CONSTRUCTION COST MANAGEMENT

LEARNING FROM CASE STUDIES

SPON TEXT

KEITH POTTS

Construction Cost Management

In the last decade, following the Latham and Egan reports, there have been many significant changes in the role of the construction cost manager. Keith Potts examines the key issues and best practice in the cost management of construction projects under traditional contracts and new methodologies. All stages within the life cycle of a project are considered from pre-contract to tendering and post-contract.

Worked examples, legal cases and over 65 project case studies are used to illustrate the practical application of the theory, where appropriate. Extensive references are captured, including the UK government's Constructing Excellence programme and the National Audit Reports, in order to further develop an understanding of the subject. Reference is made to major projects such as the Scottish Parliament Building, Wembley Stadium and BAA's Heathrow Terminal 5.

Aimed at students of Surveying and Construction Management programmes, this book uniquely embraces cost management in both the building and civil engineering sectors in the UK and overseas and should thus prove useful to practitioners. Seminar questions are included at the end of each chapter with additional links to over 100 project case studies in order to reinforce the learning experience.

Keith Potts is Senior Lecturer in the School of Engineering and the Built Environment at the University of Wolverhampton. He is a RICS external examiner in Quantity Surveying, and Award Leader of the RICS-accredited MSc in Construction Project Management.

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Keith Potts

Taylor & Francis
Taylor & Francis Group
LONDON AND NEW YORK

First published 2008
by Taylor & Francis
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Simultaneously published in the USA and Canada
by Taylor & Francis
270 Madison Ave, New York, NY 10016

Taylor & Francis is an imprint of the Taylor & Francis Group, an informa business

This edition published in the Taylor & Francis e-Library, 2008.

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
Potts, Keith F.
Construction cost management: learning from case studies / Keith Potts.
p. cm.
Includes bibliographical references and index.
1. Construction industry – Costs.
2. Construction industry – Cost control. I. Title.

TA682.26.P68 2008
624.068'1–dc22 2007032917

ISBN 0-203-93301-X Master e-book ISBN

ISBN10: 0–415–44286–9 (hbk)
ISBN10: 0–415–44287–7 (pbk)
ISBN10: 0–203–93301–X (ebk)

ISBN13: 978–0–415–44286–2 (hbk)
ISBN13: 978–0–415–44287–9 (pbk)
ISBN13: 978–0–203–93301–5 (ebk)

This book is dedicated to the memory of Francis Leon Potts, who first encouraged me to go into quantity surveying, and to the love and friendship of Lesley, Ian, Gemma and Debbie.

Contents

Preface

My first text book *Major Construction Works: Contractual and Financial Management* (Longman) (1995) was based on documentation assembled during 1993 and 1994; this now seems like a prehistoric era before the Latham (1994) and Egan (1998) reports!

In that book, I attempted to identify the key issues in the successful contractual and financial management on major projects. It was based on my experience as a senior quantity surveyor, at separate times employed by both contractor and client, on the Hong Kong Mass Transit Railway – at the time one of the largest construction projects in the world. In contrast to the norm at that time within the UK, the massive Hong Kong project – despite major difficulties – was completed on time and within budget. The lessons to be learned from this project were identified in the case study in the last chapter of the book. It was clear from this experience that any project could be completed on time and within budget providing the appropriate procurement systems, planning and control methods, contracts and financial procedures were in place – crucially with experienced, motivated people to implement them.

Over a decade later, the world seems very different, yet the same fundamentals apply – clients wish to obtain their project within budget and within time and to the necessary quality.

The relentless growth of the World Wide Web (www) meant that all could now easily access a vast array of important information. The problem for students, however, was in identifying which information was significant and which was superfluous.

In this new text, I have attempted to embrace the recommendations of the key reports and government bodies including the National Audit Office and the Office of Government Commerce. The book includes the tools and techniques required under the new partnering/alliancing philosophies as well as including chapters on valuing variations and claims based on the traditional procurement approach. Observations in the book are reinforced throughout with detailed analysis of over 60 project case studies with additional links to over 100 case studies. Many of the project case studies are taken from the *Building* magazine or the *National Audit Office* reports to whom the author is most grateful for permission to publish.

A chapter is included on the NEC *ECC Contract*, which has been the standard contract in the civil engineering and infrastructure sectors for some time and is increasingly chosen by public clients in the building sector. Its choice by the London 2012 Olympic Development Authority reinforces its status. A chapter on the new FIDIC contract is included for those working on major projects outside the UK. Uniquely, the new textbook embraces both the building and civil engineering sectors and should be of interest to both undergraduate and postgraduate students as well as practitioners.

A significant case study on the Heathrow Terminal 5 has been included. It is important that the lessons learned on this pioneering project in lean-construction are disseminated and understood by all.

Over the past two years I have received useful information from many senior quantity surveyors and commercial managers representing both consultants, public and private clients and contractors. These together with comments and observations received from undergraduate and postgraduate students at the University of Wolverhampton have deeply enriched the study. Finally, I wish to thank fellow colleagues Rod Gameson, Chris Williams and particularly Pauline Corbett for their valued help in passing learned comments on the draft chapters. Any errors or omissions are, of course, my responsibility.

Part I
Introduction

1 Introduction and overview

1.1 Setting the scene

There have been many significant changes in the construction sector within the past decade. The relentless development of computer power and the growth of the World Wide Web and knowledge management, the increasing use of Private Finance Initiative (PFI) and Public–Private Partnership (PPP), the growth of partnering and alliancing, the increasing importance of supply-chain management and the increasing use of the *New Engineering Contract* have changed the industry for the good. Yet, the same fundamentals apply – clients wish to obtain their project within budget and within time and to the necessary quality.

Significantly, the role of the quantity surveyor (QS) has also changed and many have moved on from contractual and financial management of projects to embrace the key role as the client's construction manager/project manager. One of the pioneer QS construction project managers was Francis Graves, who undertook the task of project controller in 1972 on the massive five-year-long Birmingham NEC Exhibition Centre project. He considered his terms of reference on this project very straightforward – *Get it finished on time and get value for money!*

An analysis of three of the top QS Consultants' websites shows their involvement in a wide range of cost management and related services (Table 1.1).

Significantly, following their successful partnership on the Heathrow Terminal 5 project, EC Harris and Turner & Townsend established Nuclear JV to tender for programme controls services and to subsequently target the wider nuclear decommissioning programme. Of particular interest, Rob Smith, Chairman of Davis Langdon & Seah, in his introduction to their 2005–2006 *Global Review* identifies some of the big issues facing us all – particularly environmental and sustainability concerns. He comments that part of Davis Langdon's contribution will be the introduction of sustainable design thinking and sustainable metrics into their cost plans (www.davis-langdon.com/mainpage/GlobalReview.htm. [accessed 28 February 2007]).

1.2 Construction overview

The construction sector is strategically important for Europe, providing the infrastructure and buildings on which all sectors of the economy depend. With 11.8 million operatives directly employed in the sector, it is Europe's largest industrial employer accounting for 7% of total employment and 28% of industrial employment in the EU. It is estimated that 26 million workers in the EU depend in one way or another on the construction sector. About €910 billion

Table 1.1 Range of services offered by leading construction cost consultants.

Company	*Cost management services*	
EC Harris	*Consulting*: Asset & Facilities Strategies; Enabling Technology & Management Information Systems; Performance Management; Technical & Investment Risk Management; Public Private Finance Consultancy; Supply-Chain Management; Risk Management & Business Continuity *Managing Delivery*: Programme, Project & Construction Management; Commercial Management, Quantity Surveying & Value Engineering; Safety, Health & Environmental Management; Asset & Facilities Management; Independent Advisor, Due Diligence & Insolvency; Strategic Procurement, Contractual Advice & Dispute Resolution; Development Management *Delivery of Business Support Maintenance & Construction*: Facilities Outsourcing; Prime Contracting	
Turner & Townsend	*Inception*: Feasibility Studies; Business Case; Development; Strategic Cost Planning; Benchmarking *Development*: Contract Strategies; Option Appraisals; Capital and Operational Cost Planning; Risk Management; Value Management; Whole-Life Costing; Supplier & Contractor Procurement *Implementation*: Cost Control & Management; Change Control; Payment Mechanisms; Performance Measurement *Operation and Occupation*: Maintenance Strategies; Energy and Cost-in-Use Analysis; Facilities Management	
Franklin + Andrews	Benchmarking Bills of Quantities Building Services (M&E) Capital Allowances Management Contract Advisory Services Contract Documentation Cost Modelling and Planning Due Diligence	Employer's Agent Feasibility Studies Project Audits Quantity Surveying/Cost Commercial Real Estate Due Diligence Real Estate Tax Management Whole-Life Costing Analysis

Source: Websites www.echarris.com; www.turnerandtownsend.com; www.franklinandrews.com (accessed 28 February 2007).

was invested in construction in 2003, representing 10% of the GDP and 51.2% of the Gross Fixed Capital Formation of the EU (www europa.eu.int [accessed September 2006]).

Moreover, the relationship between construction activities and the built environment, on the one hand, and sustainable development, on the other, is both significant and complex. Construction uses more raw materials than any other sector, and the creation and operation of the built environment accounts for an important consumption of natural resources. There is also a pressing need to address the regeneration of many urban areas of Europe, in particular in the newly acceded countries, and the realization of major trans-European infrastructure works.

The UK construction activity makes a considerable contribution to the national economy accounting for over 8% of the national gross domestic product. UK annual public sector construction output has grown by over a third between 1999 and 2003 from just under £24 billion per year to around £33.5 billion, and capital investment is set to continue expanding over the next three years in key sectors such as schools, hospitals, roads and social housing (NAO, 2005).

Table 1.2 shows the top ten clients/promoters by turnover from 1 January 2006 to 31 December 2006 in the UK based on analysis of contracts with a value of £100,000 or above, and all work awarded by negotiation or competitive tender, including residential and civil work. Significantly, these major clients have shown the lead in embracing the new procurement routes and conditions of contract.

Table 1.2 Top clients/promoters in the UK – year ending 31 December 2006.

Company	*Total value (£ million)*	*Main procurement type*
1 British Nuclear Fuels	6,506	Framework agreements Competitive supply chains Fixed price or Target cost contracts (when scope and risk reasonably defined)
2 Partnership for Schools	4,000	Long-term partnerships Private Finance Initiatives Design and build contracts
3 Defence Estates	3,160	Prime contracting Public–Private Partnerships/Private Finance Initiatives
4 Birmingham Council	2,310	500 million 5-year Partnership with 3 construction companies for all projects valued at more than £100,000 Contracts based on NEC3
5 Olympic Delivery Authority	1,565	Based on OGC's *Achieving Excellence in Construction* Guides Projects managed using a delivery partner Contracts based on NEC3

Source: Developed based on *Building* magazine, 26 January 2007, p. 20 and websites: www.britishnucleargroup.com; www.p4s.org.uk/; www.defence-estates.mod.uk/major_projects/ index.htm; www.birmingham.gov.uk; www.london 2012.com (accessed 1 March 2007).

1.3 Influential reports

In the last 60 years there have been numerous reports on the state of the UK construction industry (Murray and Langford, 2003), including the following:

- *Placing and Management of Building Contracts: The Simon Committee Report* (1944);
- *The Working Party Report to the Minister of Works: The Phillips Report on Building* (1948–1950);
- *Survey of Problems before the Construction Industry: A Report Prepared by Sir Harold Emmerson* (1962);
- *The Placing and Management of Contracts for Building and Civil Engineering Work: The Banwell Report* (1964);
- *Tavistock Studies into the Building Industry: Communications in the Building Industry* (1965) and *Interdependence and Uncertainty* (1996);
- *Large Industrial Sites Report* (1970);
- *The Public Client and the Construction Industries: The Wood Report* (1975);
- *Faster Building for Industry: NEDO* (1983);
- *Faster Building for Commerce* (1988).

With the exception of the Tavistock Studies, these were all government-sponsored reports, produced by large committees. Most made recommendations for improvement but were mainly ignored due to poor client involvement and no follow-up legislation to reinforce their findings. Significantly, Banwell (1964) recommended that a common form of contract be used for all construction work. This only started to become a reality 30 years later – with the introduction of the *New Engineering Contract* (NEC).

Thankfully, Sir Michael Latham's *Constructing the Team* (1994) was not ignored, being the catalyst, which has attempted to transform the industry. Since this date we have seen the publication of many significant government-sponsored or National Audit Office Reports including The Egan report *Rethinking Construction* (1998); *Modernising Construction* (2001); The Second Egan report *Accelerating Change* (2002); *Achieving Excellence in Construction Procurement Guides* (2004) and *Improving Public Services through Better Construction* (2005).

These reports and other relevant key recommendations are reviewed in Chapter 2 in order that best practice be identified.

1.4 Recommendations from professional bodies

The RICS APC/ATC requirements and competencies (RICS, 2002)

The RICS identifies that construction surveyors (quantity surveyors) may be working as consultants or working for a contracting or engineering company in the following areas:

- Preparing development appraisals for different sites, assessing the effects of capital and revenue expenditure, life-cycle costs, grants and taxation implications;
- Advising clients on the project brief, preferred procurement routes, costs and cash flow;
- Analysing the whole-life costs of a project;
- Planning the construction process;
- Monitoring and control of cost during the pre-contract stages;
- Preparing tender and contractual documentation, leading to tender selection and appraisal;
- Following the letting of the contract for the project, advising on payments to contractors and post-contract cost control, settlement of final account;
- Controlling a project on behalf of their employer;
- Negotiating with the client or subcontractors;
- Reporting on programme and financial matters;
- Risk and value management (RM and VM);
- Giving contractual advice for either party in the case of dispute.

It is noted that new guidelines for the *Assessment of Professional Competence* were issued by the RICS in July 2006 (*www.rics.org.uk* [accessed 26 April 2007]).

The Construction Industry Council

The Council (representing all the professions) in their publication *Project Management Skills in the Construction Industry* (2002) identified the key skills for those operating in construction project management under the following headings:

Strategic: strategic planning/VM/RM/quality management;
Project control: the project-control cycle/developing a schedule/monitoring/managing change/action planning/client/project interface/information management;
Technical: design management/estimating/value engineering (VE)/modelling and testing/configuration management;
Commercial: business case/marketing and sales/financial management/procurement/legal issues;
Organization and people: organization structure/selection of a project team/people issues.

The CIOB Code of Practice for Project Management for Construction and Development

This is a significant source of knowledge with a third edition published in 2002. This CIOB initiative involved the formation of a multi-institute task force; the 1991 first edition was referred to by Sir Michael Latham in his report *Constructing the Team* (1994) as an example of cooperation between the professions.

The Association for Project Management's Body of Knowledge, 5th edition (APM, 2006)

This generic guideline for project management identifies the behavioural characteristics, the knowledge areas and competencies that are desirable for professionals in project management. It is the UK vision of generic project management within guidelines set by the International Project Management Association.

APM Body of Knowledge: key topics are listed below

Section 1 – project management in context: project management, programme management, portfolio management, project context, project sponsorship, project office;

Section 2 – planning the strategy: project success and benefits management, stakeholders management, VM, project management plan, project RM, project quality management, health and safety and environmental management;

Section 3 – executing the strategy: scope management, scheduling, resource management, budgeting and cost management, change control, earned VM, information management and reporting, issue management;

Section 4 – techniques: requirements management, development, estimating, technology management, VE, modelling and testing, configuration management;

Section 5 – business and commercial: business case, marketing and sales, project finance and funding, procurement, legal awareness;

Section 6 – organizational and governance: project life cycles, concept, definition, implementation, hand-over and close out, project reviews, organizational structure, organization roles, methods and procedures, governance of project management;

Section 7 – people and the profession: communication, teamwork, leadership, conflict management, negotiation, human resource management, behaviour characteristics, learning and development, professionalism and ethics.

1.5 Learning from case studies

Some projects become iconic, reflecting the challenge of the new and the time and place. The Sydney Opera House in Australia became the symbol for the Millennium Olympics in 2000 and somehow reflected the healthy swagger of the emerging continent. The competition for the project was won in 1957 by Danish architect Jorn Utzon, whose first design according to the members of jury was hardly more than *a few splendid line drawings*. This comment could also have been made many years later in connection with Enric Miralles' first submission on the Scottish Parliament building.

The billowing concrete sailed roof had never been built before. It should therefore have been no surprise that the A$7 million project escalated to over A$100 million and the planned construction period of 5 years was finally extended to 14 years (1959–1973). The architect was put under so much pressure over the escalating costs that he left the project half-way through after which his designs were modified. As a result, the building is perfect for rock concerts but not suitable for staging classical full-scale operas (Reichold, K. and Graf, B., 1999).

Another iconic building is the *Centre Pompidou in Paris*, a building famous for being *inside-out* with all the structural frame, service ducts and escalators being on the outside allowing a flexible floor space within. The audacious steel and glass National Centre for Art and Culture was designed by two young unknown architects Renzo Piano and Richard Rogers, to last – as George Pompidou reminded architects – for four or five centuries.

After opening in 1977 the centre rapidly became a huge success, with more than 7 million visitors a year making it the most popular tourist destination in Paris. After 20 years of use the building was showing its age, including rusting on the structural frame, and was in need of a major renovation. In October 1997 the whole Centre closed, reopening in January 2000, which allowed for not only the refurbishment but also improvements to the internal layout at an estimated cost of US$100 million (Poderas, J., 2002).

Significantly, the UK Government now requires the issue of whole-life costing (WLC) to be considered with project evaluation. It is interesting to speculate as to whether the Pompidou Centre would have passed such a test if the building were proposed to be built in the UK in 2007.

The *Millennium Dome at Greenwich* was designed to be UK's showcase to celebrate the new millennium. With a diameter of 365 metres the Dome was the largest single-roofed structure in the world with a floor area the size of 12 football pitches (Wilhide, E., 1999).

However, the project was plagued throughout by problems and bad publicity, typified by the Millennium New Year's Celebration, when the great and the good were left stranded for hours at Stratford Station. Open to the public for one year, the Millennium Dome was closed to visitors on 31 December 2000 and has remained unused apart from the Ministry of Sound New Year's Eve dance parties.

The £758 million project was seen as a major part in the regeneration of the East London being built on 120 hectares of contaminated wasteland. The project was initiated by the Conservatives and was taken over in 1997 by Tony Blair's new Labour Government as an innovative public sector enterprise, which harnessed private sector funding (Report by the Comptroller and Auditor General, 2000).

The Millennium Dome was designed by architect Richard Rogers and Consulting Engineer Buro Happold with a joint venture of John Laing/Sir Robert McAlpine acting as Construction Managers with target-cost contracts incorporating *painshare/gainshare* clauses. What is often forgotten is that the £260 million project for the design and construction of the Dome was a highly significant and successful achievement being completed on time and within budget. The author visited the project in 1999 and was particularly impressed with the teamwork approach with everyone: client, consultants, contractors and subcontractors working in same open-plan office.

However, the design and organization of the interior exhibits was not of the same order and some saw the result as a disjointed assemblage of thinly veiled, corporate-sponsored promotions and lacklustre museum exhibits sub-divided into 14 so-called zones. The centre-stage show with an acrobatic cast of 160 was enjoyed by most; indeed, over 80% of visitors said that they had enjoyed the whole experience.

The project was largely reported by the press to have been a flop: badly thought out, badly executed and leaving the government with the embarrassing question of what to do with it afterwards. During 2000, the organizers repeatedly asked for and received more cash from the government. Part of the problem was that the financial predictions were based on an unrealistically high forecast of visitor numbers at 12 million; in the event, there were only 6.5 million.

The Dome has been refurbished into a soundproof 22,000-seater sports and entertainment complex and was reopened in June 2007. In 2009 it will host the World Gymnastics Championships and in 2012 will become an Olympic venue.

The London Underground's *Jubilee Line Extension* (JLE) was at the time one of Europe's largest infrastructure projects. The JLE comprised more than 30 major contracts linking the UK Government's parliamentary HQ at Westminster to London's emerging financial centre at Canary Wharf and beyond to Stratford. The entire project comprised a 10-mile underground extension with 11 stations, 6 completely new and 5 substantially enlarged or rebuilt, and 4 crossings under the River Thames.

It posed a huge management challenge, creating magnificent station architecture, but became infamous for overrunning on both time and budget.

The overall construction period for the project was 72 months, compared to the original 53 months, while the out-turn estimated cost for the project rose from £2.1 million in October 1993 to £3.5 million in December 1999. The project was completed in December 1999, just in time for the Millennium celebrations in the Dome at Greenwich, significantly after Bechtel had taken over the management of the project in September 1998.

The JLE *Conditions of Contract* was a hybrid of the ICE 5th edition and the FIDIC form, modified by the Hong Kong Mass Transit Railway Corporation (HKMTRC) and Singapore Mass Rapid Transit. The civil engineering contracts were based on bills of quantities subject to admeasurement.

Each contract contained an Interim Payment Schedule (IPS), which was based on a series of defined milestones within four main cost centres; the idea being that payment was only made if the defined milestone was achieved. A fundamental aim of this approach was to motivate contractors to achieve progress while avoiding the need to base monthly payments on measured works. The system had worked well in Hong Kong and in the early stages of the JLE.

Unfortunately, due to the changing requirements of the JLE scheme in the early stages of the project and the tight timescale, the working drawings issued at contract award remained incomplete. This resulted in extensive changes to the programmes causing delay and disruption, extensions of time and acceleration measures, and the milestones had to be continuously revised. Indeed, many contractors commented that the whole system fell in disrepute. The Major Projects Association (MPA) observed that the project culture was too adversarial and inflexible (as were the contracts used) (MPA, 2000).

The lessons to be learned from this project are best summed up by a civil contractor:

> Build your delivery strategy around collaborative working, build into your forms of contract risk and reward share and get the whole team/teams together earlier. Be decisive about objectives and keep the management team as lean as possible.
>
> (Mitchell, R., 2003)

The Scottish Parliament Building in Edinburgh is a classic tale worthy of further investigation. As anyone will know who has experience of major projects, what happens in practice is sometimes very different to what is envisaged in theory.

Initially conceived by the Barcelona architect Enric Miralles and completed 20 months late with an initial budget of £40 million and a final cost of £430 million, the building has been subject to much criticism, particularly from the taxpayers in Scotland. Lord Frasier in his report entitled *The Holyrood Inquiry* (2004) identified many concerns including the following:

- Inadequacy of the original budget, which at the feasibility stage was no more than indicative;
- Failure to identify relative significance of cost in the time/cost/quality triangle;

- Insufficient inquiry on proposed joint venture between architects EMBT (Barcelona) and RMJM Ltd (Edinburgh);
- Inadequacy of the brief;
- Failure of client to appreciate disadvantages of the construction management approach – total risk lies with client;
- Inadequate management of risk;
- Lack of involvement of key stakeholders, for example Ministers, in procurement selection and approval of revised budget;
- Lack of audit trail in selection of construction manager (Bovis);
- Failure of client to take up Bovis's parent company guarantee;
- Lack of construction experience of client's project sponsor;
- Lack of knowledge of EU procurement rules;
- Insufficient time in the programme for the planning and design phase;
- Poor level of communication between the key players;
- Inadequate reporting to Ministers of potential risks identified by cost consultant (DL&E);
- Failure to appreciate impact of complex design, such as the chamber roof;
- Inadequacy of the cost plan, designs were developed without the cost plan;
- Failure to finalize the draft project execution plan – a key document in the control process;
- Disregard by architect of constraints of the brief and budget;
- Failure of the VM exercise;
- Ineffective monitoring systems by the project team demonstrating a lack of control over the whole process.

One comment by Lord Fraser seems to sum up the situation:

> The programme was propelled by the client obsession with early completion. It appears not to have been completely grasped throughout the project that if the quality and unique complexity of the building was of overriding importance, the programme and the timing of completion would be affected significantly and extra cost inevitably occurred.

The Scottish Parliament Building was a unique project and has provided an unprecedented amount of information via the Spenceley Report (2000), two Auditor General Reports (2000 and 2004) and Lord Fraser's *Holyrood Inquiry* (2004) together with access to the actual correspondence between the parties (via the *Holyrood Inquiry* website www.holyroodinquiry.org [accessed 18 April 2007]).

In 1998 the report, *The Government Client Improvement Study*, produced by the University of Bath for the HM Treasury Procurement Group, identified that, in practice, construction project managers often resort to *crisis management*, meaning that problems are resolved through reaction rather than prevention. This report also identified that the significant lack of management effectiveness in the public sector was due to the failure of project sponsors, who are viewed as administrators rather than leaders. The report recommended that the project sponsor's role should be developed and supported by greater empowerment, training and the development of a culture that promotes and rewards openness in the way in which projects are procured, so that all can learn from good and bad experiences (*Agile Construction Initiative*, 1998).

