopted to organize the supply chain (Stavrulaki & Davis, 2010). Sanderson and Cox's (2008) core argument relates to the lack of adherence of the high-volume production and supply chain logics to a complex environment where the supply chain is organized to deliver a one-off product, often characterized as engineer-to-order (Gosling et al., 2015; Hicks et al., 2000; Hicks et al., 2001; McGovern et al., 1999), in construction (Gosling et al., 2015), offshore projects (Barlow, 2000), and shipbuilding (Mello et al., 2015).

The power dynamics between buyer and supplier might constrain the implementation of traditional supply chain management practices. Cox et al. (2004) draw upon 12 supply chain cases to highlight that, even when the dynamics favor the implementation, firms might lack organizational capability in supply chain management to proactively design and manage the system. The lack of understanding among practitioners of the benefits of integration to the entire system is a source of constraint toward unpacking the benefits of a more integrated and aligned supply chain. The study explores the buyer perspective regarding primarily the systems integrator acting on behalf of the client, which in turn is conceptualized as the end client. Ireland (2004) builds upon the power regime argument, exploring two cases in the construction industry (NHS Trust and a major restaurant chain), emphasizing that regularity in

buyer-supplier relationships is a relevant feature that might constrain the implementation of strategies to manage the supply chain. The author makes the distinction between clients and systems integrators as two different buyers, stressing that construction clients are often occasional (NHS Trust) and uninformed about the complexities of the market, being in a disadvantageous position to negotiate with their tier-one systems integrators. Therefore, the supply chain management conversation in construction is predominantly focused at the systems integrator level, only being possible at the client level when there is frequency of demand and extensive supply chain knowledge, as in the case of the major restaurant chain.

However, the argument does not address public and private hybrid arrangements (Quélin et al., 2017). Integration is at the core of the supply chain management philosophy and is advocated as a key driver to increase competitiveness (Briscoe & Dainty, 2005; Dainty et al., 2001), which is enhanced in project-based settings that tend to be fragmented, organized project by project, and in some cases suffer from poor productivity, such as construction (Segerstedt & Olofsson, 2010). Driven by this context, research in construction has focused on the inter-organizational relationships at the project level (Vrijhoef & Koskela, 2000); however, there is a lack of holistic approach to consider the relationships across the whole system, as opposed to the continuous focus on dyadic nature. The literature is extensive regarding procurement methods (Bower, 2003; Rowlinson & McDermott, 1999), which have been explored through several lenses (e.g., complex performance) (Caldwell et al., 2009) and relationship-based (Walker & Hampson, 2003); however, little has been done to look at the supply chain perspective and the design of its architecture from the client's perspective. Denicol et al. (2020a) present a review of procurement in over 80 large infrastructure projects within the European Union from 2008 to 2018, highlighting the challenges associated with the adoption of procurement procedures in different countries.

London et al. (1998) classified the construction supply chain management research into two streams: (i) supply chain clusters and (ii) supply chain networks. The first community emphasizes the management and reduction of waste in the flow of materials from clusters of suppliers to the construction site. The second group conceptualizes a supply chain network as a combination

of several supply chain clusters converging to the construction site. A systemic model through a production approach lens was proposed by O'Brien (1995), aiming to improve the interaction and flow between multiple supply chains on and off the construction site. In light of this logic, the supply chain research in construction has primarily focused on tier-one contractors and their strategies to manage the supply chain, given their close association with the construction site (Akintoye et al., 2000; Vrijhoef & Koskela, 2000). The client would be the most appropriate actor to implement supply chain management practices, given the wider visibility and potential to consolidate multiple supply chains; however, this actor remains underexplored (Briscoe et al., 2004; Cherns & Bryant, 1984; London & Kenley, 1999, 2000; Pryke, 2009, 2017, 2020; Vrijhoef & de Ridder, 2005).

London and Kenley (2001) provide an insightful piece charting the evolution of mainstream and construction supply chain management literatures from 1980 to 2000, identifying the official emergence of construction supply chain management in the mid-1990s. The study approached the evolution of the field through four themes, namely: (i) distribution, (ii) production, (iii) strategic procurement management, and (iv) industrial organization economics. The core argument is that construction researchers have focused on an operational rather than strategic level of supply chain management, emphasizing the exploration of topics related to the optimization of the construction site and materials management (O'Brien et al., 2008), as opposed to organizations, supply chains, and markets.

The exploitation of large programs and portfolios to implement supply chain management in construction highlights permanent clients with relatively constant demand and a pipeline of projects that can be forecasted in terms of utilization of resources (Davies & Brady, 2016; London & Kenley, 2001; Vrijhoef & Koskela, 2000). For those clients who are empowered by a favored power relationship with the supply chain through its buyer power and supply chain knowledge, it is beneficial to develop an in-house management department to interact with supply chain partners.

From the suppliers' perspective, there is a high level of interest in establishing a relationship with large clients, mainly supported by: (i) the possibility of accessing that given market (or program and portfolio), which in some cases would be a considerable part of their current

production, operations, or distribution; and (ii) the incentive of integration in a long-term relationship through a portfolio environment, which would provide high visibility of current and future projects, which can be translated into confirmation of demand with direct implications for production planning and control (Segerstedt & Olofsson, 2010; Wikner & Rudberg, 2005). In this perspective, suppliers are confident to invest their resources, which might be considerably reduced compared to the client's resources, to develop a productive relationship toward continuous improvement for value creation.

Considering the problems faced by the construction industry regarding supply chain management, Souza (2015) presented a conceptual framework illustrating the interfaces between main contractors, suppliers, and projects. The research was problematized following a production-based theory (Koskela, 2000), aiming to identify flows between the supply chain actors that allow transformation and the generation of value (Stadtler, 2002). In this sense, in the interface between the enterprise (conceptualized by the main contractor as the focal firm) and its suppliers, there are flows of capital and information regarding the requirements and products that should be delivered on-site. Considering the interface between the enterprise and the project, there is an information flow about what should happen on-site and how it should be conducted. In the interface between the supplier and the project (construction site), there are flows of physical goods and information. This dynamic illustrates the lack of understanding of main contractors about the supply chain in which they are inserted, constraining them to act holistically toward an enterprise-level decision making. Souza's (2015) research has identified promising avenues for

future research by the exploration of the interface between owners, as repeat clients, and the enterprises responsible for delivering the physical asset on their behalf. The need for further studies regarding the client is supported by London and Kenley (2000), who call for more research considering the perspective and involvement of the client, given that this is a highly influential player in the process.

2.5 Summary

This section offers a summary of the exploration regarding supply chain management and its applications in light of the construction industry characteristics. Considering that traditional supply chain management conceptualization is based on high-volume industries, it is a point of consideration whether isolated initiatives at some point in time, disconnected from future actions, can be classified as supply chain management practices. Similar to the project management debates and its reconceptualization through the management of projects (Morris, 1994), traditional supply chain management is associated with the strategic level and connected to ongoing operations, where the management of supply chains is here labeled at the operational level and connected to decisions to manage the temporary supply chains of project-based environments. Considering that megaprojects are composed of a large number of suppliers organized through several supply chain tiers and that large numbers tend to be delivered over budget and/or are delayed (McKinsey Global Institute, 2013), there is practical relevance for scientific research in the underexplored topic of supply chain management in megaprojects (Denicol, 2020).

3. Research Methodology

3.1 Research Design

This research understands method as one particular technique, and methodology as a group of techniques supported by a philosophical stance. The research follows the critical realism stance, which is a reaction to the linear causalities emphasized by the positivist approach, and the lack of causality emphasis by the interpretivist perspective. The philosophical underpinnings of critical realism are coherent with the setting in question, where megaprojects are pluralistic and complex endeavors with multiple variables influencing decisions. This is philosophically supported by the argument that different individuals will have their own understanding of reality, which might be influenced by a number of factors, such as their background, formation, and sector of activity within the project.

Considering the complexity and prominence of megaprojects as a research setting, one megaproject could be studied to derive insights that would potentially be followed by ordinary/regular/normal projects across industrial sectors, in particular the construction industry. However, since comparative analysis is predominantly about the sample and how rich it is, more cases allow the researcher to enhance the potential to find patterns and the generalizability power (Yin, 2003). Therefore, 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 megaprojects: Crossrail, Thames Tideway Tunnel, and High Speed 2.

In terms of configurational aspects (Yin, 2003), this research is a multicase (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 project as secondary) and a single method of analysis (narrative description of the case, zooming out [Nicolini, 2009]) to understand the configurational changes of the client organization, following a process (research philosophy) and multilevels of analysis (intra-organizational and inter-organizational) aiming to find order and patterns that explain the actions being developed in megaproject client organizations.

3.2 Data Collection

Key informants from each project were interviewed and shared their thoughts and recollections, resulting in an audio file, transcription, and individual notes for each interview. The large majority of interviews lasted one hour, with rare examples of significant variations (e.g., 30–45 and 90–120 minutes). After the initial interviews were conducted, a snowball process was followed where interviewees were asked to suggest further names with the potential to offer complementary perspectives. The research transparency is ensured by the availability of preparatory research conducted prior to each interview, interview audio, field notes, and interview transcripts. None of them are included in this document for confidentiality purposes. Equally, the informants' roles are not disclosed 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,

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
High Speed 2	71	09	38	24
Project-based firms	39	11	10	18
Total	210	37	87	86

development director, program director, managing director, chief financial officer, chief operating officer, chief executive officer). In addition to each megaproject, professionals from project-based firms involved in the projects provided insights regarding their organization's engagement.

