
ICE Companion to Engineering Management

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Chapter 1

Procurement, contracts and project management

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While many in the construction sector view the industry as unique, there is no one feature of the industry that is unique. Economists who study the construction sector have often pointed out that, while it shares many of its economic features with other industries, it is the particular combination of features that makes it unique (see, for example, Gruneberg and Francis, 2019).

Construction is a complex activity, involving many different organisations across extended time-scales, with a view to long-term impact of some sort. The processes around the procurement of a construction project may be viewed at three levels: governance, organisation and management. Project governance involves the same processes as the governance of any other kind of organisation (International Standards Organization, 2021). Indeed, every organisation will be subject to its own governance regime. However, by bringing numerous organisations together to achieve the purposes of a construction project, it is useful to think of the project organisation as a temporary multi-organisation, which demands governance at the project level. Increasingly, legal requirements for governance impact on projects.

The organisation of work is about splitting a complex whole into a series of parts. In the case of a construction project, it is common for each of the work packages to be defined by contracts since different parts of the work are carried out by different organisations. Going to the market with defined pieces of work to form a contract is needed because so much of the work is carried out by specialised firms, whether design, fabrication, logistics, assembly, commissioning, operation or maintenance.

Project management is the process that ensures the clarification of aims and objectives for each work package, the establishment of control mechanisms and an adequate discharge of responsibilities by all those involved in the process. Many clients with large programmes of work apply common strategic objectives across their projects. Programme managers ensure a collaborative focus on those objectives across the various contracts procured to deliver the programme.

Each of these themes is outlined in this chapter, with references to further reading for each topic.

1. The nature of projects and the networks of contracts

Construction projects are typically a means to an end. A construction project may be seen as a factor of production for industry or as an enabling function for other purposes. Thus, it is not an end in itself. The context and impact of construction activity are important in understanding what construction projects are and how they are managed. For an introduction to the topic of management in construction projects, see Sherratt and Farrell (2015).

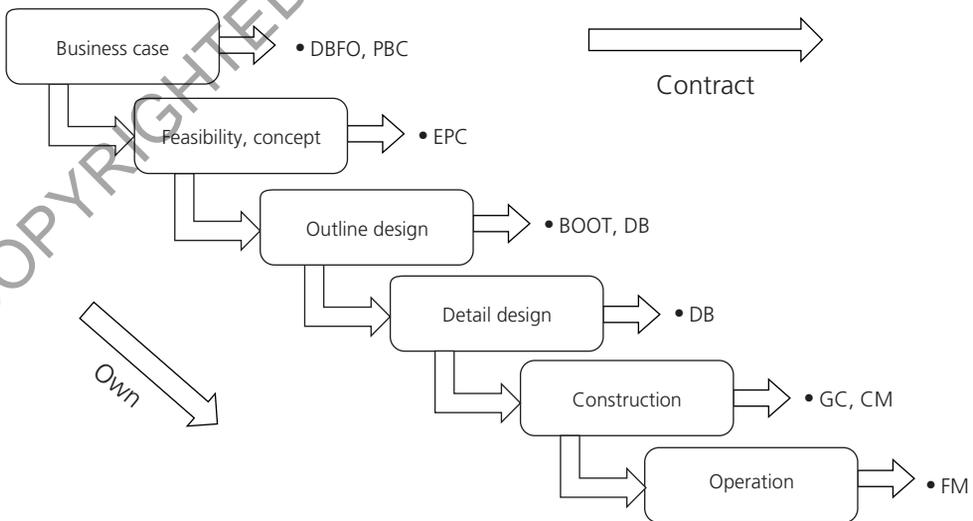
- responsibility for coordinating the construction site processes
- basis for calculating the price
- supply chain integration.

An appropriate procurement strategy for a construction project is one that fits with the capabilities, risk profiles and resources of the procurer. It is not simply a choice of contracting method but a choice about how to best organise the resources needed for any given project. It depends absolutely on the characteristics of the procuring organisation. Terminology can be very inconsistent in relation to these issues. The procuring organisation may be known as the owner, sponsor, employer or client. The latter will be used in this chapter, but the terms are used interchangeably in the industry.

Any project requires capability, knowledge and experience. A project involves risk, and it requires finance. Because construction generally constitutes a lot of expenditure up front, the risks associated with construction need very careful management. The characteristics of the client organisation are the primary variable in determining the most appropriate procurement strategy. The decision about how much of the work to carry out in-house and how much to contract out to others is known in the literature as the ‘make-or-buy’ decision (Williamson, 1979). The key point for procurement is for clients to consider the extent to which they have the capabilities, knowledge and financial wherewithal to manage projects themselves. Indeed, this can be seen purely as the client’s appetite for risk. At some point in the work, the client’s experience and knowledge will not be sufficient to deal with the risks involved in the work.