1.6 Learning from project failures

Identifying whether a project is a success or a failure can change with time. The Sydney Opera House was clearly a failure on the criteria of budget/time/function, yet the building later became the iconic image for the nation for the 2000 Sydney Olympics.

Many of the 1970s UK North Sea oil projects went way over the budget, yet following the subsequent surge in oil prices were clearly successful. The Thames Barrier at Greenwich was a project plagued by poor industrial relations finishing three years late in 1984 and 10 times the original budget, yet when the barrier was later used, the innovatively designed project was successful and London was saved from flooding. Today the Barrier is raised six times per year compared to once in six years as originally anticipated.

It is important that we understand the causes of project failures and apply the lessons learned. The Major Project Association (MPA, 2003) identifies the major reasons for project failure as follows:

- Poor project definition;
- Unclear objectives;
- Unrealistic targets;
- Inadequate risk evaluation;
- Client inexperience;
- Poor forecasting on demand;
- Lack of effective sponsor and strong leadership;
- Poor communication and lack of openness;
- Inadequate stakeholder management;
- Management focus wrongly targeted at the back end rather than at the front end of the project.

These are indeed important observations that ring true in the case studies quoted throughout this book.

1.7 Relevant observation

In 1913 the *Builder* magazine criticized the standard form of contract and concluded, ‘It does seem as though there is an appalling waste of money and effort in the tendering system . . . and it would be to the benefit of the building owners if this waste was curtailed.’ The same article went on to argue:

> The competitive system of tendering . . . divorces the interest of the contractor from that of the building owner. If some system could be devised whereby the contractor was paid in a way which would make him . . . stand in the shoes of the building owner, it would confer on the latter many of the advantages of doing the work himself.
>
> (Quoted in Cooper, 2000)

Nearly one hundred years later we can confidently state that some progress has been made in developing procurement systems that enable contractors to stand in the shoes of the building owner. However, there is still much work to be done in identifying and disseminating best practice.

1.8 Conclusion

This chapter has set the scene and identified the role of the construction commercial manager within the wider discipline of project management. The role of the commercial manager has developed embracing many aspects of project management including the following:

- Strategic: strategic planning, VM and RM, WLC;
- Control: project-control cycle, developing a schedule, controlling the cost;

- Technical: tendering procedures, contractors' estimating;
- Commercial: financial management of the pre-tender, tender and post-tender stages, procurement, managing change, managing claims, legal awareness and contracts.

The aim of this book is to embrace the subject of construction-cost management as identified within sections 2, 3, 4 and 5 of the APM's Body of Knowledge, the CIC's Construction Project Management Skills framework and the RICS's APC/ATC guidelines for construction surveyors. The linking of these sections acknowledges the reality of the role of the QS/commercial manager, increasingly embracing construction project management.

A brief analysis of two important forms of contract, the NEC3 and FIDIC's 1999 *Red Book*, representing best practice in the UK and overseas is included. The final chapter describes the Heathrow Terminal 5 project, which has embraced the lean construction philosophy demanded by Sir John Egan. Particular attention is paid to the recommendations made in the key reports and from the National Audit Office. This text should therefore prove to be of interest to built environment and project management undergraduate/postgraduate students and practitioners alike.

Commercial and contractual management is not easy; traditionally it demanded experienced, dedicated personnel with an understanding of the construction technology and an in-depth knowledge of measurement and estimating, variations and claims and contract procedures. The new strategies now demand professionals with a wider knowledge of procurement strategies and project management – particularly planning and control systems, corporate governance, strategic positioning, organizational behaviour, supply-chain management and the management of change.

However, it is not the strategy or the wording of the contract that ensures success or failure, rather it is the attitude of the people involved. A genuine team spirit must be created with all team members having a *can do, will do* attitude (MPA, 2001).

Now it's time for you to answer a few questions! Best of luck.

1.9 Questions

1. Identify the changing roles of the commercial manager within the UK construction industry.
2. What are the qualities required of a successful commercial manager within the construction sector?
3. How do clients control their investments and when?
4. How can the contractor control the project?
5. How can a contract contribute to effective project management?

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2 Reports and recommendations

2.1 Introduction

The past decade or so has seen the publication of many significant reports relevant to project management of the built environment (embracing both building and civil engineering), including significantly Latham (1994) and Egan (1998) and those issued by the UK Government's Office of Government Commerce (part of HM Treasury) and the National Audit Office.

These major studies have highlighted the inefficiencies of traditional methods of procuring and managing major projects – in particular, the fallacy of awarding contracts solely on the basis of the lowest price bid, only to see the final price for the work increase significantly through contract variations, with projects often completed late. Indeed, this was often the traditional ploy on major works – submit a low bid in the anticipation of making a profit on the variations and claims.

Experience has shown that acceptance of the lowest price bid does not provide value for money in either the final cost of construction or through-life and operational costs. Relations between the construction industry and government departments have also been typically characterized by conflict and distrust which have contributed to poor performance.

> Estimates of the cost of these inefficient practices are inevitably broad brush, but studies have identified the potential for major savings – 30 per cent in the cost of construction. Specifically by industry adopting a more collaborative approach strongly founded on a competitive process with appropriate risk sharing in which value for money is obtained by all parties through a clear understanding of the project's requirements, transparency as to costs and profits, underpinned by clear understood rights and obligations, and appropriate incentives. More attention to design and early involvement of the whole construction team could also improve the operational efficiency of the completed buildings resulting in potentially greater savings over the whole life of the building.
>
> (NAO, *Modernising Construction*, 2001, p. 4)

It is appropriate to review the recommendations contained within the major reports; the list is not exhaustive but should contain the key criteria for change and enable identification of recommended best practice.

Unlike previous UK Government reports on the construction industry, which were basically ignored, the Latham report *Constructing the Team* (1994) and the Egan report *Rethinking*

Construction (1998) have had a profound impact on the UK construction industry. These reports, together with Egan's follow-up report *Accelerating Change* (2002) have challenged the industry to throw off the old adversarial practices and reinvent itself in order to become world-class.

The UK Government as a best-practice client has instigated major changes in procurement and project management practice. Case studies indicate that the new approaches are having a significant impact on increasing the client's certainty of outcome and value for money.

In the mid-1990s the sharp reversal in fortunes and prospects of most of those in the construction industry, professionals, contractors and suppliers, prompted a radical review of the established practices and procedures. More significantly, it created a willingness to work together to consider changes and how best they be implemented for the benefit of the industry and the clients on whom it depends.

It is important that all those engaged in the construction process understand these changes as they come into effect through parliamentary statute, new forms of contract and codes of practice. All should be conscious of the changed responsibilities and liabilities that will arise and the opportunities as well as risks that they provide for their business.

2.2 The Latham report, *Constructing the Team* (1994)

The terms of reference were to consider the following.

> Current procurement and contractual arrangements; and current roles, responsibilities and performance of the participants including the client with regard to:
>
> - the processes by which clients' requirements are established and presented;
> - methods of procurement;
> - responsibility for the production, management and development of design;
> - organization and management of the construction process;
> - contractual issues and methods of dispute resolution.

The report makes 30 major points to which the industry has responded well. Perhaps most significant was the establishment of the Construction Industry Board (CIB) to which all parties in the industry contributed and supported. A number of working groups were set up under the aegis of the CIB to find ways to implement the report's recommendations.

Main conclusions and recommendations

Clients

Government and private sector:

- set up a new construction clients' forum;
- be best-practice clients;
- publish a Construction Procurement Strategy Code of Practice;
- promote a mechanism for selecting consultants on quality as well as price.

Industry:

- adopt target of 30% real cost reduction by the year 2000;
- improve tendering arrangements/registration (with government);
- draw up a code of practice for selecting subcontractors;

- implement the recent reports on training and the education of professionals;
- improve public image;
- produce coordinated equal opportunities action plan.

Contracts:

- develop standard contract documentation based on a set of principles (including independent adjudication, pre-pricing of variations and Trust Accounts for payments);
- recommendations for increased use of the New Engineering Contract;
- produce a complete standard family of interlocking contract documentation;
- contract committees – restructuring.

Legislation:

- introduce legislation against unfair contracts;
- introduce legislation to underpin adjudication and Trust Account proposals;
- implement Department of Environment working-party proposals on liability legislation;
- introduce mandatory latent-defects insurance.

Sir Michael Latham also identified what a modern contract should contain, which is particularly relevant when considering the contract between the main contractor and the subcontractor.

Panel 2.1 A modern contract

The most effective form of contract in modern conditions should contain the following:

1. A specific duty for all parties to deal fairly with each other, and with their subcontractors, specialists and suppliers, in an atmosphere of mutual cooperation.
2. Firm duties of teamwork, with shared financial motivation to pursue those objectives. These should involve a general presumption to achieve 'win–win' solutions to problems which may arise during the course of the project.
3. A wholly integrated package of documents which clearly defines the roles and duties of all involved, and which is suitable for all types of projects and for any procurement route.
4. Easily comprehensible language and with 'Guidance Notes' attached.
5. Separation of the roles of contract administrator, project or lead manager and adjudicator. The project or lead manager should be clearly defined as the client's representative.
6. A choice of allocation of risks, to be decided as appropriate to each project but then allocated to the party best able to manage, estimate and carry the risk.
7. Taking all reasonable steps to avoid changes to pre-planned works information. But, where variations do occur, they should be priced in advance, with provision for independent adjudication if agreement cannot be reached.
8. Express provisions for assessing interim payments by methods other than monthly valuation, that is, milestones, activity schedules or payment schedules. Such arrangements must also be reflected in the related subcontract documentation. The eventual aim should be to phase out the traditional system of monthly measurement or re-measurement, but meanwhile provision should still be made for it.

9. Clearly setting out the period within which interim payments must be made to all participants in the process, failing which they will have an automatic right to compensation, involving payment of interest at a sufficiently heavy rate to deter slow payment.
10. Provide for secure trust fund routes of payment.
11. While taking all possible steps to avoid conflict on site, providing for speedy dispute resolution if any conflict arises, by a predetermined impartial adjudicator/referee/ expert.
12. Providing for incentives for exceptional performance.
13. Making provision where appropriate for advance mobilization payments (if necessary bonded) to contractors and subcontractors, including in respect of off-site prefabricated materials provided by part of the construction team.

Source: Latham, 1994.

2.3 Levene Efficiency Scrutiny (1995)

Although the Latham report clearly tried to improve performance of the UK construction industry and provide a catalyst for change, further reforms were required especially in the way government departments procured contracts. The Levene Scrutiny focused in greater detail on the role of various government departments and agencies in the procurement of construction work and how they would perform being *best-practice clients* (Efficiency Unit Cabinet Office, 1995).

The review was undertaken with two fundamental aims: to improve value for money in the procurement of public works and to improve the competitiveness of suppliers to government.

The report concluded, as Latham had already stated, that the UK construction industry was in poor shape and that the performance of the government departments was a contributing factor. The report proposed 5 action points, developed into 22 recommendations which were designed to facilitate government departments into managing their projects more effectively, and to encourage the industry to be more proactive and less adversarial.

2.4 *Construction Procurement Guidance*, HM Treasury (1996)

This series of guides were produced following the recommendations of the Latham report (1994) and the Efficiency Scrutiny of Government Construction Procurement (1995). The guidance provided best-practice advice at a strategic level and covered the client's role in the procurement process; they were specifically aimed at encouraging a change in culture.

The reports made up a family of documents comprising:

No. 1 Essential requirements for construction procurement

Set out roles and responsibilities of the investment decision-maker, the project owner and project sponsor and the training they required.

No. 2 Value for money (VFM) in construction procurement

Set out a VFM framework (a structured list of activities undertaken in a project including *approval gateways*, risk and value management techniques and control procedures).

> Best VFM is the optimum combination of whole life cost and quality to meet the customers' requirement.

The National Audit Office (NAO) does not consider that achieving VFM means accepting the lowest bid – they have not criticized a project on these grounds when other considerations were more important. Neither do they wish to stifle innovation through rigid adherence to mechanistic procedures.

No. 3 Appointment of consultants and contractors

Set out the consultancy roles and responsibilities, details of the appointment process and the structure of the project team.

No. 4 Team working, partnering and incentives

Embraced the concept of teamwork declaring that 'Teamwork should be a core requirement for every element of a major project and partnering should be adopted as far as possible on all new and existing contracts. Incentives should be included to provide benefits to clients.'

No. 5 Procurement strategies

Recommended the following procurement strategies: Public–Private Partnerships (PPP), design and construct (and where appropriate maintain and operate), prime contracting and framework agreements; traditional forms of construction procurement should only be used where there is a very clear case that they will deliver better value for money than other procurement routes in terms of whole-life costs and overall performance.

No. 6 Financial aspects of projects

Provided information on preparing budget estimates and dealing with risk allowances.

No. 7 Whole-life costs

This guide identified that the primary purpose of whole-life costs is to provide the investment decision maker with the information necessary to make the best decisions in terms of project strategy and procurement route.

No. 8 Project evaluation and feedback

Identified that project evaluation includes three elements:

- Formal reviews at project gateways (including post-occupancy evaluation);
- Less formal ongoing evaluation and reporting (particularly during the development and construction stages);
- Evaluation and reporting of specific activities.

The fundamental part of project evaluation and feedback is to make sure that lessons learned from one project are transferred effectively to other projects.

No. 9 Benchmarking

The guide considered that the primary purpose of benchmark is to improve the performance of the organization. Benchmarking is a tool that allows organizations to help themselves. It is an essential part of continuous improvement and is a continuous and long-term process and not a one-off instant solution.

2.5 Construction Industry Board (CIB) working groups (1996–1997)

Following Sir Michael Latham's report *Constructing the Team* the CIB representing the professions and consultants, main contractors, subcontractors, clients, materials suppliers and the government produced reports from 12 working groups as follows:

WG1	Briefing the team
WG2	Constructing success
WG3	Code of practice for the selection of subcontractors
WG4	Selecting consultants for the team: balancing quality and price
WG4	Framework for a national register for contractors
WG5	Framework for a national register for consultants
WG6	Training the team
WG7	Constructing a better image
WG8	Tomorrow's team: women and men in construction
WG9	Educating the professional team
WG10	Liability law and latent defects insurance
WG11	Towards a 30% productivity improvement in construction
WG12	Partnering in the team.

The document WG1 *Briefing the Team* contains a checklist for construction productivity – this is essentially the solution to Latham's challenge for the industry to make a 30% real cost reduction. With the benefit of hindsight, see if you can think of any other relevant items which are not included in the WG1 report.

- Change the industry culture;
- Introduce clear, concise and comprehensive standards of briefing;
- Ensure that design and construction processes work as one;
- Foster teamwork and partnership;
- Rationalize project structures;
- Establish industry standards for information technology;
- Make quality the main requirement of all elements of the design and construction process;
- Improve the understanding and effective application of risk-management techniques;
- Health and safety should be part of the cost–benefit analysis;
- Develop standard products, components and processes;
- Prefabrication and preassembly should be part of design considerations;
- Improve designers' knowledge and understanding of the performance of components and materials;
- Designers need urgently to embrace new technologies;
- Life cycles, and whole-life costs of buildings and their fittings must be a principal part of design and maintenance considerations;
- Quality and value must not be ignored in the pursuit of the lowest price;
- The management experience of buildings and projects, and the associated costs, should be constantly fed back to, and adopted by, designers in new designs;
- Benchmarking must be used to measure improvements of practice and productivity;
- Shared construction experience must be given to trainees during their education;

- Focus on research and innovation, integrate current research projects, improve information flow; invest in implementation;
- Establish public relations channel, focus on productivity gains, highlight successes.

2.6 The Egan report *Rethinking Construction* (1998)

Rethinking Construction is the name of the report produced by Sir John Egan's Construction Task Force. The report commissioned by John Prescott, the Deputy Prime Minister, was published in July 1998. The central message of *Rethinking Construction* is that through the application of best practices, the industry and its clients can collectively act to improve their performance.

The *Rethinking Construction* report proposed the creation of a *movement for change* which would be a dynamic, inspirational, non-institutionalized need for radical continuous improvement within the construction industry. The report led to further action to facilitate cultural change; with particular emphasis on the need for involvement of the whole of the supply chain. Another such change was the launch of the Movement for Innovation (M4i) in November 1998, which since 2004 has been part of *Constructing Excellence*.

The report also encouraged the recognition that the industry can and indeed must do much better. This led to M4i capturing 180 demonstration projects submitted by clients and contractors, which exemplified some of the innovations advocated in Sir John Egan's report. Many of the demonstration projects did exceed Sir John Egan's targets in productivity, profits, defects and reduced accidents.

The report can be summarized within the 5:4:7 mantra: five 'drivers' that needed to be in place to secure improvement in construction; four processes that had to be significantly enhanced; seven quantified improvement targets.

Drivers for change

1. Committed leadership
2. Focus on the customer
3. Product team integration
4. Quality-driven agenda
5. Commitment to people.

Improving the process

1. Product development
2. Partnering the supply chain
3. Product implementation
4. Production of components.

Targets for improvement (annual)

1.	Capital cost	−10%
2.	Construction time	−10%
3.	Predictability	+20%
4.	Defects	−20%
5.	Accidents	−20%
6.	Productivity	+10%
7.	Turnover and profits	+10%

To enable the construction industry to achieve the targets, radical changes were identified within the Egan report. One such change was the replacement of traditional contract strategies with integrated supply-chain-led strategies, such as design and build, alongside long-term partnering relationships based on clear measurement of performance and sustained improvements in quality and efficiency, which continued the theme from the earlier Latham report.

Key recommendations within the Egan report were summarized by Bennett and Baird (2001) as follows:

- The industry and its major customers need to rethink construction so as to match the performance of best consumer-led manufacturing and service industries.
- Integrated processes and teams should be introduced as a key driver for change.
- The industry should organize its works so that it offers customers brand-named products, which they can trust to provide reliably good value.
- The industry should work through long-term relationships using partnering, which aims at continuous improvements in performance.
- Benefits from improved performance should be shared on an open, fair basis so that everyone has real motivation to search for better answers.
- Project teams should include design, manufacturing and construction skills from day one so that all aspects of the processes are properly considered.
- Decisions should be guided by feedback from the experience of completed projects so that the industry is able to produce new answers that provide even better value for the customer.
- Standard products should be used in designs wherever possible because they are cheaper and, in the hands of talented designers, can provide buildings that are aesthetically exciting.
- Continuous improvements in performance should be driven by measured targets because they are more effective than using competitive tenders.
- The industry should end its reliance on formal conditions of contract because in soundly based relationships in which the parties recognize the mutual interdependence, contracts add significantly to the cost of projects and add no value to the customer.

One of the more controversial comments made within the Egan report included the following:

> The Task Force wishes to see: an end to the reliance on contracts. Effective partnering does not rest on contracts. Contracts can add significantly to the cost of a project and often add no value for the client. If the relationship between a constructor and employer is soundly based and the parties recognize their mutual interdependence, then formal contract documents should gradually become obsolete. The construction industry may find this revolutionary. So did the motor industry but we have seen non-contractually based relationships between Nissan and its 130 principal suppliers and we know they work.

In reality, this may be a step too far for many within the construction industry.

The targets set by *Rethinking Construction* have been met by several major construction clients. However, after achieving the necessary cost and time reduction for three years in running without the anticipated increase in turnover and profits, there comes a time when contactors begin to wonder whether it has been worth the effort (comment from commercial manager of major contractor in 2004).

The UK Government policies have now increased the need for all public sector clients to fully implement the principles of *Rethinking Construction* which are now firmly established and recognized as best practice.

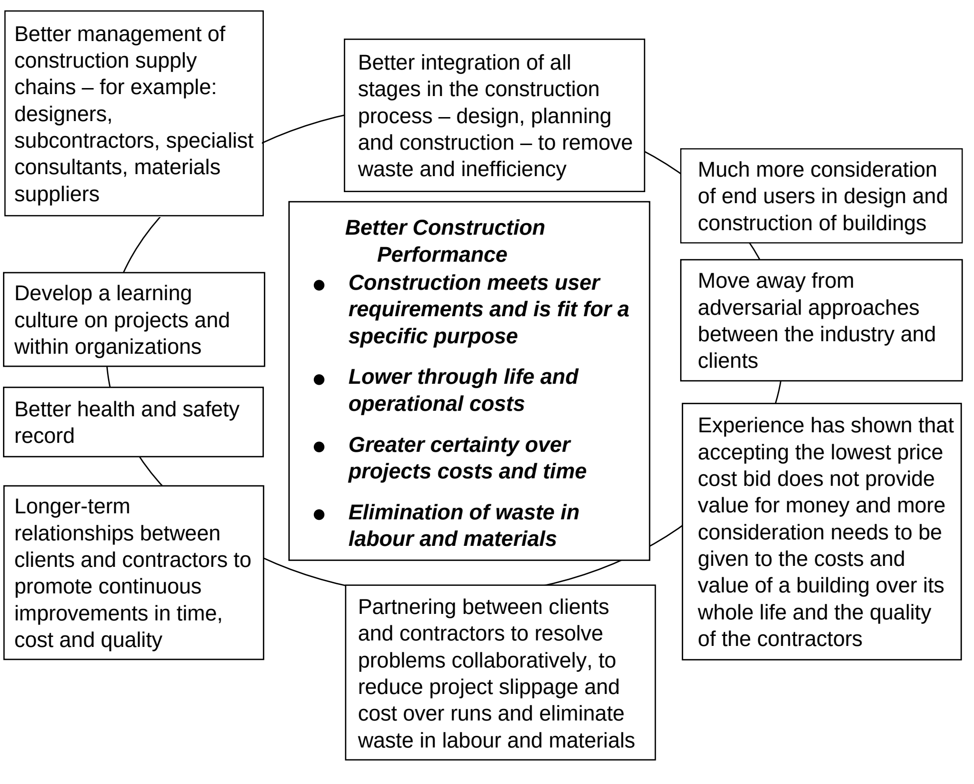
2.7 *Modernising Construction*, National Audit Office (2001)

This report identified how the procurement and delivery of construction projects in the UK could be improved. Its recommendations were made to four key groups: the Department of the Environment, Transport and the Regions, the Office of Government Commerce, line departments commissioning construction projects and the construction industry itself. The main recommendations are summarized as follows (see also Fig. 2.1):

The Department of the Environment, Transport and the Regions

- Provide more coordinated direction to initiatives to promote better performance by the construction industry;
- Use its influence as a Member for Innovation Board to ensure that demonstration projects are truly innovative;
- Develop more sophisticated performance measures, for example, indicators needed to measure:

  a. The operational – through-life running costs of the completed building;
  b. The cost-effectiveness of the construction process;
  c. Quality of completed construction;
  d. Health and safety indicators.



2.1 Better construction performance what is needed? (source: NAO analysis of Latham, Levene and Egan reports, Copyright National Audit office, reproduced with kind permission, reported in *Modernising Construction*, 2001).

The Office of Government Commerce

- Disseminate good practice more widely;

Line departments

- Actively measure improvements in construction performance;
- Train more staff to be effective construction clients.

The construction industry

Make greater use of innovation to improve public sector construction.

2.8 The second Egan report, *Accelerating Change* (2002)

Four years on from the Egan report the Strategic Forum for Construction produced a follow-up report titled *Accelerating Change*. This report tackled some of the barriers to progress against the Egan report's targets and identified ways of accelerating that change.

The vision of the follow-up report was for the UK construction industry to realize maximum value for all clients, end-users and stakeholders and exceed their expectations through consistent delivery of world-class products. The vision is being taken forward by the Strategic Forum for Construction (SFfC), a cross-industry/government body.

The following are the four key areas on which the SFfC focused:

1. Client engagement
2. Integrating teams and supply chains
3. People issues
4. Enhancing the value of the product.

Six headline targets were identified by the SFfC:

Target 1: 20% of construction projects (by value) should be undertaken by integrated teams and supply chains by end of 2004, rising to 50% by end of 2007;
Target 2: 20% of clients to embrace the principles of the Clients' Charter by 2004. Target to increase to 50% by 2007;
Target 3: by 2006, 300,000 qualified people to be recruited and trained in the industry;
Target 4: by 2007, a 50% increase in applications to built environment higher- and further-education courses, and by 2010 an increase in the annual rate of apprentice completions to 13,500;
Target 5: by 2010, a fully trained, qualified and competent workforce on all projects;
Target 6: by the end of 2004, 500 projects to have used the design quality indicators (DQIs). By the end of 2007, 60% of all publicly funded Private Finance Initiative (PFI) projects (having a value in excess of £1 million) to use DQIs and 20% of all projects (having a value in excess of £1 million to use DQIs.