3.3 Data Analysis

This research describes the evidence of each case study by adopting Langley's (1999) process research philosophy, where the client organization is at the focus of the lens (Nicolini, 2009), which sometimes is adjusted, *zooming in* to understand internal structures and relationships, while *zooming out* in other instances to capture the inter-organizational dynamics and understand the entire system. The temporal bracketing strategy suggested by Langley (1999) is employed to support the understanding of the temporal evolution of the client organization and the associated decisions drawing upon the project phases (e.g., development, delivery, and operations).

This research was presented to megaproject practitioners in several instances throughout the stages of development (design of research question, end of literature review, development of case studies, etc.). Reflecting on the data collection process and its snowballing logic, the senior practitioners were willing to recommend for further interviews not only their peers, but also their hierarchical superiors, therefore risking their social capital with senior high-caliber people who could positively or negatively affect their own network. Those instances where the senior practitioners did recommend their bosses could be translated as their positive perception of the industrial relevance of the research—an initial goal of this research rewardingly achieved (Van de Ven, 2007), which might be considered a form of verification.

3.3.1 The Retrospective Cases

High Speed 1 (HS1), originally called the Channel Tunnel Rail Link, is a 109-km, high-speed line between central London (St. Pancras Station) and the Channel Tunnel. The project's final cost was £6.16 billion, as reported by the National Audit Office (2012).

Heathrow Airport Terminal 5 provided extra capacity to one of the world's busiest airports, being the first megaproject of the promoter (British Airports

Authority), which triggered innovative solutions to cope with the inherent scale, complexity, and risks to the organization. The project was concluded in 2008 and cost £4.3 billion.

The **London 2012 Olympics** regenerated an area in East London to host the Olympic Games, building the associated facilities and infrastructure. The project's final cost was £8.77 billion (Robertson, 2013). The scope of the program was divided into eight high-level clusters aiming to create clarity to engage the market (Cornelius et al., 2011). In this configuration, two clusters (logistics and security) worked across the other six clusters (enabling works; utilities; structures, bridges, and highways; permanent venues and associated works; temporary venues; and landscape and public realm).

3.3.2 The Real-Time Cases

Crossrail is a 118-km, west-east, interurban railway that provides 10% extra capacity to London's rail network (Tucker, 2017). The project's vision is *Moving London Forward*, with the line running from Reading and Heathrow Airport in the west, passing through central London to Shenfield and Abbey Wood in the east. The project is divided into two main parts, namely: (i) the central section composed of 21 kilometers of tunnels and nine new stations, and (ii) the on-network surface sections in the east and west peripheries. The £14.8 billion project (initial funding envelope, at the moment conclusion is delayed from December 2018 with unknown final cost) was the largest infrastructure project in Europe before the confirmation of High Speed 2.

Thames Tideway Tunnel is a 7.2-meter-wide sewer tunnel with 25 kilometers of extension underneath the River Thames, running west-east from Acton to Abbey Mills. At Abbey Mills, the new tunnel will connect with the Lee Tunnel, another major wastewater project previously concluded. Tideway addresses the lack of capacity of the old Victorian sewer network to cope with London's increasing population. In addition, the inclusion of the new asset in Thames Water's network responds to the European regulatory framework regarding wastewater treatment. Tideway, the largest water and sewerage project since the sector privatization in 1989, is also known as London's super sewer, and is estimated to cost £4.2 billion (Zhivov, 2018).

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).

Phases 1 and 2a are expected to open in 2026, and Phase 2b in 2033. The project's vision is to be a national *Engine for Growth* and at the time was estimated to cost £55.7 billion, the largest infrastructure project in Europe.

4. Results and Discussion

This section presents a discussion of the six case studies aiming to contribute to advancing our theoretical and practical understanding of the megaproject inter-organizational system. The section reflects on the megaprojects analyzed from the perspective of the client organization as the focal firm, exploring its formation and relationships with the sponsor, delivery partner, and supply chain.

4.1 Designing Client Organizations

There is recognition of a spectrum of choices available to organize a major infrastructure program, as well as of the importance of context, where details are preferred over abstractions embedded into one-size-fits-all solutions. Several dimensions might be evaluated in conjunction before a final decision for a particular development and delivery model, and those decisions could start by understanding who are the major players involved with the asset before (development), during (delivery), and after (operations) the project. A turnkey contract for the entire project could be let, drawing upon the supply chain capability argument. However, in projects such as High Speed 2, which are considered a piece of national infrastructure, the decisions are political and constantly changing, which would exponentially increase the risk for the supply chain; therefore, the bidding price would be high, with an even bigger scope for escalation after the award of the contract, in light of continuous changes. Turnkey contracts are appealing in the first instance, given the simplicity of specifying the requirements, allocating a certain amount of resources and allowing freedom to the experts (contractors and partners) to deliver them. However, there are examples across the world demonstrating that turnkey contracts have the potential to go severely wrong when high levels of complexity are involved.

The supply chain strategy needs to be designed from the outset, as soon as possible, ideally in the early days of the development phase, considering the institutional context of the project, its power dynamics, and the

maturity of the players proposing the project (Mahalingam & Levitt, 2007). The consideration of designing strategies in the early days, in light of future engagements with the supply chain, advances the project management literature about the challenges of temporary and permanent clients (Davies & Brady, 2016) by inserting insights from the construction supply chain management literature (London, 2007; Pryke, 2020; Vrijhoef & Koskela, 2000), which is equally taken forward by exploring its implications in megaprojects (Denicol, 2020). A commissioning body with little or no experience of a project of a certain scale and complexity before would be an incipient entity with limited capability. The promoters (as owners, sponsors, and/or clients) may not have sufficient knowledge in house to specify the requirements of such large and complex endeavors (Winch, 2014). A commissioning body that is often involved as a regular commissioner of complex megaprojects, by contrast, would have the knowledge required to understand and manage the processes of development, delivery, and operations (Davies & Brady, 2016). The three cases analyzed in depth illustrate and support the first argument, where the sponsor decided to create an independent organization, based upon their lack of experience regarding the conduction of megaprojects. They recognized early on that regular projects and megaprojects are two distinct categories (not doing so is a common mistake committed by promoters), as well as their lack of capability to appropriately address the size and complexity of a megaproject. The understanding of the detailed processes in early decision making regarding the structuration of the client organization and its strategies advances the project management literature regarding megaprojects, building upon key studies such as Morris and Hough (1987), Miller and Lessard (2000), Davies et al. (2009), Gil (2009), Merrow (2011), Winch (2014), Davies and Mackenzie (2014), and Winch and Leiringer (2016). In addition, the research contributes to advancing the literature on construction supply chain management by exploring inter-organizational strategies in megaprojects as an innovative setting, expanding the conversation drawing upon influential studies such as Vrijhoef and Koskela (2000), London (2007), O'Brien et al. (2008), Gosling et al. (2015), and Pryke (2009, 2020).

As informed by the six cases, clients should aim to be clear about their assurance roles and outsource the delivery to the supply chain, where tier ones can

exercise their core business (Hone et al., 2011; Wright et al., 2017). Clients often become heavily involved in the delivery space, not extracting the best value from the market, and even less than that if the capability is already contracted, which emphasizes the increase of duplications. The sponsor can be the owner, the sponsor can be the owner and accumulate the operator function, or the sponsor can be just the sponsor. The ownership might lie with another party, similarly to the operations, which may be connected to another partner through a different contracting arrangement.

This research identified four main upstream supply chain players: owner, sponsor, client, and operator (Denicol et al., 2019). However, as the ownership and operation might vary considerably, this study considers primarily the organizations more actively involved during the project life cycle: sponsor and client (delivery vehicle composed of clients and delivery partners). The clarification of these roles provides visibility of what each entity is responsible for at the beginning of the project, avoiding the late establishment and engagement of other organizations, such as the operator, which is one of the biggest sources of problems, as previously seen in the Channel Tunnel project (Genus, 1997). Beyond the definition of responsibility, and through the implementation and concretization of those relationships, clients should aim to maintain a constructive tension between the sponsor and the operator. Clients might play one against the other, influencing them to apply pressure on each other, as observed in Crossrail, where two sponsors were helpful to the project dynamics, against some initial expectations and expert judgments. This constructive dialogue needs to be incentivized by the right amount of tension, enabling a constant verification such as: (i) the operator to make sure that the delivery vehicle is building an operational asset that can be smoothly integrated into their network, (ii) the sponsor to put pressure on the delivery vehicle to avoid scope variances, (iii) the client to provide the ultimate technical authority and reassurance to its development and delivery partners.

The configuration of a client organization during the development stage is different from the structure needed for a delivery organization. However, one organizational challenge is regarding the people in place at the end of the development phase, who were there for more than five years, applying their best efforts to develop and submit the hybrid bill. It is a difficult point of the project where the scope changes significantly (from hybrid bill

development and legal decisions to procurement and construction), and the composition of the organization needs to be adjusted. Sometimes the leadership might be mistaken by maintaining the competent individuals who helped the project to achieve permission to build, without adjusting the profile of the team according to the project's evolution and current organizational needs (Bingham & Gibson, 2017). The client organization needs to be designed from the outset to account for the transition from development to delivery, establishing clearer boundaries and managing expectations of the people involved, otherwise the organizational format might start the delivery phase in a suboptimal manner.