Figure 1.2 shows how a client may navigate this decision. Those who wish to go to the market for help in developing the business case and who wish to transfer as much risk as possible to the

Figure 1.2 Procurement methods as construction market engagement – the own or contract decision: DBFO, design-build-finance-operate; PBC, performance-based contracting; EPC, engineering-procurement-construction; BOOT, build-own-operate-transfer; DB, design-build; GC, general contracting; CM, construction management; FM, facilities management



1.1 What are 'management' and 'leadership'?

Despite the enormous amount of research and literature about management and leadership, there are no single definitions of these two concepts: they are terms that are often used interchangeably and there is still much debate over the essence of each:

- Koontz and O'Donnell (1964) write, 'Perhaps there is no more important area of human activity than management, since its task is that of getting things done through people. Whether in business, government, church, philanthropic institutions or other forms of enterprise, the effectiveness with which people work together towards the attainment of their joint goals is largely determined by the ability of those who hold managerial positions. It is to little or no avail to have advanced scientific knowledge, engineering skills, or technical abilities unless the quality of management in organized groups permits effective coordination of these human resources.' This view again emphasises controls and routines within groups.
- Covey (1989) offers, 'Management is efficiency in climbing the ladder of success; leadership determines whether the ladder is leaning against the right wall,' suggesting, first, that leadership is more strategic than management and, second, that management is about process, whereas leadership is about vision.
- Kotter and Heskett (1992) suggest that leadership is about 'establishing direction', 'aligning people' and 'motivating and inspiring', while management is focused on 'planning and budgeting', 'organising and staffing' and 'controlling and problem solving'.
- Jaques and Clement (1994) note the different time horizons across which managers and leaders operate, the latter looking across a longer time horizon than the former.
- Watkins (2012) describes the 'seven seismic shifts' from management to leadership, suggesting that there is a significant step change from one role to the other.
- Waterhouse (2018) suggests, 'At one level, management *is* leadership, but, often, management is the administration of established systems and routines. So, although they are not mutually exclusive, management and leadership are not the same.'
- Lussier (2021) defines a manager as the individual 'responsible for achieving organizational objectives through efficient and effective utilization of resources'.

Traditional titles of 'manager' and 'leader' focus on formalised roles and responsibilities within an organisational hierarchy. Different organisations favour particular definitions and views of management and leadership according to context and requirements. In reality, the roles of manager and leader, providing management and leadership respectively, are within a spectrum of titles and hierarchy: supervisor, team leader, manager, senior manager, leader, functional or departmental head, chief-of-, executive director, chair. Each of these is typically defined within an organisational competence framework and job families, having its own job description, targets and expected competence set. (Competency frameworks are used by organisations to present the skills, knowledge and behaviours expected from their staff.) Within the nine ICE attributes, ICE provides its own view on management and leadership. Other professional bodies have their own views and specific definitions for generic or functional management and leadership (for example, the UK's Chartered Management Institute and Institute of Leadership and Management) and for profession-specific forms of management and leadership (for example, the Association for Project Management, the Chartered Institute of Management Accountants and the Institute of Health and Social Care Management).

In the 1970s, Royal Dutch Shell identified what it termed the 'helicopter view', referring to the ability to rise above the specifics of a particular situation, to see the 'big picture' in its overall

using the toll road. If motorists find an alternative route or use other forms of transport that do not depend on the toll road, no revenue will be generated; hence, the project is subjected to market risk.

5. Financial instruments

Projects have to raise cash to fund their investment activities. This is usually done by issuing or selling securities. These securities, known as 'financial instruments', are in the form of a claim on the future cash flow of a project (Merna and Al-Thani, 2018). A project finance operation may involve a variety of financial instruments. Traditionally, financial instruments were in the form of either debt or equity. As market-based structures with different risk profiles have been used in an increasing number of industries, capital market project investors have grown in both number and type. At present, projects that are procured by utilising project finance are often financed by a combination of debt, mezzanine finance (bonds) and equity capital. The split between debt and equity is based on the risk profile of each project (Merna and Al-Thani, 2018). The higher the risk, the greater the share of equity that will be required by the lending banks. Project finance debt does not affect the credit rating of a company. However, the author believes that financial institutions have paid attention to the ratio between project finance debt and corporate finance debt of a company in the last 5 years. The implication of this is unclear.