In essence the *Accelerating Change* reinforced the challenges set out in *Rethinking Construction* calling for a most ambitious year-on-year improvement.

2.9 *Achieving Excellence in Construction Procurement Guides*, Office of Government Commerce (2003)

Achieving Excellence was launched in March 1999 to improve the performance of central government departments and other public bodies, following major failures in time and cost overruns. It aimed to provide a step-by-step change in construction procurement performance and value for money achieved by government on construction projects, including maintenance and refurbishment.

The key thrust of *Achieving Excellence* is the delivery of value for money. This is not the lowest cost but the optimum combination of whole-life cost and quality to meet the users' requirement.

The *Achieving Excellence* suite of procurement guides replaced the 1996 *Construction Procurement Guidance* series. The new series reflected developments in construction procurement over recent years and built upon government departments' experience of implementing the *Achieving Excellence in Construction* initiative.

The suite consists of three core and eight supporting documents together with two high-level documents. Electronic versions have hyperlinks across the set and to related products, such as the OGC *Successful Delivery Toolkit* and external websites. The significant OGC *Gateway Process* model is described in detail in the *Achieving Excellence Guide 3 – Project Procurement Lifecycle*.

2.10 *Improving Public Services through Better Construction*, National Audit Office (2005)

Part 3 of the report and the supporting case studies set out examples of good practice which have enabled organizations in both the public and private sectors to improve their construction delivery. The good practices have allowed the completed projects to be delivered on time and to cost and have helped improve the quality of the final built asset. In addition, the report recommended that government departments initiate the following:

1. Create more certainty in the market, with longer-term funding and programme planning;
2. Strengthen their leadership of construction programmes and projects and put in place strategies for developing construction project management capabilities;
3. Engage fully with the Gateway process and obtain independent advice and challenge at the concept and business-case stages when considering potential construction projects;
4. Consider the development of a sustainability action plan to cover all aspects of their construction activity;
5. Make decisions about construction projects based on sustainable whole-life value;
6. Make more transparent to suppliers the criteria for tender evaluation and make the most of their funding and purchasing power to influence suppliers' behaviour;
7. Keep competitive tension in framework and partnering arrangements to provide greater assurance that construction costs represent fair value, and improve the effectiveness of contract strategies to manage better risk and maximize the opportunities for improved performance;
8. Encourage collaborative working through collaborative forms of contract and fair payment practices and seek opportunities to pursue the case for project-wide insurance where appropriate and in agreement with their suppliers;
9. Evaluate the post-completion and occupancy performance of projects in terms of the *Achieving Excellence* strategic targets, whole-life value, including the financial performance and the delivery of better services and sustainable development, and embed the lessons in future activity;
10. Relevant departments should consider developing quantifiable cross-government strategic targets focused on sustainable construction.

Additional recommendations were made to the OGC advising them on the leadership and support which they should provide to all public sector organizations. The report also included a useful self-assessment tool in the form of a *maturity grid* enabling public sector clients to assess their readiness and capability to tackle construction projects and to target areas for improvement.

2.11 Conclusion

These reports have identified a substantial contribution to the construction of best-practice body of knowledge; they have identified the following key issues in order to improve the project management process:

- Leadership and commitment from the client's senior representative;
- Involvement of the key stakeholders throughout the project;
- Roles and responsibilities clearly understood by everyone involved in the project, with clear communication lines;
- An integrated project team consisting of client, designers, constructors and specialist suppliers, with input from facilities managers/operators;
- An integrated procurement process in which design, construction, operation and maintenance are considered as a whole;
- Design that takes account of functionality, appropriate build quality and impact on the environment;
- Commitment to excellence in health and safety performance;
- Risk and value management that involves the entire project team, actively managed throughout the project;
- Award of contract on the basis of best value for money over the whole life of the facility, not lowest tender price;
- Commitment to continuous improvement;
- Commitment to best practice in sustainability.

These factors challenge the industry to produce projects which achieve *best value* with a need to understand the balance between quality and whole-life cost.

2.12 Questions

1. How do the contracts used within your organization score against Sir Michael Latham's recommendations for a modern effective contract? Consider contracts between the employer and the contractor, and the contractor and its subcontractor.
2. An international contractor wins a £50 million project for construction of fast-track, high-rise, city-centre tower block from a major financial institution with whom they've worked many times before. The relationship between the constructor and employer is soundly based. The contract is contained in 120 words on one page including just the name of the client and contractor, their addresses, the project name and location, the design documents, the start and completion dates, contract sum and the payment schedule.

   The client introduces changes and acceleration instructions throughout. The final cost of the project to the contractor is £60 million. The contractor argues that the contract should be valued on cost-reimbursement basis. The client's retort is that the £50 million quoted was on a guaranteed maximum-price basis.

   After three years of bitter negotiating the parties have still not settled and agree to go to arbitration. The lawyer's fees for each side is £5 million and rising!

   a. Is this scenario possible? You decide.
   b. Identify what is the purpose of a contract.

3. Critically compare and contrast the OGC Gateway™ Process with the RIBA Plan of Work. Source: OGC framework for construction procurement: www.ogc.gov.uk/documents/CP0063AEGuide3.pdf (pp. 6–7, accessed 6 June 2007); RIBA Plan of Work: www.a4a.sk/RIBA-outline.htm (accessed 6 June 2007).
4. Identify the changes to practices and procedures which were made within your own organization (either employer or main contractor, and specialist contractor or consultant) in the past decade.
5. Critically review the lessons that the construction industry can learn from other sectors (contained within *Rethinking Construction*).
7. Review one of the five M4i demonstration projects included in *Modernising Construction* (appendices 9 to 13) and make a 10-minute presentation to your peers on the key recommendations.
8. Critically review and identify the key lessons learnt in 1 of the 10 case studies in the National Audit Office Report, Case Studies *Improving Public Services through Better Construction*, 2005 and make a 10-minute presentation to your cohort (source: http://195.92.246.148/nhsestates/procure21/p21_content/home/documents/MkCaseStudy.pdf [accessed 23 March 2007]).

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Useful websites

www.clientsuccess.org.uk (Confederation of Construction Clients)
www.constructingexcellence.org.uk (identifies and disseminates best practice)
www.nao.gov.uk (National Audit Office)
www.ogc.gov.uk (Office of Government Commerce)

Part II

Management of the pre-contract stage

3 Selecting the consultants and contractors

3.1 Introduction

The client is the key member of any team engaged in a construction project and will need to establish means of acting efficiently within the team to ensure the success of the project. Responsibilities of the client are both legal and contractual and include the following:

- Appointment of consultants and contractor(s);
- Health and safety under the CDM regulations;
- Defining and specifying the outcomes required from the project;
- Making appropriate decisions and giving approvals within a set timescale;
- Providing payment to contracted parties for services provided.

The client may also wish to consider at the outset of the project how many of the client's responsibilities they may wish to delegate to the consultant/construction team, for example, through the appointment of a client's representative, the delegation of design or cost decisions, or the entire transfer to others by means of a financing agreement to construct and manage the project.

> It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money – that is all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do.
>
> The common law of business balance prohibits paying a little and getting a lot – it can't be done. If you deal with the lowest bidder, it is well to add something for the risk you run. And if you do that, you will have enough to pay for something better.
>
> (John Ruskin, 1860)

It is now a UK Government requirement that all public sector procurement should be on the basis of value for money (VFM) and not lowest price alone; this philosophy applies to the selection of both consultants and contractors.

The recommendations require that robust mechanisms should be developed to evaluate the quality and price, including whole-life costs, in a fair and transparent manner. Selection procedures are also required to comply with the EU procurement rules where these are applicable.

There are three separate stages in the appointment process of consultants and contractors:

Stage 1 – the initial stage

During the initial stage it is necessary to identify what the consultant or contractor should do under the contract, consideration of the selection options including open, selective or negotiated, identification of specific health and safety requirements, development of the contract requirements and, in the public sector, consideration of the EU procurement directives.

Stage 2 – the selection process

The second stage involves setting the selection and award criteria, inviting expressions of interest, developing a long list and reducing it to a short list. In the public sector this will involve advertising in the *Official Journal of the European Union* (OJEU) – formerly known as the OJEC. On major projects this will normally involve the compilation of a pre-qualification questionnaire.

The selection process will involve the following stages:

- Establishing the selection criteria;
- Developing the weightings for the selection criteria;
- Identifying, where appropriate, the thresholds for the selection criteria;
- Establishing the selection mechanism;
- Inviting expressions of interest/drawing up a long list;
- Drawing up the short list.

Stage 3 – the award process

The third stage involves interviewing and inviting tenders, evaluating tenders, negotiating and awarding the contract and finally debriefing all tenderers.

3.2 Selecting consultants

Consultants and client advisers provide the foundation on which a successful project is constructed. Depending on the client's in-house resource, selected consultants could provide the following functions:

- Design services (single organization could be responsible for all design duties, with other designers appointed as subcontractors; alternatively different organizations could be appointed for each of the key disciplines with the project manager responsible for managing and controlling them);
- Project management (including cost management);
- Value management, risk management, partnering facilitator, facilities management (may be included in project management).

The consultant's brief should describe the services that the consultant is required to carry out precisely. These are dictated by the strategy adopted and whether the services are to be provided individually or in combination.

The project sponsor must also ensure that any authority delegated to the project manager is carefully defined particularly in connection with the following:

- Order variations and make changes;
- Certify interim payments;
- Grant extensions of time;

- Settle claims;
- Agree final accounts.

Developing the model for selecting consultants

Establishing VFM has as much to do with the quality of goods and services as with their price. But there must be a sound basis for evaluation and judgement.

Sir Michael Latham in his 1994 report *Constructing the Team* stated that 'professional consultants should be selected on a basis which properly recognizes quality as well as price.' Working group 4 of the Construction Industry Board (CIB) was established to choose and endorse a quality, price-assessment mechanism for appointing professionals – including architects, engineers, surveyors and project managers.

The principal features of the quality/price mechanism recommended in this report are summarized as follows:

1. The quality/price mechanism should be established by a formally constituted and fully accountable tender board before tenders are invited, and all tender documentation should be designed to ensure that appropriate responses are received to which the mechanism can be applied.
2. A quality/price ratio must be agreed at the outset, representing the percentage weightings to be given to quality and price. The more complex the project, and the greater the degree of innovation and flexibility likely to be required from the consultants, the higher the ratio should be. Indicative ratios suggested for various types of projects are

Type of project	*Indicative quality/price ratio*
Feasibility studies and investigations	85/15
Innovative projects	80/20
Complex projects	70/30
Straightforward projects	50/50
Repeat projects	20/80

3. Quality criteria (see also Table 3.1) should be grouped under four main headings and weighted. Recommended headings and suggested weightings are

Quality criteria	*Suggested weighting range (%)*
Practice or company	20–30
Project organization	15–25
Key project personnel	30–40
Project execution	20–30

4. A quality threshold needs to be established (e.g. 65 out of 100). Tenders must achieve this minimum quality score before final interviews are held and prices considered.
5. Submitted tenders are assessed for quality by marking each of the 4 quality criteria out of 100, multiplying each mark by the respective weighting percentage and then adding them together to give a total score out of 100.
6. Consultants passing the quality threshold (ideally only two to three) are then interviewed, their quality scores are reviewed and their prices examined and marked. The lowest compliant bid scores 100 and others score 100 minus the percentage figure above the lowest prices (e.g. a bid 25% above the lowest scores 75).

Table 3.1 Project-specific criteria.

Generic quality criteria (marked out of 100)	*Key aspects*	*Suggested weighting range (%)*
Practice or company	Organization Financial status Professional indemnity insurance Quality assurance or equivalent system Commitment and enthusiasm Workload and resources Management systems Relevant experience Ability to innovate References	20–30
Project organization	Organization of project team Authority levels of team members Logistics related to site, client and other consultants Planning and programming expertise	15–25
Key project personnel	Qualifications and experience relevant to project Understanding of project brief Flair, commitment and enthusiasm Compatibility with client and other team members Communication skills References	30–40
Project execution	Programme, method and approach Management and control procedures Resources to be applied to the project Environmental, health and safety matters	20–30

The final quality/price assessment (Table 3.2) is achieved by multiplying the quality and price scores by the respective weightings set by the quality/price ratio and adding them together to give a total score out of 100 (e.g. if the quality/price ratio is set at 65/35, the quality score is 69 and the price score is 100, the total score is $69 \times 65\% + 100 \times 35\% = 79.9$. The highest-scoring consultant should be awarded the contract.

The Construction Industry Council (a body representing all the professions) has developed a tool called *Selecting the Team* to help clients create a team able to work together successfully. It offers practical advice on how to put together a selection panel, develop a questionnaire, set the criteria for a shortlist and then evaluate the short-listed candidates. This publication complements two other CIC-partnering publications – *A Guide to Partnering Workshops* and *A Guide to Project Team Partnering*.

Basis of payment to consultants

There are three principal ways of paying for professional services (sometimes used in combination):

1. Time charge
2. Lump sum
3. *Ad valorem* – according to value.

Table 3.2 Example of completed tender assessment sheet.

Tender assessment sheet

Project: Halls of residence, University of Metropolis
Tenderer: bmg (Architectural services)
Assessor: Keith Potts
Project quality weighting: 65%
Project price weighting: 35%
Quality threshold: 65 (to be compared with total quality mark)

Quality threshold	*Project weighting (A)*	*Marks awarded (B out of 100)*	*Weighted marks (A x B)*
Practice or company	25%	64	16
Project organization	15%	80	12
Key project personnel	40%	65	26
Project execution	20%	75	15
	100%	Total quality score	69
Price criteria			
Tender price	260 (lowest compliant bid)		
Price score	100%	100	100

Overall assessment
Quality weighting x quality score = 65% x 69 = 44.9
Price weighting x price score = 35% x 100 = 35.0
Overall score 79.9
Signed:
Date:

The fee structure to be adopted will depend on the degree of certainty in the scope and content of the services required. When the scope and content of the services are uncertain, for example, during the appraisal of options, then reimbursement on a time basis is appropriate. However, time charges provide no surety of the eventual fee cost. They tend to be an expensive way of paying for longer-term services and are more appropriate for shorter-term commissions.

Lump-sum charges should only be used where the scope of all the services is defined precisely and there is little risk of significant variations in the scope of the works. A combination of lump-sum charges for the more certain elements of the work, and time charges for those less certain, may offer best VFM.

Ad valorem fee structures reimburse consultants in proportion (generally as a percentage) to the cost of the project.

From the client's viewpoint they may appear at times to provide an incentive for consultants to design expensive projects rather than those offering VFM. It may therefore be appropriate to introduce some form of abatement or capping mechanism to the fee structure, in order to underline the necessity of striving to contain certain costs while maintaining quality. However, great care should be taken when developing such a model in order not to penalize those who are not responsible for changes or who have carried out abortive work or had to provide additional services as a result of the changes caused by other parties.

If the consultants' fees are calculated based on the final construction cost during times of high inflation then there may be an overpayment, known as an *uncovenanted gain*, as the majority of consultants' work is usually carried out during the early stages of the project.

Panel 3.1 Case study: Scottish Parliament building

On the Scottish Parliament building each consultant's fee remuneration was wholly or mainly a percentage value of the approved construction cost of the project.

In the 2004 Audit Report on the Scottish Parliament building, the Auditor General for Scotland identified that before they appointed consultants the client's project management could have explored more carefully the alternative fee arrangements with its consultants including final incentives linked to delivering value for money. 'Percentage fees do not align the objectives of the client with the commercial objectives of the consulting firms because the more a project costs the more each consultant is paid.'

In the event, a fee cap was agreed with cost consultants and the service engineer 12 months before completion. The final fees with the architect had not been finalized three months before completion whilst the final payment to the construction manager was uncertain due to the qualified nature of the agreed cap with them.

Source: Audit General for Scotland, 2004.

3.3 Selecting contractors by value

The principal aim of the selection process is to select a contractor who offers VFM. This will nearly always involve a process of competitive tendering. 'Value for money for a particular project means optimizing the balance between best performance or quality of service and lowest price' (OGC, *Successful Delivery Toolkit*, 2005).

A very useful approach to tender evaluation is to use a quality/price mechanism which is based on a numerical scoring and weighting system. The advantages of this approach include the following:

- It formalizes what can be a very subjective process;
- It requires forethought as to what are the most important criteria for selection;
- It can be transparent;
- It can be audited.

Traditionally, there have been three types of appointment procedure:

1. *Open tendering*: all interested parties can submit tenders in response to an advertisement in a local or national newspaper or the *Official Journal to the European Union* (OJEU) notice. Normally a small deposit is required which is refundable on submission of a bona fide tender.

   The open-tendering approach is an inefficient use of the industry's resource. It can lead to an excessive number of tenders with the lowest tender being a highly risky choice; it is not recommended.
2. *Selective or restrictive tendering*: allows the number of organizations to be restricted by using a selection process in advance of tender invitation. Under this approach client bodies who are regular users of the industry can keep standing lists, which should be reviewed annually, for different values and types of work. For major one-off projects, contractors can be selected for tender using a pre-qualification questionnaire.

3. *Negotiated tendering*: available in two forms:

   a. Competitive – enables clients to negotiate the terms with selected bidders and may include a formal tender stage prior to negotiation.
   b. Without a call for competition – used in only the most exceptional circumstances for example emergency storm-damage repair.

The selection process

The selection process produces a short list of the most suitable organizations from those that expressed an interest in carrying out the project. The selection process must be objective, fair, accountable and transparent with the criteria for selection established before inviting expressions of interest.

The selection process consists of the following steps:

- Identify the selection criteria;
- Establish the weighting;
- Identify the minimum thresholds for selection criteria, where appropriate;
- Construct the selection mechanism;
- Invite expressions of interest;
- Draw up a long list;
- Draw up the short list.

The selection criteria for contractors should be based on attributes that fall under the following headings:

The contractor's personal and financial standing

Whether the contractor is financially stable and/or has the backing of a large group. Such assessment normally includes examination of accounts, annual reports (if a public company) or a confidential report from the company's bank.

Under this heading a company would not be suitable for selection on the following grounds: bankruptcy, failure to pay taxes, serious misrepresentation, grave misconduct or conviction of a criminal offence.

Technical and organizational ability

Whether the contractor has sufficient experience in the particular type and magnitude of works and has a satisfactory performance reputation in such areas as available resources; design expertise; experience of partnering, supply-chain management in force with subcontractors and suppliers; policy on risk management, for example, terms of subcontracts, history of rejected claims, skill/qualifications profile of workforce (own and key subcontractors), quality management; health and safety record.

Considerable care and effort will be required to set appropriate selection criteria for individual projects in order to make sure that only suitable contactors are selected.

Table 3.3 shows an example of a selection mechanism and demonstrates how the selection criteria and the weightings applied to them are used to evaluate each organization.

Table 3.3 Example of selection mechanism for contractors.

Project title: Baywatch Holiday Village
Assessors:
Overall quality threshold: 50
Mightybuild construction plc

Financial standing

Selection criteria	*Quality threshold (QT)*	*QT reached?*
Bankruptcy, convictions, misconduct etc.	Clean record	Yes
Profit and loss for last three years		Yes
Public liability insurance		Yes
Professional indemnity insurance (where applicable)		Yes

Technical and organizational

Selection criteria	*Criteria weighting (a)*	*Score awarded (b)*	*Weighted score (a x b)*
Relevant technical experience	20	80	16.00
Resources relevant to the project	10	70	7.00
Relevant design experience	15	60	9.00
Past performance on teamwork/partnering	15	30	4.50
Past performance on risk/value management	10	50	5.00
Rejected claims history	10	10	1.00
Health and safety record	10	70	7.00
Quality assurance	10	60	6.00
Total	100		55.50

The award process

The award process looks *forward* at the proposals for the specific contract whereas the selection process looks *back* at the status and previous performance of the bidders. The award criteria must be identified before inviting tenders and must be confirmed in the *instructions to tenderers.*

The award process is separate and distinct from the selection process. The award must be made on a *VFM basis* (value for money, that is, the most economically advantageous to the client) and not on lowest cost alone.

The award process comprises the following activities:

- Confirm candidates;
- Establish award criteria, weightings for award criteria, quality/price ratio, award mechanism, price scoring;
- Evaluate quality element;
- Prepare instructions to tenderers;
- Invite tenders;
- Evaluate *price* element;
- Balance quality and price;
- Notify award and debriefing.

Table 3.3 shows that Mightybuild Construction passed the initial financial-standing and technical/organizational tests with a score 55.50 (above the minimum threshold of 50) – they can therefore be considered for selection. However, it should be noted that although they have a good technical and design record, their performance on partnering and claims is not good. In fact, Mightybuild are currently involved in adjudication/litigation on 25% of their existing projects; potential problems may lie ahead for the client if Mightybuild are selected!

Evaluating quality

The quality evaluation of each short-listed firm will normally be based on a pre-tender interview, which is often preceded by the completion of a pre-interview questionnaire. The quality scores should be established before the price bids are opened. Mightybuild usually score well at such interviews, indeed their competitors have observed that Mightybuild have a policy of sending the 'A' team to interviews and the 'Z' team to carry out the project!

Topics likely to be considered within *Quality* include the following:

- *Team-working arrangements*: partnering with client and subcontractors;
- *Aesthetic and functional characteristics*: design, operating costs, ease of use, adaptability, innovation, maintainability;
- *Proposals for managing the contract*: planning, programming, management, milestones for achieving objectives, risk identification and proposals for management, communication, quality plan;
- *Project team organization*: qualifications and experience of team members, senior managers, partners, quality of senior personnel, resources;
- *Technical merit*: proposed methods, approach to CDM Regulations, health and safety management, the design and construction stages, quality of documentation, standards of materials, checks and inspections;
- *Services provided from external sources*: details of joint-venture proposal, arrangements for subcontracting, training amongst workforce in the supply chain.

Table 3.4 indicates typical quality/price ratios for different types of project.

Evaluating the price

There are various methods of evaluating a contractor's tender price; one method requires the following approach:

- The *mean* price of the acceptable tenders is given 50 points;
- One point is deducted from the score of each tenderer for each percentage point above the mean;
- One point is added to the score of each tenderer for each percentage point below the mean.

Unjustifiably low tenders should be rejected and not included in the assessment.

Table 3.4 Typical quality/price ratios for different types of projects.

Type of project	*Indicative quality/price ratio*
Innovative projects	20/80 to 40/60
Complex projects	15/85 to 35/65
Straightforward projects	10/90 to 25/75
Repeat projects	5/95 to 10/90

So in the example shown in Table 3.5 the mean price is £7,717,000

Alpha	50.00 + 6.05 = 56.05
Mightybuild	50.00 − 8.20 = 41.80
Zed construct	50.00 + 2.16 = 52.16

Comments: After multiplying the *quality* scores by 60% and the *price* scores by 40% the award mechanism shows that the contract should be awarded to Mightybuild (Table 3.5).

Table 3.5 Award mechanism.

Project title: Baywatch Holiday Village
Quality/price weighting: 60:40
Assessors:

Quality scores

Quality criteria	*Criteria weight (%)*	*Alpha construction*		*Mightybuild construction*		*Zed construct*	
		Score	*Wtd score*	*Score*	*Wtd score*	*Score*	*Wtd score*
Proposals for and understanding of project	30	60	18.00	80	24.00	70	21.00
Experience and resources of proposed project team	20	55	11.00	90	18.00	50	10.00
Project management/ team working skills	10	70	7.00	60	6.00	50	5.00
Risk management skills and experience	10	55	5.50	70	7.00	60	6.00
Aesthetic character of proposals	15	70	10.50	70	10.50	80	12.00
Maintainability	15	50	7.50	60	9.00	70	10.50
Total quality			59.50		74.50		64.50

Price scores

	Alpha construction	*Mightybuild construction*	*Zed construct*
Tender price	£7,250,000	£8,350,000	£7,550,000
Total Price (mean £7,717,000)	56.05	41.80	52.16

Overall scores

	Alpha construction	*Mightybuild construction*	*Zed construct*
Quality weighting x quality score	60% x 59.50 = 35.70	60% x 74.50 = 44.70	60% x 64.50 = 38.70
Price weighting x price score	40% x 56.05 = 22.42	40% x 41.80 = 16.72	40% x 52.16 = 20.86
Overall score	58.12	61.42	59.56
Order of tenders	3	1	2

However, in compiling the table, the author identified two major areas of difficulty in developing the quality part of the model, particularly:

1. identifying the key criteria and the relevant weighting;
2. identifying a realistic score against the criteria for each contractor.