The megaproject literature in the development phase is focused on decision-making processes associated with cost control and behaviors, with little in-depth exploration of organizational design aspects, apart from Gil et al.'s research (Gil et al., 2017; Gil & Pinto, 2018). Other studies have emphasized the delivery space, as illustrated by Davies et al. (2009) at Heathrow Airport Terminal 5, and Davies and Mackenzie (2014) at the London 2012 Olympics. However, the connections between the development and delivery phases remain underexplored, where there are opportunities to understand the entire process as a system of interconnected decisions, as well as its impacts over time. Therefore, this study contributes to advancing the understanding of intra-organizational decisions in megaproject client organizations, and argues that the organizational design of those entities should shift toward a supply chain design from the outset. This systemic perspective of designing not only the optimal version of one firm, but also the supply chain architecture in which that entity is inserted, will largely benefit the client to avoid lock-in situations. The design of the megaproject supply chain architecture, as well as the consideration of its evolution and future configurations over the project life cycle, might assist clients in expanding their understanding and ability to manage and integrate the inter-organizational interfaces.

4.2 The Client-Sponsor Relationship

It is important to have absolute clarity between the two different roles, sponsor and deliverer, as a great deal of tensions are caused when the sponsor wants to behave and act as the deliverer (Miller & Lessard, 2000). The sponsor needs to enact their role firmly, so the

requirements do not keep changing the input already given, being particularly aware of the political cycles and having processes and the institutional strength to manage the politicians' short-term views and desires for impact (Kumar et al., 2007; Mahalingam & Levitt, 2007). The source of failure can be tracked back to the sponsor in many programs that have gone wrong, either through not being clear about the requirements or continually changing them. Examples from Crossrail and High Speed 2 illustrate the practice of creating a document to guide the relationship between the sponsor (e.g., Department for Transport, Transport for London) and the client (e.g., Crossrail Ltd, High Speed 2 Ltd), such as Project Development Agreement and Project Delivery Agreement.

Analyzing the relationship between client and sponsor, it is important to create a transparent environment where the sponsor has visibility of what is unfolding in the project, which enables reassurance. The relationship with the sponsor depends on the life cycle, being conditioned to the project dynamics of each stage. During the development stage, clients might provide a service to the sponsor to get the hybrid bill approved and the powers to build. During the delivery stage, the relationship will be conditioned mainly to the point where the full extended-arm status is granted. Prior to the full extended-arm status, the sponsor usually retains more oversight of areas such as the procurement strategies and size of the organization.

A stage-gate process for quality assurance is being increasingly used in major programs, where there is a series of steps in which the delivery vehicle demonstrates capability to the sponsor that is representing the government's interests. The demonstration of capability will naturally pass through an expansion of the organization, and, after the government is satisfied with the level of expertise, the delivery vehicle will reach a point where it will be fully independent. This independence is granted, however uncertain to an extent, depending on how far the government wants to have control and the corporate and institutional dynamics associated with it (Mahalingam & Levitt, 2007). After the organization is empowered by the sponsor, the relationship progresses by the provision of information to the sponsor on a regular basis, allowing them access and visibility through invitations to attend meetings and reports.

4.3 The Client-Delivery Partner Relationship

With the evolution of new forms of delivery models in the UK and around the world (Davies et al., 2019), there is an increasing necessity for knowledge about how to structure client organizations to coordinate the strategies that will assemble the supply chain. Depending on where the project is located, it can range in a spectrum from small (i.e., thin, lean) to large (i.e., heavy, robust), considering factors such as the industry, sector, and the necessary size and shape of the assurance function. In this research, client organizations are represented by the delivery vehicles created to be dedicated units in charge of megaprojects, such as Crossrail Limited, Tideway, and High Speed 2 Limited, which are often designed from scratch on a blank sheet of paper. These organizations design and redesign strategies to build their in-house capability and engineer-to-order (Gosling & Naim, 2009; Hicks et al., 2000; McGovern et al., 1999) megaprojects, complementing their knowledge with supply chain partners (e.g., development and delivery partners, consultants, advisors, contractors), accessing and incorporating into the project what Grabher and Thiel (2015) labeled as reservoirs of knowledge.

When clients tried to be less informed and transferred the risk to the supply chain, several times it came back to them, and they ended up paying for that risk twice. They would be paying for the supply chain to take on the risk, since they would certainly price in their offers, and they would pay when they needed to step in as a client in failure cases, as the ultimate owner or government organization. Since the UK has a knowledgeable and experienced supply chain, there are options to consider where several firms (contractors and consultancies) can provide integrated capability and capacity. In less mature markets, that model would not be an option given the lack of expertise and appetite from industrial actors. In some cases, the client is not only buying a service but also an education for their employees, where external firms are working integrated, seconding high-caliber people to deliver the project, who will mentor the client's existing workforce. The interface between the client and the development and delivery partners is the space where the magic happens in the client organization.

The U.K. market has many contractors and consultants that are capable of completing the job, where their toolbox (i.e., systems, procedures, tools) might be almost identical from one to another. Some organizations will have more prestigious projects in their corporate profile than others; however, the key differential and competitive advantage is not associated with the hard skills, but rather with the soft ones, managing the relationship and delivering it in a collaborative and flexible manner (Denicol et al., 2017). Beyond the hard systems and tools (i.e., program management, project controls, etc.), there is a soft ingredient that is critical to ensure the team is appropriately navigating the project phases, that is leadership, which is reflected in the relationship created between the client and its partners (development and delivery). It is the recognition that it is not only about the end game (the journey is as important as the final result), and if not planned properly it can affect the organization's ability to reach the intended outputs and outcomes (Szentek & Eriksson, 2016). This rationale was at the heart of the principles adopted by Heathrow Airport Terminal 5 (Davies et al., 2009; Doherty, 2008; Potts, 2009) to challenge the construction industry approach of delivering megaprojects, culminating in the T5 Agreement to foster collaborative client-supplier relationships (Gil, 2009), exemplified by their integrated project teams.

As an example, Crossrail initially had two delivery partners, one at a program level and the other at a project level. The resulting model emerged after both partners were merged with the client organization to work in an integrated and collaborative manner; however, it was quite unique in the sense it was not designed from the outset, being the result of the project's evolution. It was designed to work as a system with each partner taking care of its level, program, and project; however, although both parts were doing well

individually, a holistic approach was largely missing, where the sum of best individual options was not equal to the best system.

4.4 The Client-Supply Chain Relationship

One of the most difficult challenges for clients is associated with the management of the supply chain, through processes of engaging, guiding, structuring, monitoring, controlling, and developing suppliers. These decisions depend on how much risk the client transfers down the supply chain and what type of organizations will be employed to be part of the client. The development stage with the hybrid bill preparation is a risky phase for the project; therefore, having a partner means that the expertise is in place and allows the organization to keep the overheads low, which is important for political implications. In light of how little information is available at that moment, clients might select to establish the relationship with partners and advisors on an emerging cost basis, aiming to avoid expending significant time on managing contractual and administrative tasks, in light of the volume of change that happens before the hybrid bill. The development stage and the design requirements for a hybrid bill will shed light on several aspects of the project, where risks will be progressively eliminated as designs advance until the bill submission (Genus, 1997). The end of development would be the optimum moment for a change in relationship and models, changing the boundaries between client and delivery partner. At this point, the client might decide to internalize all the processes and build an entirely internal delivery function, without the advice of a delivery partner, integrated or not. As a result, the client would have an increase in its overheads, with permanent staff replacing the numbers of a potential delivery partner, and would be dealing directly with the tier ones or joint ventures.

5. Conclusion

This section concludes the research by presenting a summary of the topics discussed, limitations, and future research avenues. The research advances the understanding of megaproject actors beyond previous limited conceptualizations, emphasizing their levels, intra-organizational and inter-organizational dynamics, and exploring different configurations of owners, sponsors, clients, partners, and operators.

The discussion provides terminology clarification and advances the knowledge about the dynamic and evolving nature of those entities during the project life cycle. The development phase of megaprojects is explored to improve the understanding of how the client organization is formed and engages with the supply chain to assemble complementary resources. The discussion about the relationship between clients and their partners (development and delivery) unpacks the underexplored dynamics of the upstream supply chain actors. Client organizations might select to consider a more systemic approach when designing strategies to engage the supply chain, recognizing that the intra-organizational and inter-organizational boundaries are dynamic and tightly connected. Therefore, megaprojects would benefit from a shift toward an approach of designing the system that comprises both intra-organizational and inter-organizational interfaces.

The process of configuring a delivery model to conduct the megaproject is analyzed, discussing whether to do it entirely with public funds or attract private investment through different partnership models. Once the public delivery model is selected, further decisions are explored to define whether to perform the project inside the permanent system through established infrastructure agencies, or to establish a new public entity to be in charge of, and dedicated to, a single project. When the promoters select the option of creating an independent body to oversee the project, there are emerging questions regarding the type of organization that should be built, therefore the client model.

The organizational permanence of those entities and its implications are discussed, revealing different models through the temporary versus permanent dilemma. Different configurations were conceptualized and discussed, building upon examples from the case

studies, where some delivery vehicles will disappear with the end of the construction phase, while others will have an enduring role in operations through a range of combinations of being the owner, operator, and maintainer. Considering the discussions mentioned, in summary the research contributes to advance the knowledge about the underdeveloped area of client organizations in megaprojects, emphasizing the importance of a capable and intelligent client organization providing guidance during multiple stages of the project.