Various funding sources are available for project financing. These sources are both internal and external. The parties to project investment include those with a commercial interest in the project, for instance, project sponsors, raw-material suppliers, original equipment manufacturers and purchasers of a product or service. External parties also provide a wide range of funding sources; these include export credit agencies, multilateral agencies and development banks, bilateral development banks and agencies, and commercial banks. These sources provide equity, debt or a mixture thereof for project financing (Merna and Al-Thani, 2018).

5.1 Debt finance

The most important element in project finance is the raising of the debt capital, which is determined by the bankability of a project's contractual structure (Merna and Al-Thani, 2018). Most projects are financed by utilising debt as part of the financing package (Merna *et al.*, 2010). Debt refers to borrowed capital from banks and other financial institutions. It has a fixed maturity and a fixed rate of interest is paid on the principal. Merna and Al-Thani (2018) define debt instruments as the raising of term loans from banks, other financial institutions (including commercial banks, merchant banks, investment banks, development agencies, pension funds and insurance companies), debentures and export credits. It is typically protected only against the assets of the SPV. There are many conditions attached to obtaining funds from these sources but it all depends on the criteria of the lender and the borrower, as well as the type of project being considered. The cost of raising debt capital includes certain fees and interest. Debt is senior to all other claims on the project cash flow and assets. However, the lender will never receive more than the interest and principal repayments if a project goes well. The downside risk is that the senior lender faces losing 100% of the loan to the project if the project does not perform well (Grimsey and Lewis, 2002). Thus, lenders concentrate closely on all aspects of risk and want to take the least risk of all parties involved.

In project finance, mobilising commercial debt can be quite difficult for several reasons. First of all, the number of banks involved in project finance has increased greatly in the last 10 years. Each bank has exposure limits to the project finance environment; thus, organising a syndication of

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Chapter 5

Sustainable development

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1. Introduction

Our world is changing, trending, even. It has always been changing, as has human society. Each generation through history built its world with half an eye on the future. This is most evident in infrastructure development. By its nature, infrastructure extends capability into the future, defining the world that our children will inherit, as we live in the world that our parents built for us. The infrastructure can either harm or benefit them. It is not just the built environment. It applies to all aspects of development across the natural, built and virtual infrastructure domains influencing human health and behaviour. The need for development to be sustainable is implicit in this dynamic. So, while we may instinctively understand the idea of sustainable development, it isn't always reflected in the ways that we have pursued individual development projects. When we bring financial sustainability metrics to the fore and lose sight of the societal impact or environmental damage, we skew the calculus and our holistic understanding. In pursuing production metrics, we lose sight of the outcome. Our instinctive understanding of what should be is overtaken by our desire to simplify and focus on a single aspect. The challenge is, has been and will always be, that to plan our development in context to future generations' benefit involves a complex calculus. As Professor Jowitt (2004) points out, it is just a more complex calculus, and the profession can adapt, as it has in the past. Until recently, we have preferred the simpler calculus, the familiar models and a comforting blindness to our actions' consequences – our development outcomes.

In her inauguration address as president of the Institution of Civil Engineers, Rachel Skinner articulated clearly the need for change and the profession's direction towards a future of net-zero carbon dioxide emissions (ICE, 2020a). While the evidence justifying change continues to grow, it is not harm to the next generation that provides the stimulus. Infrastructure accounts for roughly 70% of the greenhouse gas (GHG) emissions responsible for our rapidly changing climate. Our actions since the 1950s have so influenced our world's ecosystems that we now define this as a new geologic epoch, the Anthropocene. What distinguishes this epoch is that the rate of change exceeds the natural ecosystems' capacity to absorb, adapt and adjust (Kolbert, 2014). It is not just the natural ecosystems that are unable to adapt; this also extends to our socioeconomic ones. Long recognised, perhaps our experience of the pandemic has brought these fragilities to the popular consciousness, through inequity of opportunity and access to services, income disparities, the threat of further zoonotic diseases, climate refugees and increasingly erratic weather. We are standing on the threshold of change; we are in a *liminal* state. What is unique in this situation is that we are all at the same threshold, unsure of what the future holds for us and our role in it. To further complicate the situation, there is no master of ceremonies to guide us. It heralds a period of unparalleled opportunity to make good on past mistakes and build the world we wish for our children. A world that does not burden them with a legacy of pollution, denatured wilderness and