3.4 Construction Industry Research and Information Association (CIRIA) Guide – *Selecting Contractors by Value*

In 1998 the CIRIA produced the definitive guide *Selecting Contractors by Value* (Jackson-Robbins, 1998). The guide provides an overview of the key processes in selecting contractors by value.

The guide identified the following key issues to be considered in the selection of contractors:

1. Defining value – what represents value to the client?
2. Identifying opportunities for contractors to add value – where can contractors add value to the project?
3. Developing the procurement strategy to secure value – when and how can contractors be involved?
4. Defining the selection criteria – how can potential contractors be judged?
5. Obtaining information – how can a full picture be obtained of potential contractors?
6. Making the choice – how can a balanced and accountable selection be made?

The CIRIA guide includes a toolbox comprising 12 matrices which are intended to help clients and their advisers compare the ability of potential contractors to add value to a project.

Matrix 1: technical knowledge and skill;
Matrices 2–8: skill and commitment in managing time, cost, quality, risk, health and safety, environmental issues;
Matrix 9: effectiveness of contractor's internal organization;
Matrix 10: contractor's attitude and culture;
Matrix 11: quality of human resources proposed (see Table 3.6);
Matrix 12: quality of supply-chain management.

Each matrix contains up to six indicators against which there are definitions allowing the scorer to judge the contractor to be *poor, adequate, good* or *excellent*.

The total scores can be calculated against each matrix to arrive at a total weighted score similar to Table 3.2. The CIRIA toolbox removes some of the subjectivity involved in the process by giving definitions against each attribute, thus making the process more transparent and auditable.

Significantly, the author of the CIRIA guide admits that the final scores of even the most sophisticated matrix should only be used as an aid to making a judgement. The guide advises that the selection should critically assess the numerical results and if necessary test them, for example, by carrying out a sensitivity analysis. Would you recommend Mightybuild?

Table 3.6 Matrix 11: human resources – indicator 4.

Company employment policy	*Regular use of agency staff*	*Staff regularly employed, with reasonable lengths of service*	*Company training policy, including staff appraisals/development programme*	*'Investors in people' award, loyal and enthusiastic employees*
Overall assessment	Poor (−1)	Adequate (0)	Good (1)	Excellent (2)

Source: CIRIA, 1998.

Panel 3.2 Case study: Stoke-on-Trent Cultural Quarter

The appointment of an appropriate management contractor was a key decision for this project. The Council made use of a methodology, Most Economically Advantageous Tender (MEAT) that was starting to be used in the public sector.

The MEAT methodology scores each bid against a range of qualitative and quantitative factors. The Council officers decided that quality would account for 60% of evaluation, which would be assessed at interview and included previous management contracting experience and experience of working on theatres and concert halls. Cost would count for 40%, the calculation being based by the extent, which the bids were above or below the average cost of all the bids.

The Council invited five potential contractors to attend interviews and submit tenders – one contractor was deleted.

	Norwest Holst	*Tilbury Douglas*	*Bovis*	*Sunley Turriff*
Interview	344	380	470	362
Tender	300	225	113	163
Total	644	605	583	525
Fee	£1,264,188	£1,398,973	£1,602,924	£1,510,938

Norwest Holst secured the highest number of points: 644. However, they were ranked last in relation to quality assessment. The procurement route was non-traditional with a high degree of risk, therefore, the contractor's experience of management contracting was essential. Bovis had the most experience of both management contracting and refurbishment of theatres, Norwest Holst had the least relevant experience – yet were selected.

The project cost the Council £15 million more than the original budget of £22 million yielding a total spend of £37 million.

For a fuller description on this case study see Chapter 11 (Panel 11.2).

Source: Audit Commission: District Auditor's Report on Cultural Quarter Stoke-on-Trent City Council, 22 January 2004.

The Stoke Cultural Quarter case study indicates the care which must be taken in the initial selection of contractors.

In November 2005, ICC Credit one of the UK's leading credit-reference agencies reported that Sunley Turriff Construction Limited, based in Manchester, had gone into liquidation. The company was established in 1993. Over the 12-year period, the company went through a number of ups and downs. In 1998 the company achieved its highest turnover of £95 million. However, its profit record failed to perform as well. Over the last seven years the company was not profitable and in 1995, its profit slumped to a negative figure of £4.5 million and remained in the red for the rest of its existence (www-icc-credit.co.uk [accessed January 2007]).

Using the selection methodology described in the Baywatch Holiday Village example, Sunley Turriff would not have passed the financial standing section within the quality threshold and so would not have been included in the short list.

3.5 Two-stage tendering

Two-stage tendering is a procedure typically used to secure the early appointment of a contractor under a lump-sum contract. The main benefits of this approach are early completion and the potential to include the contractor's buildability expertise within the design. In addition, this approach allows the client to have a greater involvement in the pre-selection and appointment of subcontractors.

The two-stage process involves the following:

1. *Pre-qualification*: main contractor tenderers;
2. *Compile first-stage tender based on*: programme – method statement, pre-construction fee, preliminaries – overheads and profit – initial pricing of packages;
3. *Identification of preferred contractor*: pre-contract services agreement;
4. *Pre-qualification*: tender of subcontract packages;
5. *Subcontractor*: selection by employer and contractor (allows for novation of client-appointed specialists);
6. *Compile second-stage tender*: first-stage contractor; agreement of subcontract terms; risk allowances;
7. Agreement of second-stage, lump-sum tender;
8. *Award of main contract*: commencement of works and subcontractor appointment.

The second stage, which is typically managed as negotiation between employer and the preferred contractor relies on competition between second-tier contractors for work packages.

The two-stage tendering, should in theory, be well suited to design and build projects. However, while this approach should give the client additional control over the design development and the transfer of risk to the contractor, it normally comes at a premium price. For a fuller commentary on two-stage tendering see Simon Rawlinson's article in the *Building* magazine, 12 May 2006.

An economic market forecast by Davis Langdon in the *Building* magazine reported that in London 'Contractors are unwilling to take unattractive procurement routes. It is difficult to attract interest in single stage design-and-build projects with contractors more interested in two-stage design and build on traditional routes. Furthermore, two stage tenders have increasingly become contractors' preferred approach for complex projects and some projects cannot be let by any other means' (Fordham, P., 2007).

3.6 FIDIC tendering procedures

The FIDIC document *Tendering Procedure*, 2nd edition (FIDIC 1994) presents a systematic approach for tendering and awarding of contracts for international construction projects. Experience has shown that pre-qualification is desirable since it enables the employer/engineer to establish the competence of companies subsequently invited to tender.

The *Tendering Procedure* shows the following flowchart of activities:

1.0 Establishment of project strategy;
2.1 Preparation of pre-qualification documents;
2.2 Invitation to pre-qualify;
2.3 Issue and submission of pre-qualification documents;
2.4 Analysis of pre-qualification applications;
2.5 Selection of tenders;
2.6 Notification of applicants;

3.1 Preparation of tender documents;
3.2 Issue of tender documents;
3.3 Visit to site by tenderers;
3.4 Tenderers queries;
3.5 Addenda to tender documents;
3.6 Submission and receipt of tenders;
4.1 Opening of tenders;
5.1 Review of tenders;
5.2 Tenders containing deviations;
5.3 Adjudication of tenders;
5.4 Rejection of all tenders;
6.0 Award of contract;
6.1 Issue letter of acceptance;
6.2 Performance security;
6.3 Preparation of contract agreement;
6.4 Notification of unsuccessful tenderers.

Under section 5.3 Adjudication of tenders, the tendering procedures identify that the evaluation of tenders are generally considered to have three components:

Technical evaluation

- conformity with specification and drawings;
- comparison of any proposed alternatives (if allowable) with the requirements of the tender documents;
- design aspects for which the contractor is responsible;
- methods of construction and temporary works;
- environmental considerations;
- quality assurance;
- programme.

Panel 3.3 FIDIC tendering procedure

The FIDIC document *Tendering Procedure* gives guidelines on the analysis of pre-qualification applications – the evaluations should determine, for each company or joint venture:

- Structure and organization;
- Experience in both type of work and the country or region in which it is to be undertaken;
- Available resources, in terms of management capability, technical staff, construction and fabrication facilities, maintenance and training facilities, or other relevant factors;
- Quality assurance procedures and environmental policy;
- Extent to which any work would be likely to be subcontracted;
- Financial stability and resources necessary to execute the project;
- General suitability, taking into account any potential language difficulties;
- Litigation or arbitration history.

Source: FIDIC, 1994.

Financial evaluation

- capital cost;
- discounted cash flow and NPV;
- programme of payments;
- financing arrangements;
- currencies;
- securities;
- interest rates;
- down payments/retentions;
- daywork rates;
- contract price adjustment proposals.

General contractual and administrative evaluation

- conformity with instructions to tenderers;
- completeness of tenders;
- validity of tenders;
- exclusions and deviations – stated or implied;
- insurance;
- experience of key staff;
- shipping, customs, transport;
- working hours;
- labour build-up, run-down and source.

It is noted that the FIDIC contract highlights the importance of assessing tenders on a net present value (NPV) basis. The technique is also recommended by the World Bank yet it is rarely encountered in standard UK contracts. This powerful tool enables an equitable comparison to be made of all the tenderers' forecasted project cash flows on a present-day cost basis. The challenge for the client's commercial advisers is devising a tendering system that allows an NPV comparison to be made.

Panel 3.4 Case study: tender assessment – international mega project based on FIDIC

The assessment of tenders was carried out in two stages. The first stage involved a coarse assessment of all tenders to identify the tenders to be considered in depth. The second stage involved a detailed appraisal and examination of the most favoured tenders together with negotiation with tenderers, as appropriate, leading to final recommendation.

The tender assessments were carried out by groups reporting to the Chairman and Executive. The activities involved included the following:

Finance department

Examine financial package; check front loading; bring all tenders back to Net Present Value utilizing the Interim Payment Schedule included in the tender; arithmetical check of BofQs; check alternative offers; identify most favourable in financial terms.

Contracts/legal department

Examine the covering letter and all qualifying statements; indicate cost and time implications of qualifications.

Programming department

Check that the tenderers programme adheres to schedules of milestones and critical dates identified in the contract documentation.

Consultants/civil engineering department

Examine alternative design offers and recommend any which warrants further consideration and advise on any planning implication; examine method statement to highlight any anomalies and areas of non-acceptance; prepare detailed cost comparison to enable cost centres and activity bills to be compared with employer's estimate.

Utilities and civil planning

Evaluate the implications of the tenderers submission on traffic, land access and utility diversions.

At the second-stage assessment, a detailed study would be undertaken and questions of clarification would be developed. Following the issue of the questions to the tenderers and receipt of the answers, all outstanding matters would be clarified. The confirmation wrap-up letters would be incorporated into the contract.

3.7 Conclusion

We have now examined the procedures for selection of both consultants and contractors in the UK and overseas. In the UK, as part of the VFM process demanded by the government, there has been a shift by public sector clients to selection based not only on lowest price but also embracing *quality* issues.

Over the past decade many significant guides have been published by the Construction Industry Council and CIRIA in order to assist clients and their consultants in developing best practice. However, the Baywatch hypothetical case study and the Stoke-on-Trent Cultural Quarter case study demonstrate that even when *quality* issues are incorporated into the selection process of the project, major problems can still arise.

3.8 Questions

1. The University of Metropolis wishes to appoint the client's project manager with full responsibility for controlling and managing the time, cost and quality on the new £25 million Learning Centre and Teaching facility. The Executive of the university understands that the construction industry is now committed to providing best value for its clients and is keen that this philosophy is adopted by all its consultants.

   Describe the pre-qualification selection process and identify the criteria for the short list to tender.

2. Access the OJEC website (www.ojec.com) and identify the following:
   a. What does OJEU mean?
   b. Which projects are covered by its regulations?
   c. What are the public procurement thresholds?
   d. What criteria are used to evaluate tenders?
   e. What process is followed?
3. In June 1998 the Foreign and Commonwealth Office (FCO) signed a contract for the construction, operation and financing of a new embassy in Berlin with a German supplier called Arteos which had been formed by a consortium comprising Bilfinger + Berger, one of the three biggest German construction companies, and Johnson Controls, a large American-based facilities management provider. The construction was completed in 2000. Review the techniques used in the selection of Arteos on this PFI project (www.nao.org.uk/publications/nao_reports/9900585.pdf [accessed 4 February 2007]).

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4 Pre-contract cost management

4.1 Introduction

Cost management is the process, which is necessary to ensure that the planned development of a design and procurement of a project is such that the price for its construction provides value for money (VFM) and is within the limits anticipated by the client.

Construction is a major capital expenditure, which clients do not commence until they are certain that there is a benefit. This benefit may be for society in the case of public projects, with justification based on a cost–benefit analysis, or purely based on financial considerations in the case of private projects.

Most clients are working within tight pre-defined budgets, which are often part of a larger overall scheme. If the budget is exceeded or the quality not met the scheme could fail. Pre-contract estimating sets the original budget – forecasting the likely expenditure to the client. This budget should be used positively to ensure that the design stays within the scope of the original scheme.

When developing an estimate the following factors need to be considered:

- Land acquisition including legal fees;
- Client's own organization costs allocated to the project (this obviously varies but can be as much as 10% of the overall project budget);
- Site investigation (frequently underrated and under-budgeted resulting in unnecessary extra costs and time – could be as much as 1% of budget);
- Enabling works, decontamination;
- Insurances (many major clients prefer to insure against the risks and take out a project insurance policy covering both themselves and the contractor – may be up to 1% of the budget);
- Consultants' fees including design (on large transportation and infrastructure projects this can be as much as 15–20% of the budget);
- Construction costs (typically account for between 70% and 80% of the project sum) (excluding land);
- Value added tax (VAT) (currently charged at 17.5%);
- Contingency and risks (covers for the unknown and may be between 20% and 25%) or if project of long duration the contingency factor could be double or triple these items;
- Financing and legal costs (financing costs can be substantial depending on financing method chosen and typical bank rate – could be anything between 7% and 20%; lawyers are expensive – anything up to £500 per hour and more).

Cost control has to be exercised before any commitment is made. To do otherwise sees cost control become a procedure of cost monitoring only. Pre-contract financial control therefore should be a proper mix between design-cost control and cost monitoring but with the emphasis on positive cost control rather than passive monitoring. An essential tool for financial control is the cost plan.

However, in practice, the difficulties of estimate production is exacerbated when the project involves major uncertainties; perhaps because no similar work has been tackled before, or because the scope of the work is poorly defined (Swinnerton, 1995). The Scottish Parliament Building is a prime example being a unique building with a poorly defined brief – initial budget £40 million and the final cost reported to be £431 million.

4.2 Cost estimating on engineering, manufacturing and process industries

Estimates of the cost and time are prepared and revised at many stages throughout the project cycle. These are all predictions and should not be considered 100% accurate. The degree of realism and confidence achieved will depend on the level of definition of the work and the extent of the risk and uncertainty. Consequently, as the design develops, the accuracy of the estimate should improve.

The Joint Development Board's publication, *Industrial Engineering Projects,* demonstrates this principle of estimating accuracy clearly in connection with capital projects in Engineering, Manufacturing and Process Industries (JDB, 1997; see Fig. 4.1). The JDB is sponsored by the Royal Institution of Chartered Surveyors and the Association of Cost Engineers, and is charged with raising the profile of project and commercial management in the engineering industry.

The JDB document identifies four main types of estimate, which could be produced by the owner or contractor, each with a different level of accuracy and each used at different stages throughout the project cycle.

Order of magnitude estimate

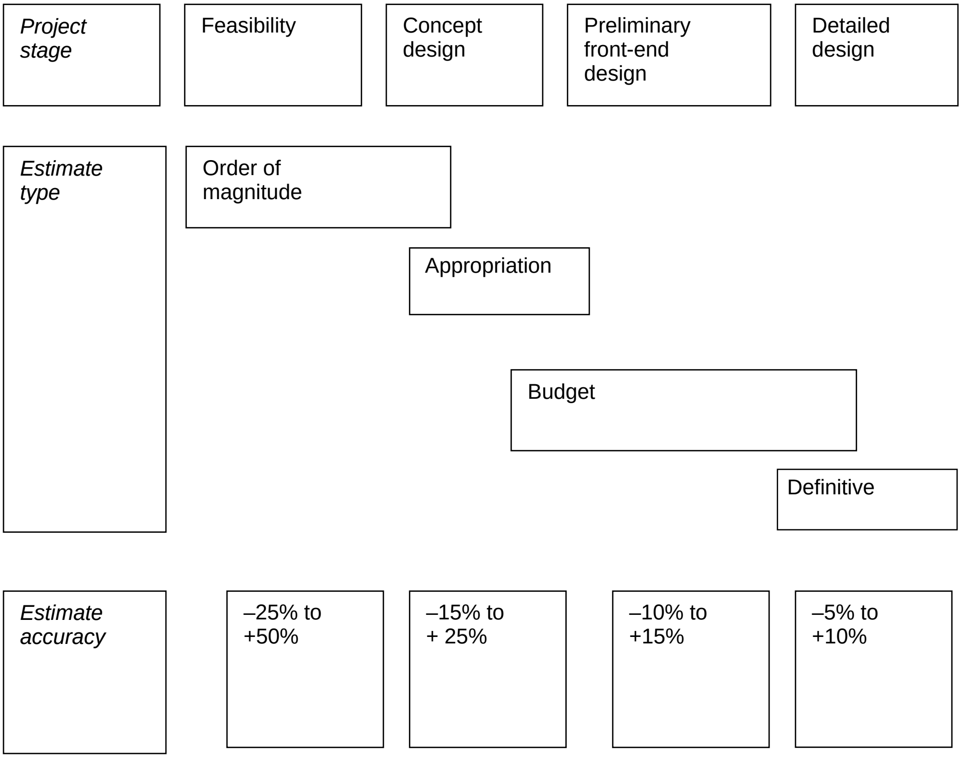
This order of magnitude or *ballpark* is produced for the rapid evaluation of commercial possibilities and economic viability of a project. Since little detail will be normally available the estimate will usually be based on data from a similar previous project updated for time, location, changes in market conditions, current design requirements and relative capacity.

In the absence of data from a near-duplicate project, the estimator will rely on published or historical data from a number of existing projects, usually related to the overall size or capacity of the project or facility concerned, adjusted as necessary. An order of magnitude estimate will typically have an accuracy of –25% to +50% (JDB, 1997).

Typical examples of this type of estimating include the following:

- Cost per megawatt capacity of power stations;
- Cost per kilometre of highway;
- Cost per tonne of product output for process plants;
- Cost per car park space (multi-storey car park), pupil (school), beds (hospital) etc.

The key issue to consider when using this approach is comparing like with like: Are the standards the same in the previous projects? Does the price include infrastructure? Are professional fees and financing costs included etc.? Despite these concerns an order of magnitude estimate can be useful, particularly at the conceptual stages of projects when information is very limited and alternatives have to be ranked quickly (Norman, 1994).



4.1 Estimating accuracy in industrial engineering projects (source: JDB, 1997).

This approach is probably realistic for all complex major projects, including civil engineering and building. It is based on the concept that the degree of accuracy of the estimate is only as good as the level of detail available. In practice, clients often demand certainty of outcome from inception requiring the design team to successfully manage the development of the design within the initial budget.

Appropriation estimate

In the engineering and process industries, the appropriation estimate is sometimes referred to as the Class III estimate as it uses information developed to a level of definition described as Class III. At this stage the designers will have identified the major equipment and determined their required outputs. This will provide an opportunity to enable the estimator to make enquiries of potential suppliers regarding the availability and price of key components. The appropriation estimate will typically have an accuracy of –15% to +25% (JDB, 1997).

Budget estimate

In the engineering and process industries, the budget estimate is sometimes referred to as the Class II estimate and is produced once the conceptual design has been completed. The budget estimate will typically have an accuracy of –10% to +15% (JDB, 1997). In those same industries information available at this stage will allow for approximate quantities to be established and guide prices obtained from potential vendors.

Definitive estimate

In the engineering and process industries, the final estimate produced immediately following commitment to the major capital expenditure is the definitive or Class I estimate with an accuracy in the range of –5% to +10% (JDB, 1997).

This estimate will typically contain the level of detail used in the execution of projects and the preparation of bids. It will be used in the maintenance of close control over the cost of the work, or for allocation of resources into work packages.

The order of magnitude estimate takes a *top-down* approach, probably based on the final cost of previous projects. In contrast, the definitive estimate takes a *bottom-up* approach; the estimate is built up from specific project information and realistically may therefore contain omissions for risks and uncertainties.

4.3 Cost estimating on civil engineering projects

In carrying out cost management there should be a clearly defined route from feasibility stage through to the placement of a contract. There should be break points, or gateways, when the client can take the decision whether to proceed or not. This is in line with the recommendations by the Office of Government Commerce in their Gateway Review Process.

One of the benefits of cost management in the pre-contract stage, especially in multi-contract projects, is that it helps the project team to better establish the appropriate project contract strategy. That is, which work should be placed in which contract and possibly the form of contract which should be adopted for particular contracts. Cost management can also help identify possible programme restraints both in contract preparation and execution.

The preparation of the first estimate would be based on a variety of techniques, for example, historic data or approximate quantities. Major projects often have substantial elements that are unique and for which there is no relevant historic data. In these cases it is necessary to analyse the project in as many individual work sections as can be identified, if possible to prepare indicative quantities and consider the resources necessary to carry out the work. During this indicative stage it is wise to contact potential contractors and manufacturers especially with regard to order-of-cost estimates for specialist sections.

Other matters that have an effect on cost and need to be addressed at this time include location of project and access thereto, especially with regard to heavy and large loads, availability of labour and the possible need for residential hostels or other accommodation for workmen, off-site construction, temporary works. It will also be necessary to consider allowances for design development, allowances for consultants' fees and client's costs, land-acquisition costs and general contingencies.

When the client has accepted the first estimate and instructs that the project proceed to the next stage, then this becomes the first cost plan against which further design developments and changes are monitored.

During the process of design development the main duties of the quantity surveyor as part of the cost management team are as follows:

- to check and report the cost of design solutions as they are established or refined by the engineers;
- to prepare comparative estimates of various design solutions or alternatives and advise the engineer accordingly;
- as changes are introduced into the project, to estimate the cost effect of the change and to report;

- to prepare a pre-tender estimate based on a bill of quantities (BofQ) or priced activities;
- to prepare a financial appraisal.

The monthly issue of the updated cost plan is the vehicle whereby the cost management team is made aware of the current estimated cost of the project. In its simplest form a pre-contract cost plan will set out in tabular form each and every work section, the approved estimate for that section, the estimate for the previous and the current month for the section and a note of the changes that have taken place in the month. The total of all the sections provides the estimated cost of the project.

There should be a continuous dialogue between the designers and the quantity surveyor (QS); ideally both should work together in the same office during the critical stages of design development. Normally, there are so many changes within a month during design development that these are better listed as an appendix to the cost plan. One national client insists that a separate appendix to the cost plans lists all potential changes and these have to be approved by his project manager before changes can be included in the cost plan. In this way the cost plan represents committed cost only (Shrimpton, 1988).

The extent of detail in the preparation and updating of cost plans is such that it is best handled on a database for transfer to a spreadsheet.

The accepted estimate in the form of priced activities or BofQs becomes the basis for the first post-contract cost plan. This then acts as the client's design datum for cost management and reporting in the construction stage.

Highway works

An approximate estimate of the cost of constructing major highway works is usually required at an early stage in the project cycle in order to determine if the scheme is reasonable and will fit in with government-funding allowance. At this early stage the proposed project will be analysed in fundamental elements. The road construction will be estimated at £x per linear metre for three-lane, dual or single carriageway – this price will normally include drainage, lighting and signage.

The estimate will be based on an analysis of previous similar tenders using the highway consultant's own data or data from personal contacts, or following up leads in government White Papers or in the *New Civil Engineer*. Adjustments need to be made for inflation and market forces using the Department of Transport's *Road Construction Price Index*, which is published quarterly and shows trends in national prices.

Additional items to be considered include earthworks, statutory undertakers' equipment to be moved, townscaping and landscaping, telephones, closed-circuit TV etc. Bridges are kept separate and are again estimated based on the consultant's own cost data, taking into account the number of spans/type of construction/length/width of carriageway etc.

The Highways Agency (HA), acting as Executive Agency for the Department of Transport has radically changed its procurement policies following the recommendations made in Egan's report *Rethinking Construction*.