5.1 Limitations

This research addresses the generalizability concern by having multiple case studies; however, it has explored only U.K. cases, where the findings might be limited and not fully transferable to other geographies with distinct institutional and contextual environments. In addition, the sample is rich by covering several cases classified as megaprojects ranging from £4.2 to £55.7 billion; however, limitations might be found due to the high amplitude of costs, which could influence different managerial approaches depending on the megaproject category of each setting. The adoption of critical realism as a philosophical stance might create a difficult context to highlight different perspectives within a concise narrative, where it is recognized that different individuals will have their version of reality and it is the researcher's job to critically analyze and compile a strong, objective, neutral, and argumentative narrative. Future research might be particularly interested in discussing in depth the methodological challenges and implications of assembling various perspectives through rich, semistructured interviews in complex settings, while maintaining a coherent and concise process-driven narrative. Finally, the findings might be limited due to the diversity of sectors considered, which might have inherent technological and complexity characteristics.

5.2 Future Research

Drawing upon the research findings, the following avenues for future research are suggested:

Explore the transition from development to delivery in megaprojects. Create awareness in the organizations promoting the project (owners, sponsors, clients) of the importance of building

delivery readiness capability, by designing and assembling the delivery organization in parallel with the last stages of the development phase.

Explore the role of the internal sponsorship function. There are opportunities to explore the interface of the sponsorship and stakeholder management functions in megaproject client organizations. The intra-organizational dynamic of functions managing the sponsor could advance the understanding of the processes to create a consolidated communication channel with the project sponsor for updates, reports, changes, and requests. Similarly, the relationship with the corporate affairs and communications functions could be explored in light of internal and external interfacing processes.

Clienting. The identification of the skill sets of clients and how they differ from those of project managers and construction managers is a promising

avenue for future research. The implications for the construction industry as well as for policy making across industrial sectors could be explored, such as impacts on the higher education system, further professional qualifications, and training.

Country-level client organization for megaprojects. Explore the potential of a consolidated national megaproject client organization, opposed to the creation and recreation of temporary organizations every time there is a new megaproject in the pipeline. The formation of this master-meta-organization could be explored through the perspective that it would be designed through a system lens and moved from program to program, functioning as an enterprise with implications for skills, people, and career paths. It would function as an umbrella organization for megaproject clienting.

References

- Akintoye, A., Beck, M., & Hardcastle, C. (2003). *Public-private partnerships: Managing risks and opportunities*. Wiley-Blackwell Publishing. doi:10.1002/9780470690703.
- Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry. *European Journal of Purchasing and Supply Management*, 6(3-4), 159-168. doi:10.1016/S0969-7012(00)00012-5.
- Aloini, D., Dulmin, R., Mininno, V., & Ponticelli, S. (2012). Supply chain management: A review of implementation risks in the construction industry. *Business Process Management Journal*, 18(5), 735-761. doi:10.1108/14637151211270135.
- Arto K. A., & Wikstrom, K. (2005). What is project business? *International Journal of Project Management* 23(5), 343-353. doi:10.1016/j.ijproman.2005.03.005.
- Banker, R. D., & Khosla, I. S. (1995). Economics of operations management: A research perspective. *Journal of Operations Management*, 12(3-4), 423-435. doi:10.1016/0272-6963(95)00022-K.
- Barlow, J. (2000). Innovation and learning in complex offshore construction projects. *Research Policy*, 29(7-8), 973-989. doi:10.1016/s0048-7333(00)00115-3.
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120. doi:10.1177/014920639101700108.
- Behera, P., Mohanty, R. P., & Prakash, A. (2015). Understanding construction supply chain management. *Production Planning and Control*, 26(16), 1332-1350. doi:10.1080/09537287.2015.1045953.
- Bertrand, J. W. M., & Muntslag, D. R. (1993). Production control in engineer-to-order firms. *International Journal of Production Economics*, 30-31, 3-22. doi:10.1016/0925-5273(93)90077-X.
- Bing, L., Tiong, R. L. K., Fan, W. W., & Chew, D. A. S. (1999). Risk management in international construction joint ventures. *Journal of Construction Engineering and Management*, 125(4), 277-284. doi:10.1061/(ASCE)0733-9364(1999)125:4(277).
- Bingham, E., & Gibson, G. E. (2017). Infrastructure project scope definition using project definition rating index. *Journal of Management in Engineering*, 33(2), 04016037-1-04016037-8. doi:10.1061/(ASCE)ME.1943-5479.0000483.
- Blomquist, T., & Müller, R. (2006). Practices, roles, and responsibilities of middle managers in program and portfolio management: A case study. *Project Management Journal*, 37(1), 52-66. doi:10.1177/875697280603700105.
- Bower, D. (2003). *Management of procurement*. ICE Publishing. ISBN: 9780727732217.
- Briscoe, G., & Dainty, A. (2005). Construction supply chain integration: An elusive goal? *Supply Chain Management*, 10(4), 319-326. doi:10.1108/13598540510612794.
- Briscoe, G., Dainty, A. R. J., Millett, S. J., & Neale, R. H. (2004). Client led strategies for construction supply chain improvement. *Construction Management and Economics*, 22(2), 193-201. doi:10.1080/0144619042000201394.
- Browning, T. R. (2003). On customer value and improvement in product development processes. *Systems Engineering*, 6(1), 49-61. doi:10.1002/sys.10034.
- Cacciatori, E. (2008). Memory objects in project environments: Storing, retrieving and adapting learning in project-based firms. *Research Policy*, 37(9), 1591-1601. doi:10.1016/j.respol.2008.04.028.
- Caldwell, N. D., Roehrich, J. K., & Davies, A. C. (2009). Procuring complex performance in construction: London Heathrow Terminal 5 and a private finance initiative hospital. *Journal of Purchasing and Supply Management*, 15(3), 178-186. doi:10.1016/j.pursup.2009.05.006.
- Cherns, A., & Bryant, D. (1984). Studying the client's role in construction management. *Construction Management and Economics*, 2(2), 177-184. doi:10.1080/01446198400000016.
- Choi, J., & Russell, J. S. (2004). Economic gains around mergers and acquisitions in the construction industry of the United States of America. *Canadian Journal of Civil Engineering*, 31(3), 513-525. doi:10.1139/104-004.
- Christopher, M. (1992). Logistics and supply chain management. *Financial Times*. ISBN: 9780786301560.

- Christopher, M. (2000). The agile supply chain: Competing in volatile markets. *Industrial Marketing Management*, 29(1), 37-44. doi:10.1016/S0019-8501(99)00110-8.
- Christopher, M., & Towill, D. R. (2000). Supply chain migration from lean and functional to agile and customised. *Supply Chain Management: An International Journal*, 5(4), 206-213. doi:10.1108/13598540010347334.
- Cooper, M. C., & Ellram, L. M. (1993). Characteristics of supply chain management and the implications for purchasing and logistics strategy. *The International Journal of Logistics Management*, 4(2), 13-24. doi:10.1108/09574099310804957.
- Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply chain management: More than a new name for logistics. *The International Journal of Logistics Management*, 8(1), 1-14. doi:10.1108/09574099710805556.
- Cornelius, M., Fernau, J., Dickinson, P., & Stuart, M. (2011). Delivering London 2012: Procurement. *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 164(5), 34-39. doi:10.1680/cien.2011.164.5.34.
- Cox, A., Ireland, P., & Townsend, M. (2006). *Managing in construction supply chains and markets: Reactive and proactive options for improving performance and relationship management*. (1st ed.). ICE Publishing. ISBN13: 9780727730015.
- Cox, A., Watson, G., Lonsdale, C., & Sanderson, J. (2004). Managing appropriately in power regimes: Relationship and performance management in 12 supply chain cases. *Supply Chain Management*, 9(5), 357-371. doi:10.1108/13598540410560748.
- Dainty, A. R. J., Millett, S. J., & Briscoe, G. H. (2001). New perspectives on construction supply chain integration. *Supply Chain Management: An International Journal*, 6(4), 163-173. doi:10.1108/13598540110402700.
- Davies, A., & Brady, T. (2016). Explicating the dynamics of project capabilities. *International Journal of Project Management*, 34(2), 314-327. doi:10.1016/j.ijproman.2015.04.006.
- Davies, A., Gann, D., & Douglas, T. (2009). Innovation in megaprojects: Systems integration at Heathrow Terminal 5. *California Management Review*, 51(2), 101-125. doi:10.2307/41166482.
- Davies, A., MacAulay, S. C., & Brady, T. (2019). Delivery model innovation: Insights from infrastructure projects. *Project Management Journal*, 50(2), 119-127. doi:10.1177/8756972819831145.
- Davies, A., & Mackenzie, D. (2014). Project complexity and systems integration: Constructing the London 2012 Olympics and Paralympics Games. *International Journal of Project Management*, 32(5), 773-790. doi:10.1016/j.ijproman.2013.10.004.
- Delaney, F. T., & Wamuziri, S. C. (2004). The impact of mergers and acquisitions on shareholder wealth in the UK construction industry. *Engineering, Construction and Architectural Management*, 11(1), 65-73. doi:10.1108/09699980410512674.
- Denicol, J. (2020). Managing megaproject supply chains: Life after Heathrow Terminal 5. In S. Pryke (Eds.), *Successful construction supply chain management: Concepts and case studies*, (2nd ed.). (pp. 213-235). John Wiley & Sons.
- Denicol, J., Addyman, S., & Morgan, O. (2020a). *Compendium of large infrastructure projects: negotiated procedure for a low value purchase*. European Commission Report. Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.
- Denicol, J., Davies, A., Brady, T., & Thurston, M. (2017). Building and leveraging capabilities to deliver megaprojects: The case of CH2M. In *Proceedings of the 15th Engineering Project Organization Conference with 5th International Megaprojects Workshop*, Stanford Sierra Camp, USA.
- Denicol, J., Davies, A., & Krystallis, I. (2020b). What are the causes and cures of poor megaproject performance? A systematic literature review and research agenda. *Project Management Journal*, 51(3), 328-345. doi:10.1177/8756972819896113.
- Denicol, J., Pryke, S., & Davies, A. (2019). Exploring innovative inter-organisational structures to deliver megaprojects: The role of owners, sponsors and clients in the Project System Organisation (PSO). *Proceedings of the 19th European Academy of Management (EURAM)*, Lisbon, Portugal.
- Doherty, S. (2008). *Heathrow's Terminal 5: History in the making*. Wiley and Sons. ISBN: 978047075453-5.