Since the mid-1990s the HA has undertaken most major projects using design and build (D&B) contracts with most risks transferred to achieve greater certainty of spend. The scope for contractor innovation has been limited because they have not been appointed until after the statutory planning stages that establish many constraints.

In addition, improved price certainty has been sought by transferring risks, without giving full recognition to a contractor's ability to assess and manage the risks. The HA now recognizes that this approach does not always support partnership working if commercial pressures come to the fore. Improved VFM can be achieved by allocating risks appropriately, and price certainty delivered by managing the risks in partnership, supported by incentives.

Panel 4.1 Highway scheme estimates

In 2006 *The Times* reported that highway schemes to ease congestion are being stalled and many could be scrapped. According to the article one-third of planned improvement schemes have been delayed up to five years.

> The Highways Agency said that the nature of the programme meant that some schemes could fall behind or progress quickly. But construction companies blame Treasury rules for budgeting, which force the Highways Agency to include a margin of error of up to 45 per cent.
>
> A Highways Agency spokesman said that the Government was committed to the programme of improvements and that all the roads would be built. The agency said that it was working with contractors to reduce costs. Where that was not possible, increases would be met from a special reserve.
>
> (Jameson, A. and Nugent, H., 2006)

Note: This approach seems to be in line with the JDB recommendations on order of magnitude estimates at feasibility stage in the range −25% to +50% accuracy.

The earlier appointment of a contractor offers considerable scope for better value, but it is important to get the right timing. The earlier it is, the more scope there is for the contractor to contribute expertise and innovation, but the time period for construction should not be too long.

The use of project-partnering arrangements on the HA's major projects in recent years has been beneficial in achieving mutual objectives for the particular projects. However, the procurement of major projects on an individual scheme basis means that the partnerships and the invested knowledge and experience of team members can be lost to the client, if there is no continuity of work. The lack of continuity also makes it difficult for suppliers to plan their resources and does not encourage the training and development of the workforce. HA now recognizes that this could be resolved by applying long-term relationships to the delivery of major projects.

HA has identified that the following actions need to be taken on D&B projects:

- For publicly funded major projects the HA will normally use a new form of D&B contract, known as early D&B, where the contractor is involved much earlier in the planning process. The contractor will be appointed as soon as possible after identification of the preferred route and well before the statutory stages which normally involve a public inquiry.
- The contractor selection process will be based largely on quality, with the HA seeking to identify a supplier that has all of the right skills and who is considered most capable of working in partnership, to identify the optimal solution and to deliver it as efficiently and safely as possible.
- Suppliers will need to demonstrate good supply-chain management practices as set out in this document. In particular, the relationship between the contractor and their designer will be very important and the HA will require designers to be adequately incentivized to deliver optimal solutions.

- The burden of tendering will be kept to a minimum by avoiding the need, as far as possible, for detailed design work during the tender stage.
- Pricing will be based on key cost components and a process to establish a target cost when the design is finalized. Target costs will be incentivized in a way that encourages continuous improvement throughout the development of the project.
- Risk schedules will be developed with tenderers as part of the quality-assessment process and also to identify a fair allocation of risks to the parties best able to manage them.
- The HA will develop ways of entering into longer-term relationships with contractors on the delivery of major projects to achieve the benefits which are being achieved on new maintenance contracts and framework arrangements. Options that will be examined will include frameworks and the packaging of projects into long-term programmes (www.highways.gov.uk/business/931.aspx [accessed 20 January 2006]).

This change of approach will have a significant impact on the cost-control process throughout the pre-tender period. Critically the design team, including the contractor and supply chain, will be working to establish innovative designs within the targets set for the key components.

4.4 Cost estimating on building projects

During the late 1950s the technique of elemental cost planning on buildings was established. This technique enabled the client to obtain a more reliable pre-tender estimate and gave the design team a template in order to control the cost during the design development stages. The technique was embraced by the Hertfordshire County Council and used successfully on the CLASP modular school building projects in the 1960s.

The technique is now well established in the building sector and has been further developed by the Building Cost Information Service of the RICS (BCIS) to include a national database of elemental cost analyses, which can be accessed using online computer techniques. Such information can be used to aid the pre-contract estimating process in the building sector as well as helping to ensure VFM by aiding the designer to ensure the most appropriate distribution of costs within the project.

Cost management is the total process, which ensures that the contract sum is within the client's approved budget or cost limit. It is the process of helping the design team design to a cost rather than the QS costing a design.

The basis of the design cost control using the cost-planning technique is the analysis of existing projects into functional elements in order to provide a means of comparison between projects planned with data from existing projects. A building element is defined as part of a building performing a function regardless of its specification. Elemental analysis allows the comparison of the costs of the same element to be compared between two or more buildings.

As the cost element under consideration is performing the same function, an objective assessment can be made as to why there may be differences in costs between the same elements in different buildings. There are four main reasons why differences in costs occur:

1. Differences in time (inflation)
2. Quantitative differences
3. Qualitative differences
4. Differences in location.

On a major project it is necessary to consider individual buildings or parts of buildings. A major shopping centre may be split into common basement, finished malls, unfinished shells, hotel and car parking. The parts of the whole may be physically linked and difficult to separate, but separation will ease estimating and control. The costs of the identifiable parts can then be compared against other schemes. For example, a composite rate per square metre is meaningless when you mix the cost of finished atrium malls with unfinished shells.

It is not only important to separate out parts of the building that serve different functions but it is equally important to separate for phasing. Many major projects have to be built around existing structures, which increase the cost because of temporary works as well as inflation.

The client's and project's status with regard to VAT will also need to be established. In the UK VAT is currently payable on building work other than constructing new dwellings and certain buildings used solely on both residential and non-business charitable purposes and also on all consultants and professional fees. The current VAT rate is 17.5%.

For further information on the application of VAT to construction works in the UK visit HM Revenue & Customs website (www.hmrc.gov.uk).

It is customary to exclude this amount from estimates and tenders, a practice that is well understood in the construction industry. However, this must be pointed out to any client who otherwise may think that the estimate is their total liability (Ferry and Brandon, 1999).

Design stages

References to design stages are to the RIBA Plan of Work (taken from the RIBA *Handbook of Architectural Practice and Management*) and refer to the main stages through which a project design typically passes. Table 4.1 shows the control tasks and deliverable reports required from the QS within the RIBA Plan of Work stages.

It is also recommended that value management and risk management are also carried out throughout the design process. These might affect both the client's requirements and the chosen design solution, and changes would, therefore, affect the budget and cost plan.

If at any time during the design process it becomes apparent that the agreed budget is likely to exceed without a change to the brief, the client should be informed and instructions requested. Likewise, if it becomes apparent that the whole of the agreed budget will not be required, the client should be informed.

Budget-estimating techniques

On projects where non-traditional procurement routes are used, the responsibility for developing the cost plan may change but the stages suggested here remain appropriate. For example, on D&B schemes, the client's QS will be responsible for the cost plan at feasibility and outline

Table 4.1 Control tasks and deliverable report.

Design stages	*Quantity surveyor*
Stage B: Feasibility	Prepare feasibility studies and determine the budget
Stage C: Outline proposals	Consider with client and design team alternative strategies and prepare outline cost plan
Stage D: Scheme design	Carry out cost checks and finalize cost plan
Stage E: Detail design	Carry out cost checks
Stage F: Production information	Carry out cost checks
Stage H: Tender action	Prepare reconciliation statement

proposal stage and the D&B contractor's QS will be responsible for developing the cost plan with the contractor's design team to produce the tender. However, the principles of budget, cost plan, cost checks and reconciliation should be adhered to whenever possible.

There are four main ways to estimate the cost of a building during the design stage, which are dependent on the quantity and quality of the information available at the time the estimate is required:

1. Function or performance related
2. Size related
3. Elemental cost analyses
4. Unit rates.

As a general principle, estimates prepared on minimal information and those taking a very short time to prepare will be less accurate than those based on the use of substantial information requiring more time to prepare.

The term *cost modelling* is often used to describe the function of cost estimating. Any form of cost prediction can be described as a cost model, whether it is based on functional, performance-related, elemental cost analysis or detailed rates calculated by contractors when pricing tenders. However, cost modelling generally implies the use of computer aids in order to allow iterations to be rapidly performed to help select the most appropriate solution to achieve VFM.

Functional or performance-related estimating

A function or performance-related estimate typically requires one quantity and one rate and is related to the client's basic requirement. Typical examples include the following:

- A 1,000-bed hotel
- A 2,000-pupil school
- A 1,500-bed hospital.

For example, an hotelier will know that a hotel will cost £75,000 per bed to build and will earn £75 per bed per night. They can use this information to calculate the relative efficiencies of two proposed hotel options of completely different sizes.

An estimate based on this technique is very simplistic, crude but of course quick. It does not take into account plan shape, number of floors, ground conditions etc. It is considered extremely risky to use this technique except at the very earliest stages of inception. Often statistical techniques are employed in an attempt to improve the accuracy and reliability of the estimate.

Using this approach it would have been possible to identify a *ballpark* figure for the anticipated cost of the new Wembley Stadium at an early stage in the project cycle based on the cost per seat (refer Table 4.2).

An independent VFM study by surveyors Cyril Sweet in April 2002 described the new Wembley Stadium and identified some of the key features of this design and construction contract with multiplex as follows:

> Value for money both in terms of the market price for the scheme as designed, and in terms of comparison with stadia of similar standing.
>
> This does not signify that it is the cheapest price, but that it falls within the broad cost parameters for a project of this type and scale.

Table 4.2 Major stadiums cost-per-seat comparisons.

Details	*Wembley*	*Stade de France*	*Stadium Australia*	*Munich (new stadium)*	*Sapporo Dome (Japan)*	*Washington State*
Location	London, UK	Saint Denis, France	Sydney, Australia	Germany	Sapporo, Japan	Washington, USA
Capacity (seats)	90,000	80,000	80,000	66,000	42,122	72,000
Accommodation area (m^2)	73,000	70,000	100,000	—	53,800	—
Area per seat (m^2)	1.92	0.88	1.25	Not known	1.28	Not known
Total cost (£ million)	£352.6	£266.6	£278.9	£248.2	£246.0	£359.6
Cost per seat	£3,918	£3,332	£3,486	£3,761	£5,839	£4,995

Source: Report on Wembley Value for Money produced by Cyril Sweet Ltd on 10 April 2002 (www.sportengland.org/ new_wembley.pdf [accessed 23 January 2006]).

> We consider that the level of the Multiplex price reflects the specific aspects of the proposed Wembley contract. Onerous conditions of contract, developed to provide greater security of outturn price for WNSL (the client).
>
> A significant amount of additional accommodation, provided to generate income, a need arising from the requirement for the stadium to be financially self-sustainable. High design standards required by the lottery funding agreement. Overall capacity of 90,000 seats, which are proportionately more expensive than those in a lower capacity stadium.
>
> (Cyril Sweet, 2002)

Size-related estimating

These techniques are invariably based on gross floor area (GFA) approaches when the total floor area of the required building is calculated and then multiplied by an appropriate unit rate per square metre of floor. In former times volumetric approaches were used, but this technique has largely fallen out of favour as large errors can arise.

More detailed approaches can be applied by the use of differential rates for different areas within the building to give a greater degree of accuracy. A major limitation of these techniques is that they take no account of the geometry of the building.

Elemental cost-analysis estimating

This technique relies on the selection of one or more suitable cost analyses and adjusting them in time, quantity, quality and location in order to provide an estimate of the building. It is a technique which is used as the means to establish the cost plan which should confirm the budget set at the feasibility stage and to establish a suitable cost distribution within the various elements.

Invariably an outline cost plan is first produced using the cost per square metre of each functional element in order to allocate elemental cost limits. When the design has developed further the elemental unit quantities are calculated in order to establish elemental-cost targets for inclusion in the detailed cost plan.

As the design evolves more information becomes available. The element unit rate can be modified as described below. Most elements have different specifications, with varying rates that need to be isolated. For example, a factory unit may have mainly unfurnished warehouse, some offices and a toilet block.

Panel 4.2 The building cost information service of the RICS

The nationally available BCIS contains two types of elemental cost analyses:

1. Concise cost analysis, which gives only a breakdown into broad elements such as substructure, superstructure, services etc.;
2. Detailed cost analysis in a standard format – fully describing each project thus:
   (a) information on the project, including description, site and market conditions, number and prices of tenders, contract period, form of contract;
   (b) elemental costs – showing element total cost, cost per square metre gross floor area, element unit quantity, element unit rate, with two sets of figures for the preliminaries shown separately and apportioned;
   (c) specification and design notes;
   (d) plan and elevation.

The elemental cost data from previous projects is accessible to subscribing members via computer link to the BCIS. Thus even in the absence of designer's drawings, the client's cost adviser is able to create on the computer a pre-contract cost model using the data from several similar previous projects.

Table 4.3 Establishment of elemental cost targets for inclusion in cost plan.

Element 43: floor finishes				
Area	*Specification*	*Quantity (m^2)*	*Rate (£)*	*Cost (£)*
Outline cost plan				
All areas	Typical mix	10,000	7.30	73,000
Detailed cost plan				
Warehouse	Floor hardener	9,000	2.00	18,000
Office	Carpet	900	50.00	45,000
Toilets	Ceramic tiles	100	100.00	10,000
		10,000		73,000

The element unit rate calculation arrives at the same cost but assumes an identical mix of specification to arrive at an aggregate rate. It is not easy to fully appreciate an aggregate rate, as it bears no relation to the specification rates. Any change in the ratios of the varying specification could have a significant cost effect. The parts of elements are referred to as components and are added together to create the elemental sum (refer Table 4.3).

Cost checking

In order to confirm the accuracy of the cost plan, which in itself will have confirmed the budget set at the feasibility stage, cost checking is deployed. Cost checking is the execution of the cost-control component in the design process. It ensures that the information as a basis for the tendering can be prepared such that the lowest tender will confidently equate closely with the budget set at the feasibility stage.

Milestone reports

If all the documentation is formatted in the same way it can be compared and reconciled. One way to do this is to use milestone reports. This is a table that summarizes and reconciles between each milestone. A milestone report is normally a report such as

- original budget
- cost plans for example 1 to 10
- pre-tender estimates
- contract sum
- financial statement for example 1 to 50
- final account.

The main-group costs, such as total finishes, are tabled together with the total cost, area, cost per square metre and a comment on any major changes to brief. The costs can be plotted on a graph. After several projects, the client's cost consultant can analyse their performance to see whether they need to adjust their level of optimism or pessimism.

4.5 General comments

The client obviously remembers the first figure reported to them. When the original feasibility study is performed the budget is often fixed; it is therefore essential that all cost reporting reconcile back to the original budget. All estimates should explain to the client and the design team about what is included in the budget. It should be a discussion document for design optimization.

As the design develops it is inevitable that some over-specification in individual elements will occur, sometimes increasing the total cost beyond the total budget. The elemental breakdown can highlight the offending elements by showing an excessive percentage of the total.

Normally the individual percentages of each elemental cost for a particular type of building produce a typical *pattern*. It is important to match the percentages, or pattern, with the norm for that type of building. Mere consideration of the total cost per square metre can be misleading as there can be two high and two low elements, which may cancel each other out and yet require a detailed examination.

4.6 Action after receipt of tenders

In most cases, sound cost planning will produce tenders within budget. If, due to market conditions or late changes in designs and specification, adjustments need to be made to a tender, information on potential savings will need to be identified by the design team. If there are significant changes from the initial tender documents, consideration should be given to the need for seeking revised tenders.

4.7 Conclusion

This chapter has briefly reviewed the key concepts of pre-contract cost management in the industrial engineering, civil engineering and building sectors in order to identify a suitable approach for construction works. Many similarities in the approach and techniques in the three sectors have been identified.

The cost manager's systems should provide clients and project managers with the maximum possible advance warning of likely expenditure so that timely and appropriate actions may be considered.

It is necessary to identify what items are included in the estimate and which are excluded. Forecasts should not be single figures, implying a degree of accuracy that does not exist; they should be a range of figures within stated parameters. Ideally, each estimate should be a logical development of its predecessor reflecting the increased level of detail available.

In the periods between revisions of estimates and cost plans, the development of designs and programmes and the progress of procurement and commitment must be controlled.

A major factor in the management of costs is the identification and management of the risks. Risks are associated with the unknown. Therefore, as a project progresses from inception through design construction and use, the unknown elements should diminish and the risk allowance reduced accordingly.

4.8 Questions

1. Describe and discuss the range of cost models and show how they are useful at different stages in the design process.
2. Discuss the steps that can be taken to ensure that cost planning and control keep the final cost of a building project within cost target.
3. The primary function of producing estimates of the cost of construction works is to be able to advise clients of anticipated development costs. Discuss the various methods of providing such pre-contract estimates in relation to a proposed marina development.

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5 Cost management on PFI projects

5.1 Introduction

Privatized infrastructure projects have been around for at least two hundred years. In the eighteenth century, one of the first concessions to be granted was given to the Perrier brothers to provide drinking water to the city of Paris. The Trans-Siberian Railway and the Suez Canal were thought to have been the first Build-Own-Operate-and-Transfer (BOOT) projects in the modern world (Merna and Njiru, 2002). The great Victorian contractor Weetman Pearson not only built railways, power stations and ports in Britain, Mexico and Chile but also promoted the companies, raised the capital and ran the operations for a number of years.

The idea behind the BOOT philosophy is that there is an increasing worldwide perception that the electorate requires improvements in the quality and availability of its public services, particularly infrastructure projects – but is not prepared to pay extra tax to fund them. A solution is to get the private sector to pay for these facilities (as well as designing, building and operating them) and in return allow the companies involved to take the bulk of the revenue produced.

In recent times the term Build-Operate-Transfer (BOT) was first introduced in the early 1980s by Turkey's then Prime Minister, Turgat Ozal. Under this arrangement the private organizations undertake to build and operate a project normally undertaken by government. Ownership normally reverts to government after a fixed concession period, normally between 10 and 50 years. The revenues generated by the project are the main source of repaying the debt. The projects are normally structured to have limited or no recourse to the project sponsors, contractors or to the government – projects being undertaken by a self-contained concession company or special-purpose vehicle.

This approach is particularly attractive for governments in the rapidly developing countries in the Pacific Rim, for example, in Thailand and Malaysia, which see the BOT approach as a means of reducing public sector borrowing, and at the same time promoting direct foreign investment in their country's infrastructure or industrial projects. Examples of such projects include power stations, toll roads, toll bridges and even pipeline systems for oil and gas.

The proactive involvement of the home government is usually critical to the success of the project. Robert Tiong's important research in the early 1990s identified that sponsoring governments adopted a range of strategies to support these major infrastructure projects. These included giving concession periods up to 55 years, offering support loans, giving concessions to operate existing facilities, facilitating foreign exchange guarantees and interest rate guarantees etc. (Tiong, 1990).

The first BOT project in the UK was the Channel Tunnel linking UK and France, constructed by a consortia of five British contractors, five French contractors and five banks. This was followed by other infrastructure projects including the Skye Bridge, the Second Severn Crossing, the Dartford Bridge, the London City Airport and the Manchester Metrolink.

5.2 Structure of BOT projects

The main parties involved in a BOT project are as follows:

- *The host government*: often the host government provides critical financial support without which the project would not become a reality;
- *The project sponsors*: normally a joint venture comprising contractors/ banks/entrepreneurs;
- *The banks*: may include major world banks, for example Asian Development Bank, European Investment Bank as well as major national banks;
- *The shareholders*: include pension-fund holders and major investors;
- *The contractors*: often multinational joint ventures.

The typical five phases of a BOT project, with the roles and responsibilities of the project sponsors identified, are as follows:

1. *Pre-investment*: acting as consultants the project sponsors carry out the feasibility study;
2. *Implementation*: acting as consultants the project sponsors carry out the engineering/ building design, as project sponsors they negotiate favourable concession agreements from government, and as project promoters they raise equity and borrow finance during the implementation phase;
3. *Construction*: the project sponsors act as the contractor to build the facility, usually on a fixed-price turnkey basis, during the construction phase;
4. *Operation*: the project sponsors act as the operator and owner of the facility, using the project revenues to repay the loans during the operation phase;
5. *Transfer*: transfer of ownership to the government.

5.3 Case study: Nottingham Express Transit (NET) Light Rail

In 1990 the Nottingham City Council and Nottinghamshire County Council formed a private company limited by shares under the name of Greater Nottingham Rapid Transit (GNRT) to undertake the construction and operation of the LRT system.

In 1994 the Act of Parliament (GNLRT Act) was passed granting the City and County Councils the powers to develop and operate an LRT system, to authorize the construction of the works and acquisition of land required and to transfer the undertaking to GNRT Limited or any other organization.

In 1997 Arrow Light Rail was selected as the preferred bidder. Arrow Light Rail is an SPV company formed to design, build, fund, operate and maintain Line One of the Nottingham Express Transit.

The promoter is Nottingham Express Transit (NET), the private company formed by Nottingham City Council and Nottingham County Council (GNRT under the Parliamentary Act).

The concessionaire is Arrow Light Rail comprising six partners each bringing their own particular skills and expertise to the organization.

1. *Bombardier (formerly Adtranz)*: one of the leading providers of total rail systems and tailor-made solutions for rail-transport services worldwide;

2. *Carillion Private Finance (CPF)*: part of Carillion plc, the leading services to construction company. CPF is a UK leader in private finance, primarily in health, prisons and transport sectors;
3. *Transdev*: the leading operator of integrated urban transport systems in Europe and operating over 70 public transport networks in France including modern tramways;
4. *Nottingham City Transport*: the leading bus-operating company in the Nottingham area.
5. *Innisfree*: the leading private equity investor in the UK Private Finance Initiative (PFI) and Public–Private Partnership (PPP) infrastructure projects and a 30% shareholder of Arrow;
6. *CDC Projects*: a 20% shareholder of Arrow, the major French public sector financial institution.

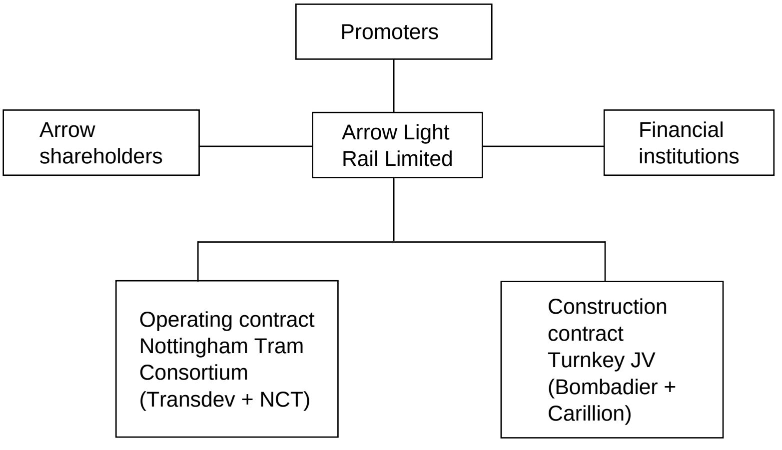
Figure 5.1 shows the PFI organizational structure on stage 1 of the Nottingham Tramway. The contractor is Bombadier Carillion Consortium (BCC), a segregated consortium in which the two members take responsibility for delivery of their respective scopes of work, and are jointly and severally bound to supply the entire scope of works to the client – Arrow Light Rail.

The operator is the Nottingham Tram Company, a special-purpose company owned by Transdev and NCT, which took over the project on completion.

Arrow's £220 million funding of the project is met by bank loans, sponsor equity and grants. The loans will be paid back during the operating period from performance-related payments from the promoters and revenue from fares.

The promoter awards a concession to the concessionaire who in turn procures design and construction from the contractor, and operations from the operator. The principal documents are as follows:

- *Concession agreement and schedules*: specifies the rights and obligations of the promoter and the concessionaire;
- *Turnkey contract and schedules*: specifies the rights and obligations of the concessionaire and the contractor;
- *Railtrack agreements*: specifies the rights and obligations of the promoter, the concessionaire, the contractor and railtrack for the railtrack-enabling works.



5.1 PFI organization on Nottingham Tramway.

Both members of the Bombadier Carillion Consortium are bound by the Consortium Agreement, which defines their respective scopes of work and responsibilities within the Consortium.

Some ten years in the planning, NET is a key part of Greater Nottingham's integrated transport strategy, to improve access to the city centre and reduce traffic congestion and pollution. Line 1 was anticipated to take 2 million car journeys per year off the roads and was also expected to bring economic regeneration and environmental benefits to the area. The project finished six months late, the public sector was protected by a robust PFI structure; however, the turnkey contractors, mainly civil engineering lost money on the project.

NET Line One was opened by Transport Minister Alistair Darling in March 2004 and has shown strong patronage with 8.4 and 9.7 million passengers respectively in its first two years of operation. A recent passenger survey revealed 98% satisfaction with the service and 80% support for the planned new lines south and west of the city.

5.4 Factors leading to success on BOT projects

The following factors have been identified by the United Nations Development Unit as important for the success of BOT projects (United Nations, 1996):

1. The project must be financially sound, feasible and affordable.
2. The country risks must be manageable.
3. There must be strong government support.
4. The project must rank high on the host government's list of infrastructure projects.
5. The legal framework must be stable.
6. The administrative framework must be efficient.
7. The bidding procedures must be fair and transparent.
8. BOT transactions should be structured so as to be concludable within a reasonable time and at a reasonable cost.
9. The sponsors must be experienced and reliable.
10. The sponsors must have sufficient financial strength.
11. The construction contractor must have sufficient experience and resources.
12. The project risks must be allocated rationally among the parties.
13. The financial structure must provide the lenders adequate security.
14. The foreign exchange and inflation issues must be solved.
15. The BOT contractual framework must be coordinated and must reflect the basic economics of the project.
16. The public and the private sectors need to cooperate on a win–win basis.

Building a BOT toll road in a developed country might be an attractive proposition to a potential sponsor. However, in contrast, building such a road in a developing country might not be so attractive due to the economic and political situation and potential risks involved.

5.5 Risks and securities

The United Nations Development Unit (United Nations, 1996) has identified the range of potential risks on major international BOT projects which could include the following:

- Political risks including changes in taxation, import restrictions or even cancellation of the concession;
- Country's commercial risks including foreign exchange, inflation and interest rates;
- Country's legal risks including changes in law and regulations;

- Development risks including bidding, planning and approval;
- Construction risks including delay, cost overrun, force majeure, loss or damage to work and liability;
- Operating risks including technical, demand, supply, cost escalation and management risks.

The Channel Tunnel project highlighted the risks to investors involved in BOT projects. The project opened more than one year late and cost at least three times the initial budget of £3.5 billion. In contrast, the £80 million QE2 bridge on the Thames crossing at Dartford was completed on time and within budget and will show a generous return for the investors; it is anticipated that the toll revenue in the last year before handover to the government will equate to the total initial cost.

Given the complexity of BOT schemes and the magnitude of the funds required, it is important for project sponsors to identify, evaluate and allocate the main risks in a BOT project. Indeed, the analysis and allocation of risk is central to the financial structuring of a BOT project. In the first instance, the objective must be to minimize the risks associated with the project, for example, by adequate geological, technical and market studies. Thereafter, the process is one of insuring, controlling and apportioning risks according to the parties' willingness to bear them.

The key to successful BOT project financing is structuring the project finance with as little recourse as possible to the sponsors or government, while providing sufficient guarantees and undertakings so that lenders will be satisfied with the credit risk.

PFI projects have significant benefits for clients, not only is the project considered off the balance sheet but all the risks should be transferred to others. However, the termination of the PFI contract for the National Physical Laboratory (NPL) demonstrated that sometimes the risks may be too great for the private sector to carry.

In 1998 Laser, an SPV jointly owned by Serco Group plc and John Laing plc, signed a 25-year PFI contract under which Laser would build and manage new facilities for NPL, comprising over 400 laboratories. Laser awarded John Laing a fixed-price contract to design and build the new facilities. However, intractable problems occurred in designing 30 specialist laboratories which required stringent temperature and/or the sub-audible noise controls facilities which considerably delayed the project.

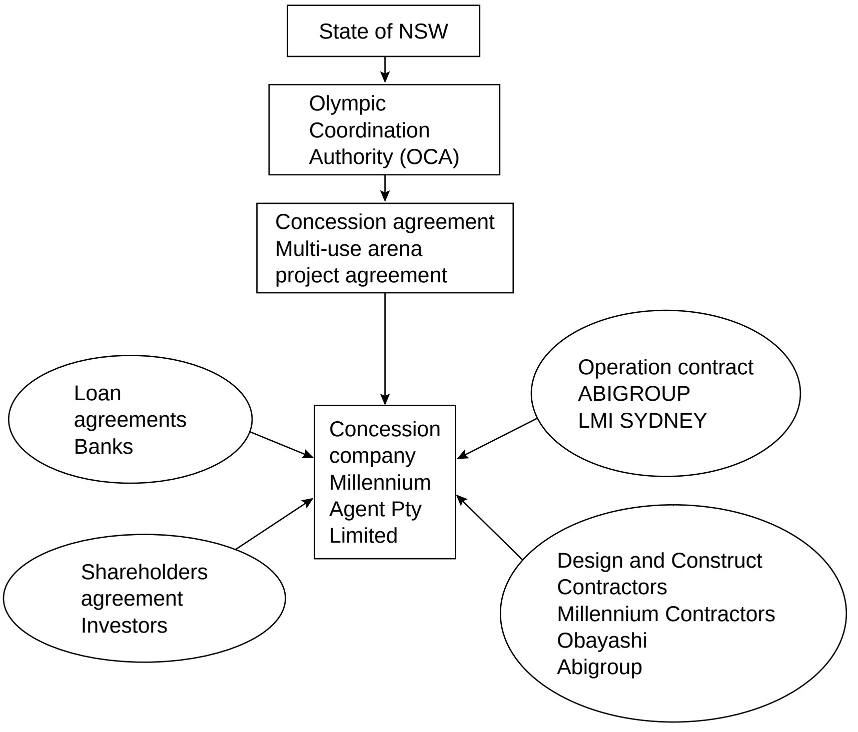
Ultimately John Laing plc was unable to carry the massive financial burden, with losses estimated at £67 million; John Laing Construction was sold and the remaining company restructured. In turn Serco recognized that it could not complete the project and the PFI agreement was terminated in 2004 (www.nao.org.uk/publications [accessed 20 May 2007]).

Postscript: The project was completed by the client, the Department of Trade and Industry, in 2007.

5.6 Case study: Sydney SuperDome, Australia

In the last two decades the BOOT strategy has become popular in Australia with examples such as the Sydney Harbour Tunnel, the Stadium Australia in Sydney, the M2, M4 and M5 toll ways in New South Wales and the Ord River Hydro-Electric Scheme in Western Australia.

The Sydney SuperDome is a 70,000 m^2 multi-use indoor arena with seating capacity for 20,000 spectators. It was built at a cost of A$280 million (£115 million) over 25 months as part of the 2000 Olympic Games infrastructure programme with a 30-year operation concession period. The SuperDome, which is the largest indoor venue in Australia, can be used for gymnastics, tennis, basketball and ice hockey and also for concerts and exhibitions. The SuperDome was designed and constructed by Abigroup together with the Japanese big-five contractor Obayashi. Figure 5.2 shows diagrammatically the simplified corporate structure clearly identifying the main parties in the project.



5.2 Simplified SuperDome corporate structure.

The Australian government contributed 72% towards the cost of the arena alone with the Millennium Consortium contributing the balance. The Australian government also paid the Consortium for the construction of an adjacent car park and landscaping.

The Multi-use Arena Project Agreement obliged Millennium Agent to

- finance, plan, design, construct and commission the arena;
- plan, design, construct and commission the adjacent car park and public domain areas;
- procure the operation, maintenance and repair of the arena during the lease until 2031;
- make the arena available for the Olympic Games;
- yield up possession of the arena to the OCA in 2031 (Jefferies, 2006).

The Sydney SuperDome is a success story and is setting the benchmark for future PPPs to be initiated by the Australian New South Wales Government. In 2006 it was renamed the Acer Arena (www.acerarena.com.au [accessed 24 March 2007]).

5.7 The Private Finance Initiative (PFI)

The PFI was launched in November 1992 by the then chancellor of the exchequer, Mr Norman Lamont. It came against the backdrop of a major programme of privatization during the 1980s under the leadership of the then prime minister, Margaret Thatcher.

The PFI is a form of PPP that marries a public procurement programme, where the public sector purchases capital items from the private sector, to an extension of contracting-out, where public services are contracted from the private sector. Under the PFI structure revenue is received from the government. In contrast, PPP projects are stand-alone and receive no government support.

In 1994, the then Conservative government introduced the requirement for all central ministry departments to check whether every project they planned was capable of being procured under PFI. With the change of government in May 1997 the Labour government conducted a thorough review of the experience of PFI in the previous five years. The results of this review – the Bates Review – endorsed the use of PFI and led to a substantially improved process and simplified market (CIC, 1998).

Since 1996, PFI has accounted for around 10–15% of all the UK's gross public investment with the health and education sectors contributing the greatest number of projects. However, the largest capital-value projects are in the transport and defence sectors with the £10 billion Channel Tunnel completed in 1994 and the £17 billion maintenance and upgrading of two-thirds of the London Underground by Metronet.

In July 2007 Metronet went into administration claiming that the 30-year project had already overspent by £1.2 billion in the first seven-and-a-half years due to London Underground repeatedly asking for work outside the original scope. Metronet's five shareholders WS Atkins, Balfour Beatty, EDF Energy, Bombardier and Thames Water had already written off considerable sums from their company balance sheets. This case study clearly identifies that major PPP/PFI projects involve potential massive risks for private companies and their shareholders and may not be appropriate for all public projects.

As of December 2006, 794 PFI deals had been awarded by the UK Government including expenditure on schools replacement and refurbishment, prisons, hospitals, new or refurbished health facilities, transport projects including roads bridges, waste and water projects with over 150 local authorities involved in PFI projects (CBI, 2007).

The UK Government is committed to using PFI as a procurement option wherever it is value for money to do so. The HM Treasury paper *PFI: Strengthening Long-term Partnerships* (HM Treasury, 2006) identified that PFI has a strong record on delivering projects on time (76% compared to 30% on non-PFI projects) and on budget (79% compared to 27%).

Five key lessons concerning PFI projects have been identified in the relentless search for improvement in public services (CBI, 2007):

1. Integrating service and design leads to a whole-life approach;
2. Allocating risks creates incentives for better delivery;
3. Increasing transparency and accountability has wider benefits for government financing;
4. Improving customer and staff satisfaction is key;
5. Opportunities are created to prioritize environmental sustainability.

However, PFI projects are not without controversy with two principal complaints. First, the high cost of bidding (estimated at £11.5 million for hospitals and £2.4 million on schools projects), and second the diminishing number of firms who are prepared to do so.

Structure of PFI projects

The aim of the PFI initiative is to bring private sector skills into projects that would have previously been wholly or mainly provided by the public sector. The underlying principle behind PFI has many dimensions. The obvious one is the pure PFI case where a facility and service is provided at minimal cost to the public sector. Second, it is the public sector's exploitation of the private sector's ability to design and manage more efficiently. The public sector is characterized by substantial cost overruns and poor management skills; utilizing PFI and passing over control may eliminate some of these inefficiencies.

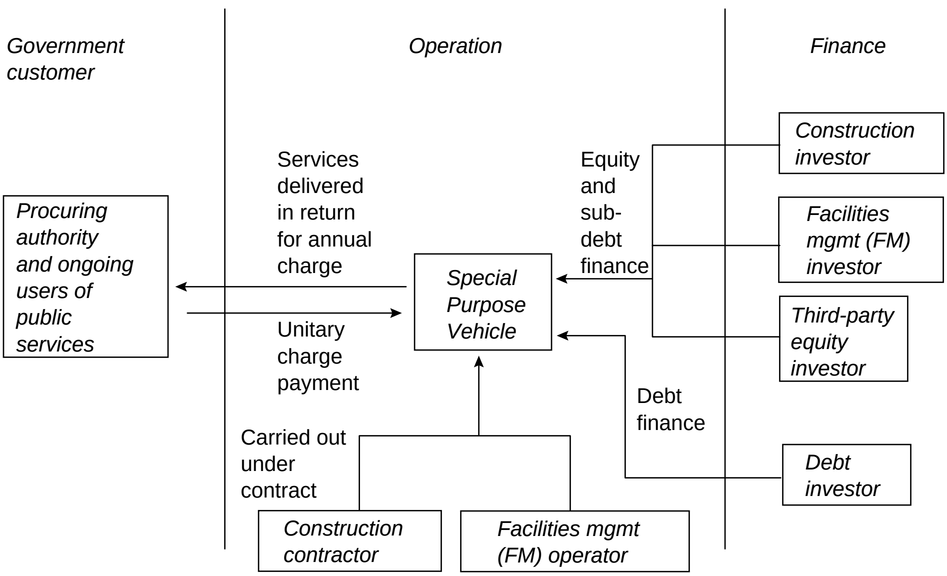
The choice of PFI as the most appropriate route for procurement is governed by Treasury rules for developing an outline business case. The government department has to support an application for funding with appropriate feasibility studies. In addition, the department has to demonstrate that significant benefit would be derived from this type of contract over any alternatives. This includes cost savings, but is principally governed by the benefits of transferring inherent risks to the private sector.

In PFI accommodation projects, such as hospitals or prisons, the construction element typically represents around 25–30% of the total value of the contract. But other project costs, such as maintenance, will be influenced by the quality of the construction work.

Figure 5.3 shows the commercial structure of a PFI project with the three main parties: the government customer, the operation carried out using a special-purpose vehicle (SPV) and the provider of finance.

The key role in any PFI project is an SPV which is the legal entity; essentially a shell organization which is created by shareholders in a bidding company or consortium. The SPV is designed to fund the project and contract with the public sector client for the purpose of delivering the PFI service. Depending on what is included in the contract, the SPV is likely to include the equity provider, the contractor and a facilities management provider. During the selection process the SPV will need to provide detailed financial models showing how, amongst other things, they intend to fund a project over the lifetime of the project.

The concessionaire is the company, which has been awarded the contract by the public sector client to provide the PFI service. The concessionaire company will either be an SPV established by a bidding firm for the sole purpose of the specific project, or an existing company, which will be taking the liabilities of the PFI, project 'on balance sheet'. The concessionaire is responsible for the design, construction, financing and operation of the built facility required to provide the PFI service.



5.3 A typical commercial structure of a PFI project (source: World Bank Infrastructure Governance Roundtable United Kingdom PPP Forum (www.worldbank.org/transport/ learning [accessed 23 March 2007])).

Types of PFI strategies

The Treasury has described three different types of PFI strategies:

Financially freestanding projects

1. In these projects the private sector undertakes the design, building, finance, operation and maintenance of the completed asset. The project may involve building a new asset or taking over the operation and maintenance of an asset.
2. Examples include the Skye Bridge, the A50 Stoke-Derby link road and the M40 widening. The concessionaire's revenue is generated from the collection of tolls (real or shadow – based on monitored usage).

Services sold to the public sector

In this type of PFI project, the cost of the project is met wholly or mainly by charges from the private sector service provider to the public sector body, which let the contract. Examples include privately financed prisons and hospitals. In the case of prisons, the Prison Service does not lease the prison accommodation; rather it pays for a complete service provided to the inmates.

Joint ventures

The cost of joint ventures is met partly from public funds and partly from private funds, with overall control of the project resting with the private sector. Examples of such projects include the Channel Tunnel Rail Link and the Croydon Tramlink.

This type of project requires a value-for-money test conforming to the following criteria:

- Private sector partner chosen in competition;
- Joint-venture control held by private sector;
- A clear definition of government contribution and its limitations;
- Clear agreement on risk and reward allocation, defined and agreed in advance.

Government contributions can take various forms and include equity, concession loans and asset transfer. Typically, government contributes through aiding initial planning or granting subsidies.

The PFI Process

The four 'p's (4ps) (Public–Private Partnership Programme) is a local government central body set up to assist local authorities to develop and procure projects through Public–Private Partnerships and the PFI. The 4ps (pronounced four-peas) offers comprehensive procurement support to local authorities including hands-on project support, gateway reviews and skills development and know-how procurement guidance in the form of procurement packs, case studies and extranets.

The 4ps publication *A Map of the PFI Process: Using the Competitive Dialogue* provides an overview of the process as a whole and a short introduction to each of the identified stages (www. 4ps.gov.uk [accessed 23 March 2007]). The guide states that the PFI transforms local authorities from being the owners and operators of assets, to the purchasers of services. In a PFI transaction, a private sector service provider is given responsibility for designing, building, financing and operating assets, from which a public service is delivered.

Once the need for the service/facility is identified, procurement options are considered and investment appraisal exercises undertaken. The conclusions of the detailed options appraisal exercises should be documented in an Outline Business Case (OBC).

From the appraisal of a number of possible project and procurement options, a preferred service delivery option the *Reference Project* will be identified; this is the benchmark solution against which bids are subsequently identified. The same project option procured through a traditional route is known as the Public Sector Comparator (PSC) and provides a benchmark against which the value for money (VFM) of the PFI can be assessed at the OBC stage.

The output specification, developed as part of the suite of bid documents provided to bidders, is arguably the most important document in the procurement of a PFI project. It sets out what is expected of the SPV, written in terms of outputs or outcomes. This means specifying what the authority expects to see as a result of the project rather than how it expects that result to be achieved thus encouraging innovation.

The payment mechanism has two main elements: availability standards and performance standards. The availability standards define when the asset is considered *available for use.* The performance standards cover any standards not covered by the availability standards, in general the service and maintenance standards.

The authority pays a monthly or yearly *unitary charge* to the SPV. The charge is calculated based on the availability and performance of the facilities and associated services and deductions are made for poor performance. In order to determine the unitary charge prior to submitting their tender for the project, the sponsors would have to estimate the following:

- The capital costs of the project;
- The likely financing costs, and hence, debt-service responsibilities of the contractor;
- The operating costs of the project for 25–30 years (including subcontractor costs, administrative costs, employment costs, insurance costs, tax liabilities and other costs, expenses and fees;
- Any other costs, expenses and risks inherent in the project;
- Surplus by way of dividends or interest on subordinated loans.

At the end of the contract term the Authority might have the right to acquire the building at a specified value or to walk away if it has no further need for the asset. Alternatively, there might be provision to re-tender the service with the building being made available to the successful bidder. Whether the SPV get paid for the asset will depend on the approach to residual value and whether this is reflected in the charges.

Contract management under PFI

The invitation to tender should include a draft of the PFI contract – called the model contract. This sets out the terms on which the local authority expects bidders to submit a standard bid. The HM Treasury *Standardisation of PFI Contracts* and the service-specific model contracts included in 4ps *Procurement Packs* (where relevant) should be used to develop the model contract.

Contract management is the process of managing and administrating the PFI/PPP contract from the time it has been agreed at contract award, through to the end of the concession period. The 4ps publication *A Guide to Contract Management for PFI and PPP projects* (www.4ps.gov.uk [accessed 23 March 2007]) identifies that there are four components of contract management:

1. *Setting up the contract management team*: determines when the contract management should be set up, the structure, the attributes and training needs.
2. *Managing relationships*: establishes relationships, communication routes and systems, and the active support and enhancement of them throughout the life of the project.

3. *Managing service performance*: assesses whether the services being delivered by the service provider meet the required standards and whether remedial measures are effective.
4. *Contract administration*: ensures obligations and responsibilities defined under the contract are met, ensuring underperformance, risks, payment of the unitary charge, reporting and change are all managed effectively so that VFM and continuous improvement are achieved.

The 4ps guide also includes a map of contract management involvement throughout the project development and procurement stages.

5.8 The role of the cost consultant in PFI/PPP projects

The cost consultant has a significant role to play under the three procurement systems: traditional, design and build, and the management approach. Their expertise has developed based on a sound appreciation of construction technology, measurement and estimating, legal and contractual, budgeting, cost-planning and cost-control systems, change and claims management. A challenge for the profession is to provide services, which add value under the PFI procurement route.

During the early stages of the project the client may rely on external advisors to supplement the skills and knowledge bases of the in-house personnel. This is particularly relevant if the client is new to PFI or if in-house resources are being utilized on other projects.

There are three main categories of professionals involved in PFI/PPP projects: financial, legal and technical. The financial advice is usually undertaken by personnel from the major banks and specialist PFI advisors. Likewise, legal advice is usually undertaken by leading lawyers. The technical team includes traditional construction-related specialisms and facilities management disciplines.

The process of appointing external consultants will be dependent upon public sector procurement procedures appropriate to the market sector. Clients traditionally appoint advisers independently, but a turnkey appointment may also be used, as consultants gain experience of working effectively with each other.

The structure of a PFI project is complex and involves many different parties. Eaton and Akbiyikli (2004) identify that this should create the following advantages for quantity surveyors (QS): QS services are required by more parties; added value services are now required and QS services are needed for longer duration. These QS services are required by a potentially wider range of clients including the public sponsor, the SPV, the design and construction companies, the operation and maintenance companies, and by the various financial institutions providing equity, commercial loans and debt finance.

The structure for the construction phase of a contract is typically representative of traditional procurement – usually based on the design and build approach. The operational phase will reflect typical facilities management contract structures.

In addition, cost managers have established themselves as independent certifiers – crucially being involved at the sign-off of the project for occupation or use by the client body. Table 5.1 indicates the range of roles undertaken by construction cost and project managers on PFI/PPP projects.

Under the PFI structure the QS needs to develop expertise in relatively new areas of knowledge including checking the sustainability of the design, validating the acceptability of innovative solutions, developing more expertise in risk management, developing payment systems linked to performance measurement, executing audit procedures and undertaking life cycle and operational cost management.

Table 5.1 Roles of cost manager and project manager on BOT/PFI projects.

Client		*Cost management*	*Project management*
Public sector	Project sponsor	Construction cost advice	Bid process management
		Public sector rules/OGC gateway advisory and review	OJEC procedures
		Business case, public sector comparator advice	Advisor team management
		FM cost advice	Construction advice
		Procurement strategy	Long-term contract management
		Commercial negotiations	
		Tender analysis	
		Risk advice	
		Capital tax advice/VAT	
		Life cycle cost advice	
		Output specification development	
		Technical evaluation	
Independent	Sponsor and bidder	Independent certifier	Independent certifier
Private sector	Bidder	Construction cost manager	PM for SPV
		FM cost manager	SPV bid manager
		Risk manager	Construction cost manager
		Capital tax advisor	
		FM consultancy	
		Life cycle cost manager	
	Financier	Technical advisor	Technical advisor

Source: Adapted from Hedgecox, D. *Costing out PFI/PPP* (www.publicservice.co.uk/pdf/pfi/spring2001/p168.pdf [accessed 27 March 2007]).

5.9 Case study: Stoke-on-Trent Schools, UK

In 1997 many of the schools in Stoke-on-Trent were in a dilapidated state and not fit for modern teaching and learning practice. The schools included buildings dating back to the nineteenth century, some of which had not been upgraded or refurbished for 50 years. Furthermore, the annual budget for maintenance of all the schools was £120,000; totally inadequate when one large replacement boiler would cost £80,000. The City Council's annual expenditure was already stretched to its absolute limit so a radical brave new way of thinking was required.

In November 2000, after three years of intense planning and negotiation, one of the first PFI partnership charters in the UK was signed to cover the refurbishment and maintenance for 25 years of all Stoke-on-Trent's 122 schools. This five-year capital expenditure scheme was very much a pioneer in PFI school projects. There was no precedence to follow and no standard contracts were available at the time. It is noted that the Treasury Task Force later issued guidance for standardizing the terms of PFI contracts.

The project cycle followed the 4ps process with independent *Gateway Reviews* at key points, all as the OGC *Gateway Process* model (www.ogc.org.uk). The different procurement options were considered before selecting the PFI approach. Feasibility studies were undertaken using the public sector comparators as the benchmark. Output specifications were developed embracing such issues as minimum temperature in classrooms. Sophisticated financial models, which included sinking funds and risk allowances, were developed and rigorously tested.

The winning bid was received from a special-purpose company called Transform Schools (Stoke) comprising shareholders Balfour Beatty Capital Projects (50%) and Innisfree (50%). The project is unique in being the largest bundled refurbishment scheme ever attempted in England and is valued at £153 million of which £80 million is for building nine new schools and refurbishing the rest of the portfolio. One of the principal reasons that Balfour Beatty succeeded in securing the contract was its innovative proposal to replace nine schools rather than refurbish them.

Once the SPV was chosen there was a 12-month intense period of activity in which the architects Aedas worked with the school governors to develop acceptable designs. The construction contracts were let on a design and build basis.

The PFI Board, comprising City Counsellors, representatives from the Department for Education and Skills (DfES) and 4ps together with the authority's project director, met on a monthly basis. The PFI team comprising the authority's project director, lawyers, financiers and the technical team met on a two-weekly basis. Some meetings comprised over 40 participants so one of the biggest challenges facing the project team was capturing the knowledge and expertise and incorporating the feedback into the project.