- Elfving, J., & Ballard, G. (2011). *In search of lean suppliers - Structuring a preferred supplier program*. Proceedings of the 19th Conference of the International Group for Lean Construction (IGLC), 13-15 July 2011, Lima, Peru, 125-134.
- Ellram, L. M., & Cooper, M. C. (1990). Supply chain management, partnership, and the shipper - Third party relationship. *The International Journal of Logistics Management*, 1(2), 1-10. doi:10.1108/95740939080001276.
- Ellram, L. M., & Cooper, M. C. (2014). Supply chain management: It's all about the journey, not the destination. *Journal of Supply Chain Management*, 50(1), 8-20. doi:10.1111/jscm.12043.
- Engwall, M., & Jerbrant, A. (2003). The resource allocation syndrome: The prime challenge of multi-project management? *International Journal of Project Management*, 21(6), 403-409. doi:10.1016/S0263-7863(02)00113-8.
- Ernst & Young. (2011). *Innovating for the next three billion: The rise of the global middle class and how to capitalize on it*. Ernst & Young.
- Fisher, M. (1997). What is the right supply chain for your product? *Harvard Business Review*, 2, 105-116.
- Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition*. Cambridge University Press. ISBN: 0521804205.
- Foundation Earth. (2015, March 9). [Letter to President Recep Tayyip Erdoğan] Regarding: G20 plans for infrastructure finance. <http://www.fdnearth.org/files/2012/11/G20.Letter.Turkey.pdf>.
- Frederiksen, L., & Davies, A. (2008). Vanguards and ventures: Projects as vehicles for corporate entrepreneurship. *International Journal of Project Management*, 26(5), 487-496. doi:10.1016/j.ijproman.2008.05.006.
- Gann, D. M., & Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: The construction of complex products and systems. *Research Policy*, 29, 955-972. doi:10.1016/S0048-7333(00)00114-1.
- Genus, A. (1997). Managing large-scale technology and inter-organizational relations: The case of the Channel Tunnel. *Research Policy*, 26(2), 169-189.
- Geraldi, J., & Söderlund, J. (2018). Project studies: What it is, where it is going. *International Journal of Project Management*, 36(1), 55-70. doi:10.1016/j.ijproman.2017.06.004.
- Gil, N. (2009). Developing cooperative project-client relationships: How much to expect from relational contracts. *California Management Review*, 51(2), 144-169. doi:10.2307/41166484.
- Gil, N., Lundrigan, C., Pinto, J. K., & Puranam, P. (2017). *Megaproject organization and performance: The myth and political reality*. Project Management Institute. ISBN: 9781628251760.
- Gil, N., & Pinto, J. (2018). Polycentric organising and performance. A contingency model and evidence from megaproject planning in the UK. *Research Policy*, 47(4), 717-734. doi:10.1016/j.respol.2018.02.001
- Goldratt, E. M., & Cox, J. (1984). *The goal*. North River Press.
- Goldsby, T. J., Griffis, S. E., & Roath, A. S. (2006). Modeling lean, agile, and leagile supply chain strategies. *Journal of Business Logistics*, 27(1), 57-80. doi:10.1002/j.2158-1592.2006.tb00241.x.
- Gosling, J., & Naim, M. M. (2009). Engineer-to-order supply chain management: A literature review and research agenda. *International Journal of Production Economics*, 122(2), 741-754. doi:10.1016/j.ijpe.2009.07.002.
- Gosling, J., Towill, D. R., Naim, M. M., & Dainty, A. R. J. (2015). Principles for the design and operation of engineer-to-order supply chains in the construction sector. *Production Planning and Control*, 26(3), 203-218. doi:10.1080/09537287.2014.880816.
- Grabher, G., & Thiel, J. (2015). Projects, people, professions: Trajectories of learning through a mega-event (the London 2012 case). *Geoforum*, 65, 328-337. doi:10.1016/j.geoforum.2015.02.006.
- Guimerà, R., Uzzi, B., Spiro, J., & Nunes Amaral, L. A. (2005). Team assembly mechanisms determine collaboration network structure and team performance. *Science*, 308(5722), 697-702. doi:10.1126/science.1106340.
- Gunasekaran, A., & Ngai, E. W. T. (2005). Build-to-order supply chain management: A literature review and framework for development. *Journal of Operations Management*, 23(5), 423-451. doi:10.1016/j.jom.2004.10.005.

- Hallgren, M., & Olhager, J. (2009). Lean and agile manufacturing: External and internal drivers and performance outcomes. *International Journal of Operations & Production Management*, 29(10), 976-999. doi:10.1108/01443570910993456.
- Hicks, C., McGovern, T., & Earl, C. F. (2000). Supply chain management: A strategic issue in engineer to order manufacturing. *International Journal of Production Economics*, 65(2), 179-190. doi:10.1016/S0925-5273(99)00026-2.
- Hicks, C., McGovern, T., & Earl, C. F. (2001). A typology of UK engineer-to-order companies. *International Journal of Logistics Research and Applications*, 4(1), 43-56. doi:10.1080/13675560110038068.
- Ho, W., Dey, P. K., & Lockström, M. (2011). Strategic sourcing: A combined QFD and AHP approach in manufacturing. *Supply Chain Management: An International Journal*, 16(6), 446-461. doi:10.1108/13598541111171093.
- Hobday, M. (2000). The project-based organisation: An ideal form for management of complex products and systems. *Research Policy* 29, 871-893. doi:10.1016/S0048-7333(00)00110-4.
- Hone, D., Higgins, D., Galloway, I., & Kintrea, K. (2011). Delivering London 2012: Organisation and programme. *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 164(5), 5-12. doi:10.1680/cien.2011.164.5.5.
- Ireland, P. (2004). Managing appropriately in construction power regimes: Understanding the impact of regularity in the project environment. *Supply Chain Management*, 9(5), 372-382. doi:10.1108/13598540410560757.
- Jiao, J., Simpson, T. W., & Siddique, Z. (2007). Product family design and platform-based product development: A state-of-the-art review. *Journal of Intelligent Manufacturing*, 18(1), 5-29. doi:10.1007/s10845-007-0003-2.
- Jones, C. (1996). Careers in project networks: The case of the film industry. In M. B. Arthur and D. M. Rousseau (Eds.), *The boundaryless career: A new employment principle for a new organizational era* (pp. 58-75). Oxford University Press.
- Jones, C., & Lichtenstein, B. B. (2008). Temporary inter-organizational projects: How temporal and social embeddedness enhance coordination and manage uncertainty. In S. Cropper, M. Ebers, C. Huxham and P. Smith Ring (Eds.), *The Oxford handbook of inter-organizational relations* (pp. 231-255). Oxford University Press. doi:10.1093/oxfordhb/9780199282944.003.0009.
- Kasvi, J. J. J., Vartiainen, M., & Hailikari, M. (2003). Managing knowledge and knowledge competences in projects and project organisations. *International Journal of Project Management*, 21(8), 571-582. doi:10.1016/S0263-7863(02)00057-1.
- Koskela, L. (1992). *Application of the new production philosophy to construction*. Stanford University, CIFE Technical Report No. 72.
- Koskela, L. (2000). *An exploration towards a production theory and its application to construction*. (Doctoral dissertation, VTT Publications 408, Espoo, Finland, 296).
- Krishnamurthy, R., & Yauch, C. A. (2007). Leagile manufacturing: A proposed corporate infrastructure. *International Journal of Operations & Production Management*, 27(6), 588-604. doi:10.1108/01443570710750277.
- Kumar, U., Kumar, V., Dutta, S., & Fantazy, K. (2007). State sponsored large scale technology transfer projects in a developing country context. *Journal of Technology Transfer*, 32(6), 629-644.
- Kumaraswamy, M., & Palaneeswaran, E. (2000). Selection matters - In construction supply chain optimisation. *International Journal of Physical Distribution & Logistics Management*, 30(7-8), 661-680. doi:10.1108/09600030010346431.
- Lambert, D. M., & Cooper, M. C. (2000). Issues in supply chain management. *Industrial Marketing Management*, 29(1), 65-83. doi:10.1016/S0019-8501(99)00113-3.
- Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply chain management: Implementation issues and research opportunities. *The International Journal of Logistics Management*, 9(2), 1-20. doi:10.1108/09574099810805807.
- Lambert, D. M., & Enz, M. G. (2017). Issues in supply chain management: Progress and potential. *Industrial Marketing Management*, 62, 1-16. doi:10.1016/j.indmarman.2016.12.002.
- Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review*, 24(4), 691-710. <http://www.jstor.org/stable/259349>.