The key lessons learned from this project include the following:

- A real belief in the partnering ethos by all the parties. There were difficult problems to resolve throughout the negotiation period but the parties kept talking until these were finally resolved. The original contract, with 9 new schools, was extended to a total of 17 new schools; 15 were built by the SPV contractor and 2 by other contractors.
- Detailed identification and evaluation of the main risks throughout the 25-year period to be passed to the SPV. In this contract, the additional risks were estimated at 17%. Some risks were considered unreasonable for the SPV to carry and were retained by the authority, for example vandalism in school time.
- The importance of teamwork with the complete integration of the key stakeholders in an open forum.
- Attention to detail in the innovative contract which included

    a. a clause requiring the contractor to demonstrate a 20% saving in energy consumption in each school in the first five years by 2006 and a further 5% saving by 2010;
    b. an agreement on the refinancing provision with the authority retaining 25% of any profits; this was a particularly difficult point for the negotiation team with the SPV wanting to retain the whole benefit, while the authority wished to take a 50:50 split;
    c. the client's involvement in securing a quality design, for example, they could comment at the point of handover and the contractor might be required to make changes at their own expense if not acceptable;
    d. a stipulation that at the end of the 25-year period the estate should be in a position where there would be no major repair necessary for the next five years;
    e. change or variation clauses allowing the authority to bring in other contractors to do the work if the SPV contractor's price for the variation was considered too high.

This pioneering PFI project not only provided one of the best portfolios of school buildings in England but also resulted in other positive features including employment of 500 local labour during construction; apprentices taken on by the SPV contractors and sponsorship of a local community football team. Most significantly, there has been a dramatic reduction in school vandalism and a raising of student and teaching staff morale. It is anticipated that the improved buildings will also result in improved student performance in the years to come.

The main parties involved in this pioneering project were as follows:

Client: Financial Advisor: ABROS; Legal Advisor: Eversheds; Technical Advisors: Gleeds and the Building Research Establishment;

SPV: Financial Advisor: HSBC Plc; Legal Advisor: Clifford Chance; Legal Advisors: Clifford Chance, Tods Murray; Technical advisors: Summers Inman (life cycle assessments, technical assessments), Hurst Setter (health and safety), Capita (M&E and structural), Walker Cotter (planning supervisor) and Atkins Faithfull & Gould (monitoring engineer/technical advisor to the lending banks);

Service Provider: Transform Schools (Stoke) Limited; Shareholders (providing the equity): Balfour Beatty Capital Projects 50% Innisfree 50%; Funders (providing the senior debt funding): Lloyds TSB and Dexia Public Finance Bank;

Subcontractor 1: Stoke Schools JV comprising Balfour Kilpatrick Limited (Design and Build) and Balfour Beatty (Design and Build); Subcontractor 2: Haden Building Management Limited (Hard FM).

Sources: www.transformschools.co.uk (accessed 13 July 2007); www.balfourbeatty.com (accessed 23 March 2007); interview with the Authority's Project Director Mike Inman, 12 July 2007.

5.10 Conclusion

There is strong evidence that PFI projects are far better at keeping to time and budget than other forms of procurement. With support from both the Labour and Conservative parties, it is clear that PFI is here to stay in the UK. The PFI arrangement is attractive to governments worldwide as it allows them to keep public borrowing down as the projects are funded throughout their usable life cycle. However, the evidence on quality of service and to some extent design is mixed.

To date, it would appear that the most successful projects have been of the financially freestanding variety, for example the Dartford crossing. However, there was widespread frustration at the lack of projects financially closed, particularly in the health sector. Likewise, in the highway sector there has been frustration at the time and cost involved in the Design-Build-Finance-and-Operate (DBFO) market. It is not uncommon for DBFOs to take nearly two years from receipt of tender documents to financial close and for the bidding process to cost more than £3 million.

Initially, local authorities had an ambivalent attitude towards the initiative but are now showing interest particularly for the provision of schools, which should create opportunities for smaller contractors executing the building work as subcontractors.

In practice, construction cost managers and project managers have established themselves as key participants within PFI/PPP projects in a number of areas. As well as performing advisory roles for public sector clients, cost and project managers are called upon to assist with the other key parties to a PFI/PPP transaction, namely the bidders and the financiers. Construction cost managers and project managers have a significant role to play in this challenging environment not only in the UK but also internationally in countries such as South Africa and Australia.

5.11 Questions

1. The proposal is to widen the M6 motorway between Birmingham and Manchester – a distance of 80 miles – from 3 lanes each way to 5 lanes each way.

   Bids are invited from international consortia to execute the project under a PFI arrangement.

   Identify the main risks for the public sponsors, the SPV, the lenders and the contractors under the following headings:

   a. Social
   b. Legal
   c. Economic
   d. Environmental

e. Political
f. Technological.

For solution see Fig. 6.2 p. 68 in David Eaton's *A Report on PFI and the Delivery of Public Services Quantifying Quality*, RICS (2005) www.rics.org/NR/rdonlyres/A37E17C2-C4FC-4F50-AE40– 14F62E949BD3/0/PFI_Report.pdf (accessed 23 March 2007)

2. Compare and contrast the key differences between traditional public sector procurement and PFI (for a solution see CIC, 1998, p. 10);
3. Identify the key issues and the lessons to be learned on the PFI case study, *The Redevelopment of the Cruciform Building*, University College London www.hefce.ac.uk/Pubs/hefce/1999/99_43.htm (accessed 23 March 2007)
4. The NAO has produced 58 reports on PFI/PPP projects. Make a 10-minute presentation to your peers on the key findings and recommendations of one report. http://nao.gov.uk/guidance/pfi_ppp_reports_by_sector.htm (accessed 15 February 2007)
5. David Eaton's research at the University of Salford, 'A report on PFI and the Delivery of Public Services Quantifying Quality' contains eight case studies. Make a 10-minute presentation to your peers on the key findings and recommendations of one case study. (www.rics.org/NR/rdonlyres/A37E17C2-C4FC-4F50-AE40-14F62E949BD3/0/PFI_Report.pdf [accessed 23 March 2007])
6. The Commission for Architecture and the Built Environment (CABE), *Client Guide Achieving Well-designed Schools through PFI*, gives a good overview of the design process under a PFI project. Make a 10-minute presentation to your peers on the recommendations from one chapter (chapters 2 to 7) www.cabe.org.uk/AssetLibrary/1919.pdf (accessed 23 March 2007)

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Useful websites

www.4ps.gov.uk
http://en.wikipedia.org/wiki/Private_Finance_Initiative

6 Contractor's estimating and tendering

6.1 Introduction

In the *Code of Estimating Practice* the Chartered Institute of Building defines estimating as 'the technical process of predicting costs of construction' and tendering as 'a separate and subsequent commercial function based on the estimate' (CIOB, 1997). At first sight the production of an estimate might appear to be a precise technical and analytical process. However, in reality it is often a subjective process based on knowledge and experience of the key participants.

The estimating process is very important, as it enables construction companies to determine their direct costs, and provides a *bottom line* cost below which it would not be economical for them to carry out the work (Smith, 1999). Overestimated costs result in a higher tender price and rejection by the client. Likewise, an underestimated cost could lead to a situation where a contractor incurs losses. If the contractor is selected then the estimate should also provide the basis for project budgeting and control.

The submission of successful tenders is obviously crucial to the very existence of contractors. Yet, a fundamental truth of competitive tendering, particularly on major works, is that the lowest tenderer is often the one who has most seriously underestimated the risks which obviously could have drastic consequences particularly in times of recession when margins are slim to say the least.

A study by Al-Harbi *et al*. (1994) identified that the main problems facing estimators in Saudi Arabia while compiling tenders for building works included tough competition, short contract period, incomplete drawings and specification, incomplete project scope definition, unforeseeable changes in material prices, changes in owner's requirements, current workload, errors in judgement, inadequate production time data, lack of historical data for similar jobs and lack of experience of similar projects. These items indicate the challenges faced by estimators no matter where the work is carried out.

Further research on the factors influencing project-cost-estimating practice in the UK (Akintoye, 2000) identified several key issues including complexity of the project, scale and scope of construction, market condition, method of construction, site constraints, client's financial position, buildability and location of the project. It is believed that these factors have a direct effect on the productivity levels on site and the overall performance of the project.

Additional research by Akintoye and Fitzgerald (2000) identified that the most significant factors resulting in inaccurate estimates included insufficient time for tender preparation; poor tender documentation; insufficient analysis of the documentation by the estimating team; low level of involvement from the site team that will be responsible for construction; poor communication between the estimating and construction teams and lack of review of cost estimates by company management. Tendering for work in an area which contractors have little knowledge is also a significant reason leading to inaccurate estimating (Carr, 1989). Thus, when tendering for work overseas, UK contractors sometimes form joint ventures with home-based contractors.

Smith (1995) identified three main factors which could lead to inaccurate estimates: first, inappropriate assessment of risk; second, inappropriate contract strategies; third, human characteristics of the individual estimator.

Despite these challenges, however, there can be scope for innovation when tendering. It is not unknown, on major civil engineering projects, for the award to be made to the contractor who devises a more economic design than the one proposed by the engineer for part or even the whole of the works. Furthermore, contractors have been awarded contracts even though their tenders were not the lowest; this may be due to a highly original method statement and design solution for the temporary works. On major international infrastructure projects it is not unknown for the major *big six* Japanese contractors to offer the client a deferred payment scheme. Japanese firms will often bid low and provide an excellent service in the hope of establishing a new, long-term, loyal customer.

Detailed investigation and pre-planning is essential as considerable site overhead costs can be saved by early completion of the project including salaries of site staff, accommodation, site services, standing construction equipment etc.

However, before any estimates can be submitted the first step for contractors is to get onto the tender lists. This could be done on an ad hoc basis or preferably in accordance with a sort of longer-term strategic marketing plan that is usually of a five-year duration. The five-year plan, which should be based on an analysis of the past and consideration of the future trends within the market, should be re-examined on an annual basis and modified accordingly.

Panel 6.1 Case study: Cessnock Dock Railway, Glasgow

Winning contracts through innovation is not a new concept. In 1893 the original Robert McAlpine won a contract for the Cessnock Dock Railway in Glasgow with a tender far below any other. Everyone agreed that it would be impossible for him to do the work for the tender as he had no means of transporting the substantial amount of excavated material from the project to the sea where it was required to be dumped.

Excavations on the job were made in plastic clay, in shale and in sand. A brick-making plant was constructed and in the event every brick used in the project was made from the excavated material and millions of bricks were sold. Roads were constructed to the sandpits and McAlpine not only had the sand hauled away for him but was paid a fair price.

Source: Saxon Childs, 1925.

6.2 Stage 1 – decision to tender

The first stage in the tendering process is the decision to tender. As soon as the tender documents are received the estimator should quickly skim through the documents in order to establish the following:

1. Amount and type of work involved in project and whether the company has any competitive advantage;
2. The approximate value of the project together with a review of the major resources required, particularly construction equipment, staff, key subcontractors and suppliers;
3. The programme requirements, that is, completion dates, sectional completion and critical milestone dates – will these require excessive overtime?
4. The form of contract, specification, method of measurement and if any amendments have been made to standard documents?
5. The time and recourses required for preparation of the tender;
6. Whether any contractor's design is required, and whether the main contractor is required to accept liability for any subcontractors' design. The contractor should be provided with a design brief and a performance specification clearly identifying their design responsibility;
7. Possible alternative methods of construction (where the contractor's expertise leads them to consider that a more economical design could be used, for example precast piles in lieu of cast in situ);
8. Design for temporary works (including support structures/cofferdams/temporary bridges/river diversions/special shuttering/scaffolding/groundwater control systems etc.);
9. Whether the risks are acceptable – this could include the following: weather conditions/flooding/suitability of materials – particularly filling material from quarries/reliability of subcontractors/non-recoverable costs, for example excesses on insurance claims/outputs allowed such as productivity/cost increases/terms and conditions in contract/ability to meet specification for price allowed/availability of labour/plant) and whether the tender is of particular interest.
10. Contract requirements for performance bonds, warranties and parent company guarantees;
11. Funding requirements for the project. It will be necessary to plot income against expenditure using the programme of works and the bill of quantities (BofQ)/priced-activity schedule – payments in arrears and retentions, both from the employer and to suppliers and subcontractors must be considered.

Upon completion of the review the estimator should complete a pre-tender data sheet, grade the tender based on the interest to the company and recommend whether or not to tender. If a contractor decides not to tender, the documents should be returned to the employer; however, in practice this rarely occurs.

The technical process of predicting the net cost of the works is carried out by a team comprising the estimator, planning engineer, materials estimator, estimating technician, together with possible contributions from temporary works designers and an experienced construction manager if the work is of a specialist or complex nature. At the end of the process the team will produce the *cost estimate*. The *estimate* is the prediction of the cost to the contractor. The *tender* is the price submitted by the contractor to the employer.

6.3 Stage 2 – determining the basis of the tender

During this stage the estimator, prior to the preparation of the cost estimate, will disseminate and assemble the key information and generally become familiar with the documents. Unlike pricing a BofQ in the building sector, a civil engineering BofQ/priced activities can be priced only when read in conjunction with the engineer's drawings and the specification. Projects carried out for water authorities, railway or road transport authorities are normally in accordance with standard sector-specific requirements.

Enquiries will be sent to subcontractors and major materials suppliers, the latter often based on the quantities calculated by the contractor's quantity surveyor from drawings. The contractor should also check that the major quantities in the BofQ are correct; if any are found to be incorrect this factor will be considered later at the commercial appreciation stage.

However, the most important part of this stage is for the team to determine the *construction method* and sequence upon which the tender is based, together with an *outline programme of the works*, two items that are inseparable.

The construction method will often be dependent on the design of the temporary works necessary to enable the permanent works to be constructed. Temporary works are normally designed in-house by the contractor, but in case of scaffolding and falsework, design may be supplied by specialist contractors.

Temporary works may have considerable time and cost implications, and can include cofferdams and temporary bridges on riverworks, temporary piling and jetties on marine projects, overhead gantries on elevated motorways, dewatering systems and grout curtains on deep basements etc.

The contractor may further be required to design part of the works to meet a performance specification, for example, concrete specified to strength or piling to a load-carrying capacity; this design would often be undertaken by specialist suppliers or subcontractors.

A further involvement of the contractor's design department may be in identifying more economic alternative design solutions for sections of the permanent works. This is often done in the hope of sharing the saving involved, which could be considerable.

The programme could be in the form of a bar chart or in the case of major works based on a network showing the critical path produced utilizing computer software. The programme will be used by the successful contractor as a control document for monitoring progress and calculating the effects of delay and disruption to the flow of the works.

The programme is particularly important as 15–40% of the cost of civil engineering work is time related and many items such as site overheads are computed directly from it. Furthermore, as most contractors will be bidding using the same quotations from subcontractors, hirers of construction equipment and materials suppliers, obtaining a saving in time is one of the few ways in which the contractor can show a substantial saving to the project cost.

During this stage the estimator will need to identify any inherent restrictions (e.g. delivery of bulk materials by rail or water) and any items on long delivery (e.g. special equipment). They will further need to consider alternative methods of construction, sequence of construction and the level of utilization of resources.

In accordance with the requirements of the standard conditions of contract the contractor is deemed to have inspected the site and examined its surroundings. The contractor may also visit the engineer's office and the local authority in order to examine core samples, location of existing services, traffic requirements and any other relevant information available. If the contractor is to be responsible for the design of a significant part of the works then the contractor may need to carry out further site investigations. However, it is the employer who should identify how this can be done most efficiently.

Following the site visit a standard, comprehensive pro-forma checklist will normally be prepared listing such items as access to site, site security, provision of services, soil and ground-water information, nature of excavation fill and disposal, nearest tipping facilities, availability of labour, construction equipment and materials, site organization and layout, land purchase for borrow pits etc.

Method statement
Contract: New Reservoir, Bryn Gwynant *Sheet No.:*
Tender No.: *Prepared by:*
Date:

No.	*Operation*	*Quantity*	*Method*	*Sequence of operations*	*Plant and labour*	*Output*	*Duration*
1.	Strip topsoil	7,500 m^3	Excavate using loading shovel and transport to temporary tip using dump trucks		Loading shovel and three dump trucks	50 m^3/hr	15 days
2.	Drainage To dam	300 m	Excavate using back actor, load, transport to temporary tip using dump trucks	Excavate, load trench support, lay pipes, backfill	Backactor +three dump trucks	Based on 3 gangs 15 m per day	20 days

6.1 Typical method statement.

The method statement (see Fig. 6.1) is a key document in the preparation of the tender and should consider the site-visit report, the geotechnical report, the sequence and methods for the main operations of work, subcontracted work, bulk quantities, schedule of labour and construction equipment and any temporary works required.

The Construction (Design and Management) Regulations 2007 (CDM2007) also require the principal contractor before the start of the construction phase to prepare a construction-phase plan which is sufficient to ensure that the construction phase is planned, managed and monitored in a way which enables the construction work to be started as far as reasonably practicable without risk to health and safety. The CDM2007 Regulations also require the principal contractor to ensure that the construction-phase plan identifies the risks to health and safety arising from the construction works and includes suitable and sufficient measures to address such risks.

Stage 2 can be summarized as follows:

- *Examine key documents*: drawings/specification/BofQ (works information, site information, contract data);
- Send enquiries to major subcontractors and materials suppliers;
- Check major quantities in the BofQ;
- Determine the method of construction and the outline programme of the works;
- Examine more economic alternative designs, design temporary works and any necessary permanent works;
- Identify inherent restrictions for example access to site/transport;
- Visit engineer's office – examine core samples;
- Visit site – compile site-visit report.

6.4 Stage 3 – preparation of cost estimate

During this stage the estimator will assemble information on the net cost of the works including calculating the following: the current rates for labour materials and construction equipment, the unit or activity rates, the preliminaries or general items and finally the summaries.

Current rates for labour, materials and construction equipment

The rates for labour will be the 'all-in' rates, that is, the contractor's total cost per hour of employing the different categories of labour. These hourly rates are calculated based on the basic rates as the national working rule agreement with the defined allowances for special skills together with bonus payments, holiday pay, CITB levy, employers' insurance etc. An example of the detailed build-up of the all-in labour rate is shown in the latest copy of E&FN Spon's *Price Book for Civil Engineering Works*.

The rates for material should cover for transport to site, offloading/storage, unavoidable double handling and waste. Prices for bulk materials must be scrutinized in order to ensure that they meet the specification and testing/sampling requirements; delivery must also meet the demands of the programme.

The construction equipment rates should cover for transport to site, erection/dismantling, operators, maintenance and fuel. Major static items of construction equipment such as tower cranes are normally priced separately in the general items or method-related charges section whilst other items are often included in the individual rates.

Unit rates for each item in the BofQ/activity schedule

The three main estimating techniques used by contractors when pricing major construction works are detailed below.

Unit-rate estimating

Unit-rate estimating, which is the standard procedure in the sector, involves pricing individual rates in the BofQ which has been prepared in accordance with a method of measurement for example SMM7. The unit rates are calculated using one of the following methods:

- Historical rates based on productivity data from similar projects;
- Historical rates based on data in standard price books for example E&FN Spon's, Wessex, Laxtons, Hutchins *UK Building Costs Blackbook*;
- *Built-up* rates from an analysis of labour, materials and construction equipment for each item and costed at current rates.

There are several possible disadvantages of using the unit-rate method for estimating major works. The system does not demand an examination of the programme or the method statement and does not encourage an analysis of the real costs and major costs risks in undertaking the work. Furthermore, the precision and level of detail in pricing each item can give a false sense of confidence in the resulting estimate.

Generally, it is not recommended that the data from standard price books are used in the estimating of major civil engineering works, either at tender or when variations are required. The reason for this is due to the possible differences in ground conditions, method statements, temporary works, availability of construction equipment, location of the project and the time of year in which the work is executed etc. Each project should be considered on its own merits and the cost estimate based on first principles using the operational method.

Operational estimating

Operational estimating, which is the recommended method for estimating civil engineering works, requires the estimator to build up the cost of the operation based on first principles, that is, the total cost of the construction equipment, labour and permanent/temporary materials. This method of estimating links well with the planning process as it embraces the total anticipated time that the construction equipment and labour gang are involved in the operation including all idle time.

If a BofQ approach is used, the total cost of the operation is then divided by the quantity in the BofQ to arrive at an appropriate rate. A significant advantage of this approach is that it provides a complete integration between the estimate and the programme which in turn enables a project cash flow to be produced. Furthermore, the pricing of operations, or activities, is obviously compatible with the NEC ECC *Priced Activities* approach. The process involves the following:

- Compiling a method statement, showing sequence, timing, resources required;
- Refining the method statement to show an *earliest completion* programme with no limit on resources;
- Adjusting the programme by *smoothing* or *levelling* the resources in order to produce the most economic programme to meet the time constraints;
- *Applying current unit costs*: fixed, quantity proportional and time related.

Establishing realistic productivity levels for labour and construction equipment on major operations can prove difficult, particularly on overseas work. However, the operational estimating approach enables the estimating team to better appreciate the major risks and uncertainties in the work.

Man-hours estimating

Man-hours estimating is most suitable for work which has significant labour content and/or for which extensive reliable productivity data exists for the different trades/specialisms involved. Typical applications include the following:

- Design work and drawing production, both engineering and architectural;
- Installation of process plants and offshore modules.

This method of estimating is frequently used by the major mechanical and electrical contractors as well as by the large American contractors, for example Bechtel. It should be used in conjunction with a construction programme/schedule in order to highlight any restrictions, for example availability of heavy-lifting equipment, which may affect labour hours expended in fabrication yards or on site.

AN EXAMPLE OF OPERATIONAL METHOD OF ESTIMATING

The question relates to the construction of a reinforced concrete basement (size 50 m × 30 m × 10 m deep) built below ground on a green field site.

The contractor's estimator is required to calculate an appropriate BofQ rate.

E326 Excavation for foundations, material other than topsoil,

rock or artificial hard material maximum depth 5–10 m 15,000 m^3

Approach: Consider two alternative construction methods.

- Method A – open cut with battered sides (assume total volume of excavation equals 2.5 × net volume) – the open-cut method will require additional working space to allow for erect and strip shutter to the outer face;
- Method B – steel cofferdam built around net perimeter of basement.

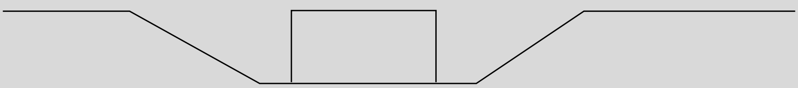
Assume the following net costs (based on quotations from subcontractors):

- Excavation open cut – £10 per m^3;
- Disposal on site – £1 per m^3;
- Bring back and fill – £2 per m^3;
- Excavation restricted within cofferdam – £25 per m^3;
- Sheet piling (assume 15 m deep) – £35 per m^3;
- Mobilization/demobilization-piling rig – £5,000 each way;
- Extract cofferdam piling – £5,000;
- Site overheads – 10%, head office overheads and profit – 12%.

Solutions

There are two solutions; costs involved as described in method A (open cut) and costs involved in method B (steel cofferdam) (see Figs 6.2 and 6.3); both are discussed in detail in the following sections.

Costs of method A (open cut)



6.2 Method A (open cut).

Excavating in open cut 15,000 × 2.5 m^3 = 37,500 m^3 @ £10/m^3	£375,000
Disposal on site 37,500–15,000 = 22,500 m^3 @ £1/m^3	£22,500
Bring back and fill 22,500 m^3 @ £2/m^3	£45,000
Total net cost	£442,500

It is up to the contractor to select the most economic method of working. The additional excavation required is dependent on the nature of the ground and the natural slope of inclination – generally the harder the material the steeper the slope.

Costs of method B (steel cofferdam)

6.3 Method B (steel cofferdam).

Sheet piling – mobilization/demob 2 × £5,000	£10,000
Sheet piling 160 × 15 = 2,400 m^2 @ £35/m^2	£84,000
Excavate within cofferdam 15,000 m^3 @ £25/m^3	£375,000
Extract cofferdam	£5,000
Total net cost	£474,000

Thus, based on the above, the estimator would choose the open-cut method.

Net cost of open-cut method	£442,500
+ 10% site overheads	£44,250
	£486,750
+ 12% head office overheads and profit	£58,410
	£545,160

So rate to be included in the BofQ should be £545,160/15,000 m^3 = £36.34/m^3

Subcontractors

The management of subcontractors can make or break a contract as typically subcontractors comprise over 75% of the total work executed. Few contractors have the necessary continuity in projects to justify purchasing specialist plant or have the expertise necessary to execute all the work, for example, specialist piling or diaphragm walling, hence the use of subcontractors. Indeed, over the years the role of the main contractor has shifted from a traditional works contractor towards the management of works packages.