- Larson, P. D., Poist, R. F., & Halldórsson, Á. (2007). Perspectives on logistics vs. SCM: A survey of SCM professionals. *Journal of Business Logistics*, 28(1), 1-24. doi:10.1002/j.2158-1592.2007.tb00230.x.
- Levitt, R. E. (2011). Towards project management 2.0. *Engineering Project Organization Journal*, 1(3), 197-210. doi:10.1080/21573727.2011.609558.
- Li, B., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005). Critical success factors for PPP/PFI projects in the UK construction industry. *Construction Management and Economics*, 23(5), 459-471. doi:10.1080/01446190500041537.
- Lindkvist, L. (2004). Governing project-based firms: Promoting market-like processes within hierarchies. *Journal of Management & Governance* 8(1), 3-25. doi:10.1023/B:MAGO.0000015392.75507.ad.
- Locatelli, G., Mariani, G., Sainati, T., & Greco, M. (2017). Corruption in public projects and megaprojects: There is an elephant in the room! *International Journal of Project Management*, 35(3), 252-268. doi:10.1016/j.ijproman.2016.09.010.
- London, K. (2007). *Construction supply chain economics*. Taylor & Francis. ISBN: 9780415409711.
- London, K., & Kenley, R. (1999). Client's role in construction supply chains: A theoretical discussion—Customer satisfaction a focus of research and practice in construction. In *Customer Satisfaction a Focus of Research and Practice in Construction, Proceedings of Joint Triennial Symposium CIB W65 and W55*, Cape Town, South Africa, pp. 100-111.
- London, K., & Kenley, R. (2000). Mapping construction supply chains: Widening the traditional perspective of the industry, *Proceedings 7th Annual European Association of Research in Industrial Economic EARIE Conference*, Switzerland.
- London, K., & Kenley, R. (2001). An industrial organization economic supply chain approach for the construction industry: A review. *Construction Management and Economics*, 19(8), 777-788. doi:10.1080/01446190110081699.
- London, K., Kenley, R., & Agapiou, A. (1998). Theoretical supply chain network modelling in the building industry. In W. Hughes (Ed.), *14th Annual ARCOM Conference*, 9-11 September 1998, University of Reading. *Association of Researchers in Construction Management*, 2, 369-379.
- Luhtala, M., Kilpinen, E., & Anttila, P. (1994). *LOGI managing make-to-order supply chains*. Helsinki University of Technology.
- Lundin, R. A., Arvidsson, N., Brady, T., Ekstedt, E., Midler, C., & Sydow, J. (2015). *Managing and working in project society: Institutional challenges of temporary organizations*. Cambridge University Press. ISBN: 9781107434462.
- Lycett, M., Rassau, A., & Danson, J. (2004). Programme management: A critical review. *International Journal of Project Management*, 22(4), 289-299. doi:10.1016/j.ijproman.2003.06.001.
- Mahalingam, A., & Levitt, R. E. (2007). Institutional theory as a framework for analyzing conflicts on global projects. *Journal of Construction Engineering and Management*, 133(7), 517-528. doi:10.1061/(ASCE)0733-9364(2007)133:7(517).
- Martinsuo, M. (2013). Project portfolio management in practice and in context. *International Journal of Project Management*, 31(6), 794-803. doi:10.1016/j.ijproman.2012.10.013.
- Mason-Jones, R., Naylor, B., & Towill, D. R. (2000a). Lean, agile or leagile? Matching your supply chain to the marketplace. *International Journal of Production Research*, 38(17), 4061-4070. doi:10.1080/00207540050204920.
- Mason-Jones, R., Naylor, B., & Towill, D. R. (2000b). Engineering the leagile supply chain. *International Journal of Agile Management Systems*, 2(1), 54-61. Doi:10.1108/14654650010312606.
- Maylor, H., Meredith, J. R., Söderlund, J., & Browning, T. (2018). Old theories, new contexts: Extending operations management theories to projects. *International Journal of Operations & Production Management*, 38(6), 1274-1288. doi:10.1108/IJOPM-06-2018-781.
- McGovern, T., Hicks, C., & Earl, C. F. (1999). Modelling supply chain management processes in engineer-to-order companies. *International Journal of Logistics: Research and Applications*, 2(2), 147-159. doi:10.1080/13675569908901578.
- McKinsey Global Institute. (2013). *Infrastructure productivity: How to save \$1 trillion a year*. McKinsey and Company. https://www.mckinsey.com/~media/McKinsey/Industries/Capital%20Projects%20and%20Infrastructure/Our%20Insights/Infrastructure%20productivity/MGI%20Infrastructure_Full%20report_Jan%202013.ashx.

- Mead, J., & Gruneberg, S. (2013). *Programme procurement in construction: Learning from London 2012*. Wiley-Blackwell. ISBN: 978-0-470-67473-4.
- Mello, M. H., Strandhagen, J. O., & Alfnes, E. (2015). Analyzing the factors affecting coordination in engineer-to-order supply chain. *International Journal of Operations & Production Management*, 35(7), 1005-1031. doi:10.1108/IJOPM-12-2013-0545.
- Mentzer, T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, A. G. (2011). Defining supply chain management. *Journal of Business Logistics*, 22(2), 1-25. doi:10.1002/j.2158-1592.2001.tb00001.x.
- Merrow, E. W. (2011). *Industrial megaprojects: Concepts, strategies, and practices for success*. John Wiley & Sons. ISBN: 9780470938829.
- Meyr, H. (2009). Customer segmentation, allocation planning and order promising in make-to-stock production. *OR Spectrum*, 31(1), 229-256. doi:10.1007/s00291-008-0123-x.
- Midler, C. (1995). Pergamon and the characterization of the firm: The Renault case. *Scandinavian Journal of Management*, 11(4), 363-375. doi:10.1016/0956-5221(95)00035-T.
- Miller, R., & Lessard, D. R. (2000). *The strategic management of large engineering projects: Shaping institutions, risks, and governance*. The MIT Press. ISBN: 9780262122368.
- Morris, P. W. G. (1994). *The management of projects*. Thomas Telford. ISBN: 9780727716934.
- Morris, P. W. G. (2010). Research and the future of project management. *International Journal of Managing Projects in Business* 3(1), 139-146. doi:10.1108/17538371011014080.
- Morris, P. W. G., & Hough, G. H. (1987). *The anatomy of major projects: A study of the reality of project management*. John Wiley. ISBN: 9780471915515.
- Müller, R., Glückler, J., Aubry, M., & Shao, J. (2013). Project management knowledge flows in networks of project managers and project management offices: A case study in the pharmaceutical industry. *Project Management Journal*, 44(2), 4-19. doi: 10.1002/pmj.21326.
- Müller, R., Martinsuo, M., & Blomquist, T. (2008). Project portfolio control and portfolio management performance in different contexts. *Project Management Journal*, 39(3), 28-42. doi:10.1002/pmj.20053.
- National Audit Office (NAO). (2012). *The completion and sale of High Speed 1*. Report by the Comptroller and Auditor General HC 1834 Session 2010-2012.
- Naylor, J. B., Naim, M. M., & Berry, D. (1999). Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics*, 62(1-2), 107-118. doi:10.1016/S0925-5273(98)00223-0.
- Nicolini, D. (2009). Zooming in and out: Studying practices by switching theoretical lenses and trailing connections. *Organization Studies*, 30(12), 1391-1418. doi:10.1177/0170840609349875.
- O'Brien, W. (1995). Construction supply-chains: Case study. Proceedings of 3rd Annual Workshop on Lean Construction, Albuquerque, New Mexico.
- O'Brien, W. J., Formoso, C. T., Vrijhoef, R., & London, K. A. (2008). *Construction supply chain management handbook*. CRC Press. ISBN: 978-1-4200-4745-5.
- Ohno, T. (1988). *The Toyota production system: Beyond large scale production*. Productivity Press. ISBN: 9780915299140.
- Olhager, J. (2003). Strategic positioning of the order penetration point. *International Journal of Production Economics*, 85(3), 319-329. doi:10.1016/S0925-5273(03)00119-1.
- Ozorhon, B., Arditi, D., Dikmen, I., & Birgonul, M. T. (2007). Effect of host country and project conditions in international construction joint ventures. *International Journal of Project Management*, 25(8), 799-806. doi:10.1016/j.ijproman.2007.05.003.
- Pandit, A., & Zhu, Y. (2007). An ontology-based approach to support decision-making for the design of ETO (engineer-to-order) products. *Automation in Construction*, 16(6), 759-770. doi:10.1016/j.autcon.2007.02.003.
- Pellegrinelli, S. (1997). Programme management: Organising project-based change. *International Journal of Project Management*, 15(3), 141-149. doi:10.1016/S0263-7863(96)00063-4.

- Pellegrinelli, S., Partington, D., Hemingway, C., Mohdzain, Z., & Shah, M. (2007). The importance of context in programme management: An empirical review of programme practices. *International Journal of Project Management*, 25(1), 41-55. doi:10.1016/j.ijproman.2006.06.002.
- Porter, M. (1985). *Competitive advantage: Creating and sustaining superior performance*. The Free Press.
- Potts, K. (2009). From Heathrow Express to Heathrow Terminal 5: BAA's development of supply chain management. In S. Pryke (Ed.), *Construction supply chain management: Concepts and case studies* (pp. 160-181). Wiley-Blackwell. doi:10.1002/9781444320916.ch8.
- Prencipe, A., & Tell, F. (2001). Inter-project learning: Processes and outcomes of knowledge codification in project-based firms. *Research Policy*, 30(9), 1373-1394. doi:10.1016/S0048-7333(01)00157-3.
- PricewaterhouseCoopers. (2014). *Capital project and infrastructure spending outlook to 2025*. <https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/cpi-outlook/assets/cpi-outlook-to-2025.pdf>.
- Pryke, S. D. (2009). *Construction supply chain management: Concepts and case studies*. Wiley-Blackwell. doi:10.1002/9781444320916.
- Pryke, S. D. (2017). *Managing networks in project-based organisations*. Wiley-Blackwell. doi:10.1002/9781118929896.
- Pryke, S. D. (2020). *Successful construction supply chain management: Concepts and case studies* (2nd ed.). John Wiley & Sons.
- Quélin, B. V., Kivleniece, I., & Lazzarini, S. (2017). Public-private collaboration, hybridity and social value: Towards new theoretical perspectives. *Journal of Management Studies*, 54(6), 763-792. doi:10.1111/joms.12274.
- Robertson, H. (2013, July 16). LOCOG and public sector funding. [Written statement from UK Parliament] <https://publications.parliament.uk/pa/cm201314/cmhansrd/cm130716/wmstext/130716m0001.htm#13071676000595>.
- Rodan, S., & Galunic, C. (2004). More than network structure: How knowledge heterogeneity influences managerial. *Strategic Management Journal*, 25(6), 541-562.
- Roehrich, J. K. (2008). Outsourcing: Management and practice within the automotive industry. In G. Parry and A. Graves (Eds). *Build To Order*. (pp. 75-97). Springer. doi:10.1007/978-1-84800-225-8_5.
- Roehrich, J. K., Lewis, M. A., & George, G. (2014). Are public-private partnerships a healthy option? A systematic literature review. *Social Science and Medicine*, 113, 110-119. doi:10.1016/j.socscimed.2014.03.037.
- Rowlinson, S., & McDermott, P. (1999). *Procurement systems: A guide to best practice in construction*. Routledge. ISBN: 9780419241003.
- Sahlin-Andersson, K., & Söderholm, A. (2002). *Beyond project management: New perspectives on the temporary-permanent dilemma*. Malmö: Liber. ISBN: 91-47-06403-X.
- Sanderson, J., & Cox, A. (2008). The challenges of supply strategy selection in a project environment: Evidence from UK naval shipbuilding. *Supply Chain Management: An International Journal*, 13(1), 16-25. doi:10.1108/13598540810850283.
- Schwab, K. (2017). *The fourth industrial revolution*. Crown Publishing. ISBN: 9781944835002.
- Segerstedt, A., & Olofsson, T. (2010). Supply chains in the construction industry. *Supply Chain Management: An International Journal*, 15(5), 347-353. doi:10.1108/13598541011068260.
- Setak, M., Sharifi, S., & Alimohammadian, A. (2012). Supplier selection and order allocation models in supply chain management: A review. *World Applied Sciences Journal*, 18(1), 55-72. doi:10.5829/idosi.wasj.2012.18.01.3258.
- Shen, L. Y., Wu, G. W. C., & Ng, C. S. K. (2001). Risk assessment for construction joint ventures in China. *Journal of Construction Engineering and Management*, 127(1), 76-81. doi:10.1061/(ASCE)0733-9364(2001)127:1(76).
- Shenhar, A. J., & Dvir, D. (2007). *Reinventing project management: The diamond approach to successful growth and innovation*. Harvard Business School Press. ISBN: 9781591398004.
- Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E., & Shankar, R. (2007). *Designing and managing the supply chain: Concepts, strategies and case studies*. (3rd ed.). Tata McGraw-Hill Education. ISBN: 9780073341521.

- Song, J. S., & Zipkin, P. (2003). Supply chain operations: Assemble-to-order systems. *Handbooks in Operations Research and Management Science*, 11, 561-596. doi:10.1016/S0927-0507(03)11011-0.
- Souza, D. V. S. (2015). *A conceptual framework and best practices for designing and improving construction supply chains*. [PhD thesis, University of Salford].
- Stadtler, H. (2002). Supply chain management - An overview. In H. Stadtler, & C. Kilger (Eds.), *Supply chain management and advanced planning: concepts, models, software and case studies* (pp. 9-35). Springer.
- Stavrulaki, E., & Davis, M. (2010). Aligning products with supply chain processes and strategy. *The International Journal of Logistics Management*, 21(1), 127-151. doi:10.1108/09574091011042214.
- Stevenson, M., Hendry, L. C., & Kingsman, B. G. (2005). A review of production planning and control: The applicability of key concepts to the make-to-order industry. *International Journal of Production Research*, 43(5), 869-898. doi:10.1080/0020754042000298520.
- Sydow, J., & Windeler, A. (1999). Projektnetzwerke: Management von (mehr als) temporären systemen (Project networks: Management of [more than] temporary systems). In J. Engelhard, & E. Sinz (Eds.), *Kooperation im Wettbewerb*, (pp. 211-235). Gabler. Reprinted in J. Sydow, & A. Windeler (Eds.) (2004). *Organization von content-produktion*. (pp. 37-55). Westdeutscher Verlag.
- Szentes, H., & Eriksson, P. E. (2016). Paradoxical organizational tensions between control and flexibility when managing large infrastructure projects. *Journal of Construction Engineering and Management*, 142(4), 05015017-1-05015017-10. doi:10.1061/(ASCE)CO.1943-7862.0001081.
- The Economist. (2008, June 7). *Building BRICs of growth: Record spending on infrastructure will help to sustain rapid growth in emerging economies*. <http://www.economist.com/node/11488749>.
- Thiry, M., & Deguire, M. (2007). Recent developments in project-based organisations. *International Journal of Project Management*, 25(7), 649-658. doi:10.1016/j.ijproman.2007.02.001.
- Tu, Q., Vonderembse, M. A., & Ragu-Nathan, T. S. (2001). Impact of time-based manufacturing practices on mass customization and value to customer. *Journal of Operations Management*, 19(2), 201-217. doi:10.1016/S0272-6963(00)00056-5.
- Tucker, W. (2017). Crossrail project: The execution strategy for delivering London's Elizabeth line. *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 170(5), 3-14. doi:10.1680/jcien.16.00021.
- Turner R., & Simister, S. J. (2001). Project contract management and a theory of organization. *International Journal of Project Management*, 19(8), 457-464. doi:10.1016/S0263-7863(01)00051-5.
- Ulrich, K. T., & Eppinger, S. D. (1995). Design for manufacturing. In *Product design and development*. (pp. 180-216). McGraw-Hill.
- United Nations. (2018). *World urbanization prospects: The 2018 revision*. Department of Economic and Social Affairs, Population Division. Online Edition. <https://population.un.org/wup/>.
- United Nations. (2019). *World population prospects 2019: Highlights*. Department of Economic and Social Affairs, Population Division. https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf.
- Van de Ven, A. H. (2007). *Engaged scholarship: A guide for organizational and social research*. Oxford University Press. ISBN: 9780199226306.
- Vrijhoef, R., & de Ridder, H. A. J. (2005). Supply chain integration for achieving best value for construction clients: Client-driven versus supplier-driven integration. *Proceedings QUT Research Week*, 4-6 Brisbane, (January 2005), 260-271.
- Vrijhoef, R., & Koskela, L. J. (2000). The four roles of supply chain management in construction. *European Journal of Purchasing & Supply Management*, 6(3-4), 169-178. doi:10.1016/S0969-7012(00)00013-7.
- Walker, D. H. T., & Hampson, K. D. (2003). Enterprise networks, partnering and alliancing. In D. H. T. Walker, & K. D. Hampson (Eds.), *Procurement strategies: A relationship-based approach* (pp. 30-73). Blackwell Science. doi:10.1002/9780470690635.ch3.

- Walker, D. H. T., & Lloyd-Walker, B. M. (2014). The ambience of a project alliance in Australia. *Engineering Project Organization Journal*, 4(1), 2-16. doi:10.1080/21573727.2013.836102.
- Whitley, R. (2006). Project-based firms: New organizational form or variations on a theme? *Industrial and Corporate Change*, 15(1), 77-99. doi:10.1093/icc/dtj003.
- Wikner, J., & Rudberg, M. (2005). Integrating production and engineering perspectives on the customer order decoupling point. *International Journal of Operations & Production Management*, 25(7), 623-641. doi:10.1108/01443570510605072.
- Winch, G. M. (2014). Three domains of project organising. *International Journal of Project Management*, 32(5), 721-731. doi:10.1016/j.ijproman.2013.10.012.
- Winch, G. M., & Leiringer, R. (2016). Owner project capabilities for infrastructure development: A review and development of the "strong owner" concept. *International Journal of Project Management*, 34(2), 271-281. doi:10.1016/j.ijproman.2015.02.002.
- Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world*. Simon & Schuster. ISBN: 9780743299794.
- World Economic Forum (WEF). (2012). Strategic infrastructure: Steps to prioritize and deliver infrastructure effectively and efficiently. http://www3.weforum.org/docs/WEF_IU_StrategicInfrastructure_Report_2012.pdf.
- World Economic Forum (WEF). (2016). The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution. *Global Challenge Insight Report*.
- Wright, S., Palczynski, R., & Ten Have, P. (2017). Crossrail programme organisation and management for delivering London's Elizabeth line. *Proceedings of the Institution of Civil Engineers Civil Engineering*, 170(CE6), 23-33. doi:10.1680/jcien.17.00016.
- Yin, R. K. (2003). *Case study research: Design and methods*. Sage. ISBN: 9781452242569.
- Yusuf, Y. Y., Sarhadi, M., & Gunasekaran, A. (1999). Agile manufacturing: The drivers, concepts and attributes. *International Journal of Production Economics*, 62, 83-84. doi:10.1016/0010-4485(94)90028-0.
- Zhivov, N. (2018). *The Thames Tideway Tunnel: A hybrid approach to infrastructure delivery*. Working group paper, International Transport Forum.

Biography

Juliano Denicol, PhD, is Assistant Professor in Project Management at the School of Construction and Project Management, the Bartlett Faculty of the Built Environment, University College London. Dr. Denicol holds a doctor of philosophy (PhD) in megaproject management from University College London, a master of research (M.Res.) in industrial engineering, and a bachelor's degree in architecture and urbanism (BArch) from the Federal University of Rio Grande do Sul (UFRGS). He is part of Project X, a major research network that aims to improve major project delivery in the UK, established by nine universities in collaboration with the Infrastructure and Projects Authority (IPA) and the Cabinet Office. Dr. Denicol has worked as a supply chain management consultant at High Speed 2, the largest infrastructure project in Europe, and as an advisor to the European Commission on public procurement policies. As Global Head of the Megaprojects Special Interest Group (SIG) at the International Project Management Association (IPMA), Dr. Denicol coordinates a global platform with 73 countries to advance our understanding of megaproject delivery.

His work on megaprojects has been regarded of high global impact, receiving research awards from the IPMA, the Project Management Institute (PMI), and the Major Projects Association (MPA). He is the recipient of the 2019 Global Young Researcher Award from IPMA and the 2019 Best Reviewer Award from the Project Organising Special Interest Group of the European Academy of Management (EURAM).

Dr. Denicol has led the publication of two large-scale reviews of major and megaprojects: the Compendium of Large Infrastructure Projects for the European Commission, analyzing the procurement procedures in over 80 large infrastructure projects across the European Union from 2008 to 2018; and a systematic literature review of megaproject performance for PMI, where 6,007 papers were analyzed to identify 18 causes of poor performance and 54 solutions.

He regularly presents his research at international conferences, including the annual meetings of the European Academy of Management (EURAM), European Group for Organization Studies (EGOS), International Research Network on Organizing by Projects (IRNOP), Engineering Project Organization Conference (EPOC), and International Megaprojects Workshop: Theory Meets Practice (MW).

Twitter: https://twitter.com/Juliano_Denicol

LinkedIn: <https://www.linkedin.com/in/juliano-denicol>

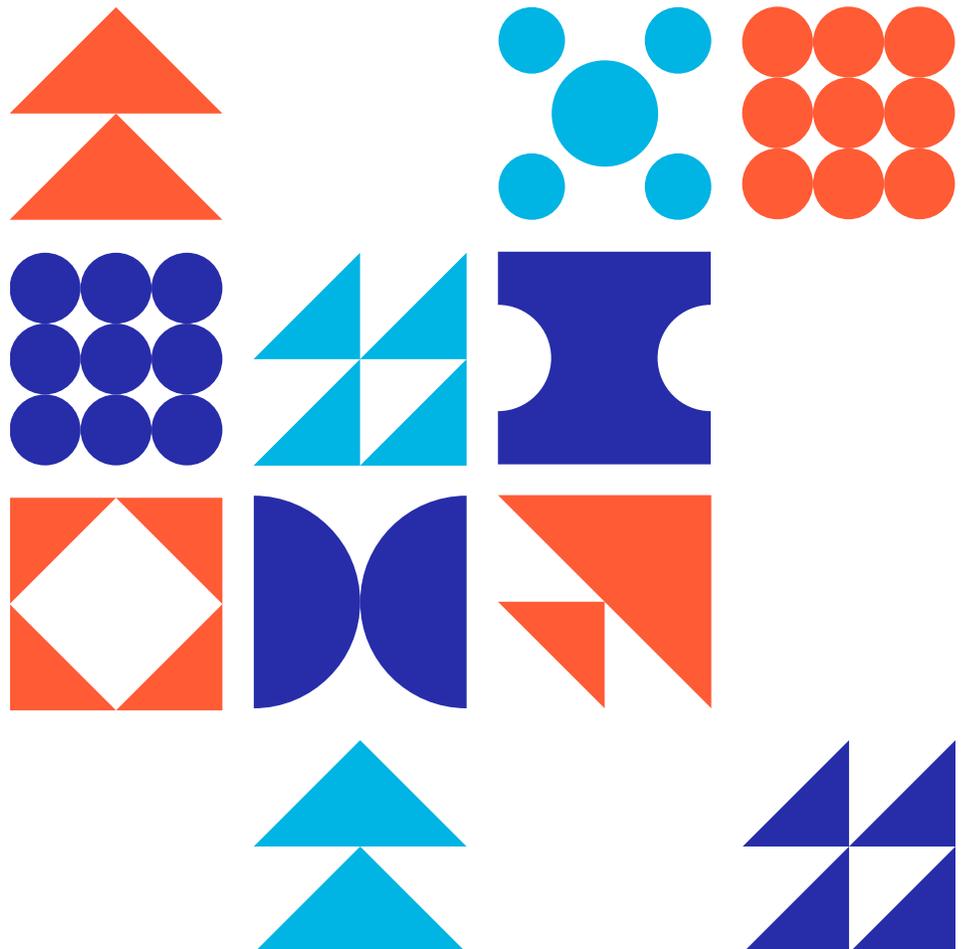
About Project Management Institute (PMI)

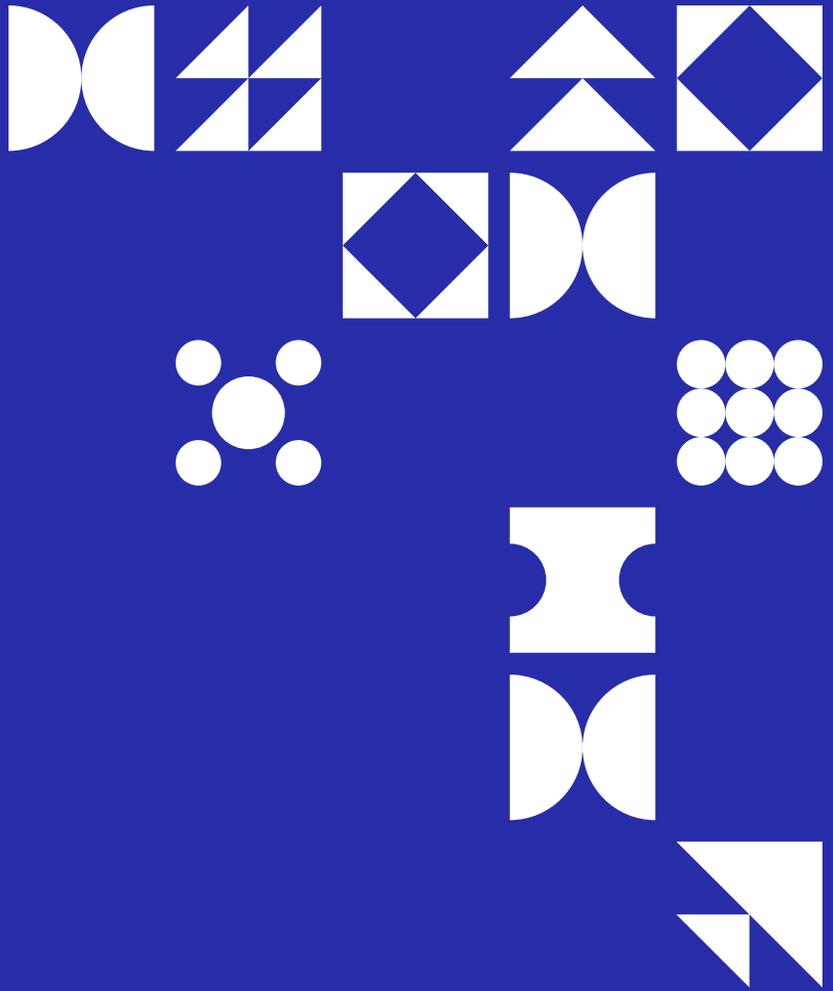
PMI is the world's leading association for those who consider project, program or portfolio management their profession.

Through global advocacy, collaboration, education and research, we work to prepare more than three million professionals around the world for the Project Economy: the coming economy in which work and individuals are organized around projects.

Celebrating our 50th anniversary in 2019, we work in nearly every country around the world to advance careers, improve organizational success and further mature the project management profession through globally recognized standards, certifications, communities, resources, tools, academic research, publications, professional development courses and networking opportunities.

As part of the PMI family, ProjectManagement.com creates online global communities that deliver more resources, better tools, larger networks and broader perspectives.





Powering The Project Economy™

PMI.org



Project Management Institute | Global Headquarters | 14 Campus Blvd Newtown Square, PA 19073-3299 USA | Tel: +1 610 356 4600

©2020 Project Management Institute. All rights reserved. "PMI," the PMI logo and the slogan "Powering the Project Economy" are marks of Project Management Institute, Inc. For a comprehensive list of PMI trademarks, contact the PMI Legal Department. All other trademarks, service marks, trade names, trade dress, product names and logos appearing herein are the property of their respective owners. Any rights not expressly granted herein are reserved.