However, it is still a prudent policy for main contractors to price as much of the basic subcontract work as if it were being carried out by their own resources, this should ensure that the work is adequately priced and reduce the risk to the main contractor.

The construction industry has traditionally had an uneasy relationship with its subcontractors often going back to subcontractors in order to gain price reduction or increased discounts after tender award. Furthermore, main contractors choose to dump as much risk as possible onto subcontractors through the use of penal clauses in the subcontract documents. However, the more enlightened clients are now adopting a partnering approach with integrated project teams and fair conditions of contract, for example, the NEC ECC subcontract form.

Enlightened contractors could conduct a buildability review with the specialist designers in order to identify more economic/practical/safe methods of working. The developed improvements might or might not be declared at tender depending on the particular terms of the contract. For example, under a target-cost contract it may be advisable to leave the identification of these savings until the construction stage.

General items (preliminaries)

The general items or preliminaries represent the cost of operating the site and will need to be calculated separately. These items can be included on a time-related or a fixed-price basis. Typical general items on a major civil engineering project might include the following:

- Site staff, including project manager, agents, engineers, foremen, quantity surveyors, office manager, store keeper, clerks, secretarial;
- Head office staff allocated to project, for example, designers; health and safety;
- Company cars;
- Site offices, mess huts, toilets, running costs;

- Transport for construction equipment;
- General site labour;
- Services connections and running costs;
- Haul roads;
- Temporary fencing;
- Construction equipment purchases including personnel carriers, land rovers, compressors, pumps, cranes, miscellaneous;
- Scaffolding and hoists;
- Access for subcontractors;
- Small tools;
- Plant consumables including fuel and fuel distribution;
- Contract works insurances;
- Setting up compounds;
- Security;
- Signboards;
- Road-cleaning facilities;
- Computing equipment;
- Office stationery etc.

If the contractor is successful and is awarded the contract then detailed records will need to be kept for these preliminaries items. If any extension of time claims are made these items will form the basis of the *site overheads* component within a prolongation claim.

Preparation of summaries, tender summary, analysis sheets, special conditions

Self-explanatory but basically the bringing together of the estimate. Stage 3 (preparation of the cost estimate) can be summarized as follows:

Calculate current cost rates for labour/materials/plant

- Calculate unit rates for each item using one of the following methods:

    a. Operational method (based on method statement and construction programme – consider total resources, that is, teams of operatives and equipment);
    b. Unit rates (normal approach in the building sector);
    c. Man-hours estimating (used by US contractors on Petrochemical projects – based on work study feedback).

- Analyse and check subcontractors' quotations;
- Price preliminaries;
- Prepare summary sheets.

6.5 Stage 4 – commercial appreciation

Tender committee meeting – part 1

Following the production of the cost estimate a small management team, comprising the chief estimator and proposed contracts manager, will make a separate comprehensive evaluation of the estimate to ensure that the bid is both feasible and commercially competitive.

The first task of the senior management team at this tender committee meeting is to review the estimate taking into account the construction method and programme, the technical and commercial risks, the contract cash flow and finance, the potential for use of own construction equipment, the competition, the economic climate and the commercial opportunities.

On contracts involving major earthworks the risk can be considerable, particularly in connection with borrow pits and quarries, as the material to be extracted may subsequently be rejected as unsuitable by the engineer, or the local authority may refuse a planning application for the extraction.

Weather conditions can also be influential with continuous wet weather likely to cause a prolonged shutdown of all major earthmoving operations, the costs of which may not be recoverable under the contract.

Other risks include reliability of subcontractors – failure to perform or bankruptcy is at the contractor's risk; increases for inflation, for example steel and fuel; availability of suitable labour – specialist labour may need to be brought in from elsewhere within the UK or from overseas; terms and conditions in suppliers or construction equipment contracts; estimator's productivity allowance; premiums on insurances.

The team will also consider the commercial opportunities, particularly the method of billing and whether the major quantities are under or over measured or any items omitted entirely, any differences between the specification, drawings or B of Q, the lack of drawings or poor design and the contractor's alternatives. This stage can be summarized as follows.

Review the following:

- Method statement;
- Programme;
- Technical, design and commercial risks (NEC3 has introduced the concept of a risk register which allows contractors to identify which items they have/have not allowed for);
- Cash flow and finance;
- Use of own construction equipment;
- Competition;
- Commercial opportunities;
- Economic climate.

6.6 Stage 5 – conversion of estimate to tender

Tender committee meeting – part 2

The second task of the senior management team at the tender committee meeting is to convert the estimate into the tender bid. The following items are considered and agreed upon:

- The financial adjustment to be made following the commercial review;
- The allowances for discounts on subcontractors and suppliers;
- Late quotations, these could be included as an *adjustment* item at the end of the tender;
- The contribution for head office overheads – usually between 4% and 8%;
- Profit, normally on what the market can stand;
- Qualifications to the bid, if any.

At the conclusion of the meeting the estimator will be required to convert the cost estimate to the tender bid.

The difference between the 'prime cost' (the cost of doing the work in the field including all operatives below foreman level (labour/materials/plant/subcontractors) and the 'final tender' is called *the spread*, which can amount to 25% of the tender. This amount can be allocated to the tender in a number of ways:

- Evenly on all rates;
- Differentially, for example, front-end loading on early items;
- As a lump sum in the preliminaries.

6.7 Stage 6 – submission of tender

Finally the tender should be submitted to the client in the form specified in the invitation letter, arriving at the correct address at the right time. The contractor should keep all copies of the tender documents marking drawings 'used for tender'.

6.8 Conclusion

Establishing the cost of the estimate and the price of a traditional, or design and build project, in the civil engineering sector presents a massive challenge to the contractor.

In the UK, fewer clients in the civil engineering and infrastructure sector are using the standard ICE *Conditions of Contract* with tenders based on detailed BofQs. Instead, many clients are now choosing to use the NEC engineering and construction contract's priced-activities route. This approach complements the operational method of estimating but often requires the contractor to calculate their own quantities.

Using the data generated from the operational method of estimating, and the information received from specialist subcontractors, the estimator should be able to prepare a detailed method statement. This key document identifies the activities and the methods of working, the labour gangs and construction equipment, the temporary works, and critically, the production rates (concrete output per hour or day) enabling the calculation of total days per activity. The method statement thus provides the key data which forms the basis for the construction programme (or schedule).

All estimates will require the estimator to assess the risks for the project, which on civil engineering projects can be considerable, and forecast future increases in raw materials, if it is a fixed-price tender. Traditionally, contractors have sought to shift these risks onto subcontractors through the use of harsh conditions of subcontracts.

Furthermore, in the past, many contractors were selected on the basis of the lowest bids. These low bids might have been developed based on innovative working methods or alternative designs but might also have been a result of the contractor's misunderstanding or underestimating of risks in the project. This traditional approach often resulted in an adversarial position being taken by both the client and the contractor.

In order to improve the process, we have seen in Chapter 4 how some clients are now selecting contractors on the basis of a Quality/Cost model typically (60/40%). For one-off projects, some clients are selecting contractors based on a design and build approach under a partnering arrangement. Other clients, with a long-term building programme, are utilizing framework agreements with payments made based on target costs under an open-book accountancy approach. So the world is rapidly changing, but the estimating and tendering approach described in this chapter will still have relevance for many projects, including PFI schemes, both in the UK and overseas.

6.9 Questions

1. Why would a promoter wish to make amendments to the standard contract documents?
2. Why would an estimator go to the trouble of checking the major quantities?

3. Labour costs are estimated based on an *all-in* rate. What is meant by an *all-in* rate and how is it calculated?
4. How would the contractor's estimator calculate a due allowance for waste on materials and how accurate is this likely to be?
5. What are the main elements of cost, which must be taken into account a tender for civil engineering works and how would the estimator assess each item?
6. A tender for a project requires considerable deep excavation for which you propose allowing the use of temporary sheet piling. However, you are aware that battered side slopes may be a suitable alternative at a similar cost. How would you insert the costs in the tender BofQ/activity schedule?
7. Describe the steps you would take as a contractor to ensure that before submitting a tender you had obtained for yourself all the necessary information as to site conditions, risks, contingencies and all other circumstances influencing or affecting your tender, as required under the NEC ECC contract.

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Part III
Key tools and techniques

7 Value management

7.1 Introduction

The value management process (see Fig. 7.1) originated during World War II within the General Electric Company (GEC) in the USA. GEC was faced with an increase in demand but had a shortage of key materials. Larry Miles of GEC, instead of asking 'how can we find alternative materials', asked 'what function does this component perform and how else can we perform that function?' This innovative approach led the company to use substituted materials for many of its products. They found, surprisingly, that the cost of the product was often reduced but the product improved; care and attention to function provided *better value for money*.

A spin-off of this approach was the elimination of cost, which did not contribute to performance – this was known as value analysis. Over the next ten years this was further developed by GEC and became known as value engineering (VE). Value management (VM) developed from VE and is now a requirement on many public and private projects in the USA and Australia.

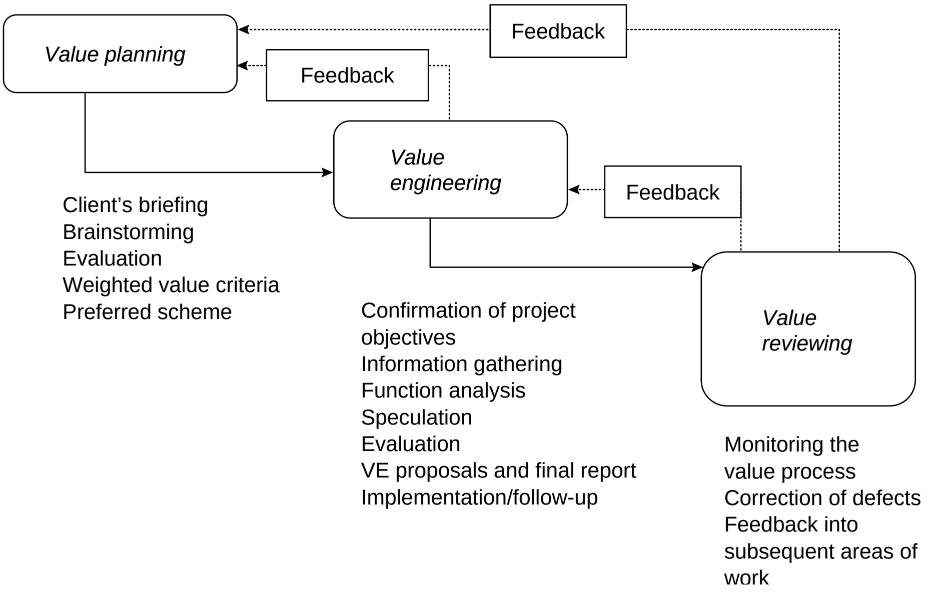
It was only in the late 1980s that VM began to be used in the UK. The author first came across the use of VM on the £50m International Convention Centre in Birmingham; this four-year project was completed in 1991. Two years into the construction period an American VM consultant was engaged to execute VE exercises. However, by that time it became too late to effect any meaningful changes. In reality, there are various triggers for a VM exercise, which are usually workshop based, for example new legislation, new opportunities for a commercial product, solution of a social problem or simply overspend on the budget.

In the UK, the public sector has been slow to take up VM; however, with the introduction of concepts such as 'Best Value' and 'Prime Contracting' there has been an uptake in interest. However, the ultimate challenge is to integrate risk management and VM into a single framework that evolves throughout the life of the project.

7.2 What is value management?

Value management (VM) is the wider term used in the UK to describe the overall structured, team-based approach to a construction project. It addresses the value process during the concept, definition, implementation and operation phases of a project. It encompasses a set of systematic and logical procedures and techniques to enhance project value throughout the life of the facility.

VM embraces the whole-value process and includes value planning (VP), VE and value reviewing (VR).



7.1 The value management process (source: ICE, 1996).

The basic steps are as follows:

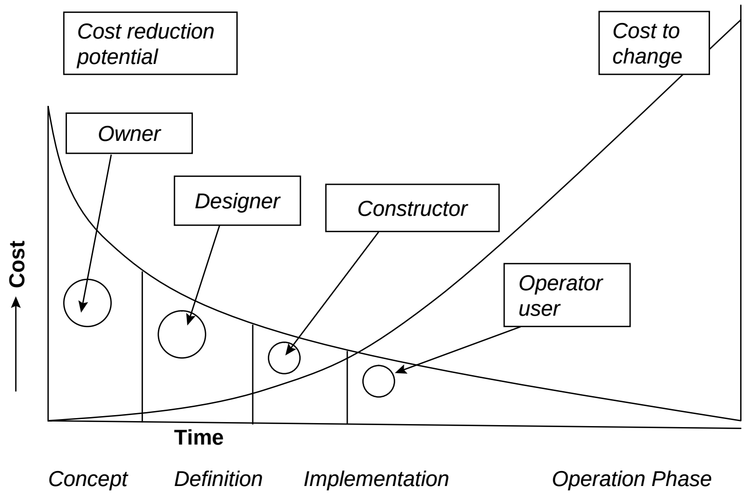
1. To determine the functional requirements of the project or any of its constituent parts;
2. To identify the alternatives;
3. To examine the cost and value of each alternative to enable the *best value selection.*

Terminology

Confusion has arisen in the definitions of value depending on geographic location; VM/VE, VP, value auditing are often interchangeable. The following definitions are preferred:

- ***Value:*** value is the level of importance that is placed upon a function, item or solution.
- ***VE:*** value engineering is the process of analysing the functional benefits a client requires from the whole or parts of the design.
- ***VP:*** value planning is applied during the development of the brief to ensure that value is planned into the project from the beginning.
- ***VM:*** VM is a systematic and creative procedure operating on the relevant aspects of the value process through the life of the project or facility.
- ***Function:*** a mode of action or activity by which a thing fulfils its purpose. Understanding the concept of function is important as this can provide the catalyst to introducing innovative solutions. For example, consider the function of an internal wall, it can: separate space, secure space, maintain privacy, support heating systems, support fittings and fixtures, transfer load, reduce noise etc. If we merely required to separate floor space we could use a row of potted plants or different floor material.

Figure 7.2 shows the introduction of the parties into the project cycle under the traditional procurement route; this highlights the importance of involving all the key parties early in the process under a partnering agreement or better still a long-term alliance. Studies at the early stages of a project are much more effective and of shorter duration than those conducted later on. This is because the opportunities for making changes reduce as the project progresses, and



7.2 Stakeholders' impact on project cost (source: ICE, 1996).

the cost of making such changes increases. Indeed, once the concept has been frozen, about 80% of the total cost has been committed – even though no design exists.

All client bodies operate a capital-approval process that calls for certain criteria to be met before passing from one stage to the next – known as approval gateways. Each approval gateway presents a natural opportunity to conduct a VM study to verify that the scheme, as it has evolved so far, represents optimum value to the client. It is unusual to conduct a formal study at all of these gateways – usually two, or at most three, are sufficient.

The first stage in any project is to establish that a project is the most appropriate way in which to deliver the benefits which are required and then consider the following questions. Is it likely to be viable? Do the conditions exist to enable the project to stand a chance of success? Is it affordable? Answering these sorts of questions is the main purpose of Gateway 0 in the OGC's Gateway Review Process. VM can play a significant contribution at this stage. Table 7.1 identifies the key questions which should be asked at each stage of the VM study throughout the project cycle.

7.3 Value planning (VP)

Value planning (VP) is applied during the concept phase of a project. VP is used during the development of the project brief to ensure that value is planned into the whole project from its inception. Several outline designs are assessed to select a preferred option which best meets the functional and other requirements.

At this stage the value criteria are identified and concept proposals are put forward to satisfy the client's needs and wants. The needs are those items which are fundamentally necessary for the operation of the project, whereas the wants are items which the client would like to have but are not essential. Best value is provided by delivering a solution which delivers all the needs and as many of the wants as possible within the permitted budget.

In order to achieve maximum benefit from the effort applied by the individuals, it is common practice to apply the principle of the Pareto rule (80% of the value lie in 20% of the items).

Table 7.1 Typical questions to be asked at each stage of the value management (VM) study on a new urban highway project.

Stage in project	*Questions to be asked*	*Comments*
Concept	What is the problem?	Road congestion, lack of decent infrastructure
	Is this the right project to deliver the benefits?	Yes
	Does this meet our business criteria?	Part of government/local transport plan
Feasibility	Which is the best option?	Route B
	Does this solution satisfy our need?	Yes, least demolition of existing housing
Design	Does the solution fulfil all requirements?	Best compromise solution
	Is it good value for money?	As good as possible
	Can it be built?	Yes
Construct	Are the components cost-effective?	Detailed value engineering (VE) exercise required on road surface, bridge and tunnel construction
Use	Did we achieve the expected benefits?	Improved transport links now helping to regenerate city
	Are there lessons to be learnt for our next project?	Develop-design-build partnering approach; always expect the unexpected!

Source: Adapted based on Dallas, M., 1998.

7.4 Metropolis United's new football stadium

Second division Metropolis United is keen to move from their cramped town centre stadium to a greenfield site on the edge of town. The directors of the club realize that they require a 30,000 all-seater stadium if they are to compete in the top division.

The client's project manager suggests that a VM exercise would enable the directors and the council officers representing the local council who are partly funding the project to identify the priorities for the club. Unfortunately, there is little involvement of other key stakeholders – the fans, the manager and the players! The mechanism for incorporating best value into the project design is through the use of VP workshops. The first step of the workshop is to gather information concerning the project – generally through a briefing with the client.

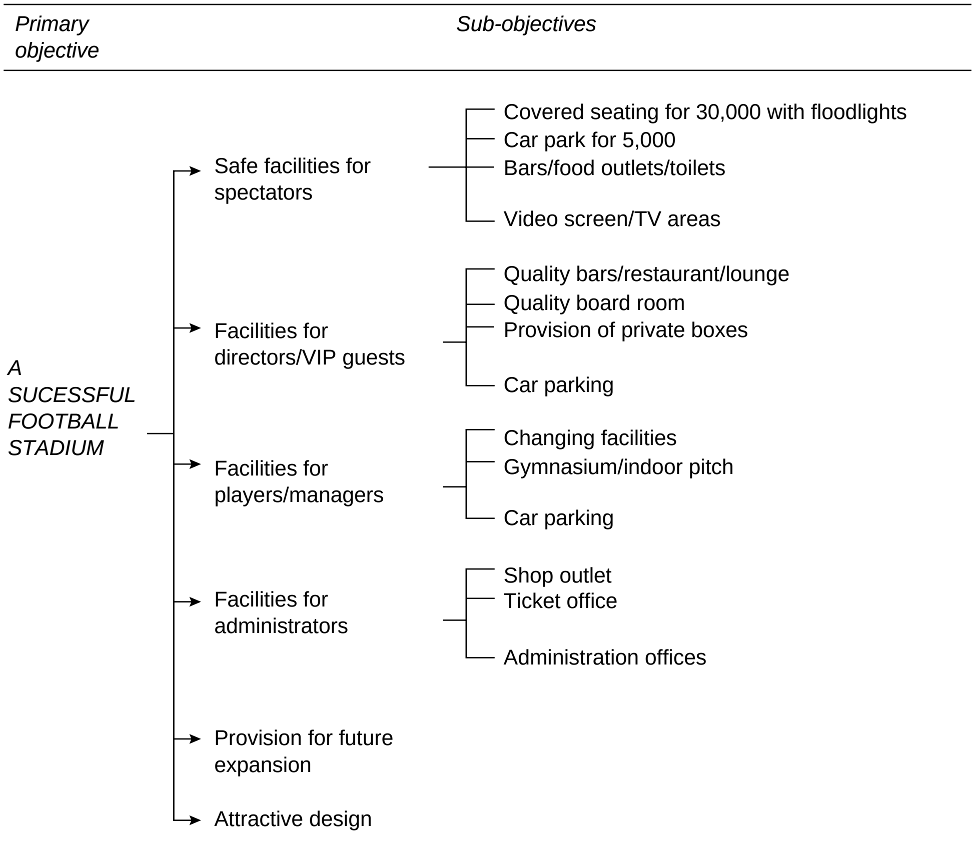
In the first stage of VP, at the Concept Stage, a *value hierarchy* (see Fig. 7.3) is developed. It aims to establish a shared perception of the design objectives and attributes.

In the second stage of VP a *value tree* is drawn up (see Fig. 7.4) based on a simplified hierarchy. Although capital cost is one of the attributes used to evaluate design options, it is preferable to omit it from the value hierarchy and deal with it separately at the end of the analysis.

The logic of the diagram emanates from the how–why approach. In essence, by providing all the criteria on the right-hand side of the diagram, one will have provided all primary requirements on the left-hand side of the diagram. These criteria can then be weighted according to their degree of importance to the client.

In the second stage of VP, the project solutions would have been proposed which met these criteria; usually this exercise takes the form of a brainstorming session where creative thinking and synergy between experienced participants lead to effective solutions to meet the value criteria.

After some considerable deliberation, the client representatives compile a weighted value tree (with the highest attribute scoring 50 and the lowest scoring 10). Naturally the directors of the club, who are providing their own financial support to keep the club in existence, consider



7.3 Value hierarchy at concept stage for new football stadium (note: Developed by author based on CIRIA, 1996).

that the facilities for directors and visiting VIPs are paramount; these attributes are therefore scored with a high 40 or 50. Attractive design is considered low priority for these self-made businessmen and is marked at 20.

The sum of the initial scores is 540. Each of the weightings of the six secondary objectives is then calculated. Thus a *safe facilities for spectators* equates to 130 (40 + 30 + 30 + 30) divided by the total score of 540 equals a weighting of 0.24% or 24% of the total.

In the next stage, the possible design solutions submitted by the design and build (D&B) contractors would be evaluated and ranked. The allocation of importance weights to the value hierarchy forms the basis for the next stage of the second workshop, which is deciding which of the available designs provide the best value. Evaluation involves assessing each option against each of the identified attributes, and this is best done in the form of a *decision matrix* (see Fig. 7.5). Finally, the team would make recommendations to the client.

Design option B shows the highest score with 54.0, with the highest score for *facilities for directors* but the lowest score for *safe facilities for spectators*. Design C shows a marginally lower overall score than B but with improved *spectator facilities* and a lower score for the *directors' facilities*.

This exercise is typical of the possible dilemmas facing clients and their advisors. This is not a science, but more an art. It is extremely difficult to score each of the sub-objectives and choosing

Primary objective	*Secondary objective*	*Sub-objectives*	*Initial score*	*Weighting for each attribute*
A SUCESSFUL FOOTBALL STADIUM	Safe facilities for spectators	Covered seating for 30,000 with floodlights	40	0.24
		Car park for 5,000	30	
		Bars/food outlets/toilets	30	
		Video screen/TV areas	30	
	Facilities for directors/ VIP guests	Quality bars/restaurant/lounge	50	0.33
		Quality board room	50	
		Provision of private boxes	40	
		Car parking	40	
	Facilities for players /managers	Changing facilities	40	0.20
		Gymnasium/indoor pitch	30	
		Car parking	40	
	Facilities for administrators	Shop outlet	30	0.17
		Ticket office	30	
		Administration offices	30	
	Provision for future expansion		10	0.02
	Attractive design		20	0.04
			540	1.00

7.4 Simplified value tree at feasibility stage with importance weightings (note: Developed by author based on CIRIA, 1996).

Attributes	*Safe facilities for spectator*		*Facilities for directors/ VIP guests*		*Facilities for players*		*Facilities for administrators*		*Provision for future expansion*		*Attractive design*		*Total*
Weight of importance	0.24		0.33		0.20		0.17		0.02		0.04		
DESIGN OPTION A	70	16.8	20	6.6	10	2.0	20	3.4	40	0.80	60	2.4	32.0
DESIGN OPTION B	40	9.6	80	26.4	20	4.0	60	10.2	70	1.4	60	2.4	54.0
DESIGN OPTION C	50	12.0	50	16.5	80	16.0	40	6.8	10	0.2	40	1.6	53.10

7.5 Decision matrix (note: Shows the process of comparing the total scores of the various design options).

between one contractor's design and another again becomes subjective. In the event, design option B is chosen!

7.5 Value engineering (VE)

VE is applied during the definition stage and, as required, in the implementation phases of a project. VE investigates and analyses in order to identify the required function and then compares and selects from the various options to produce the owner's best value requirements.

During the VE phase any unnecessary cost is eliminated from the proposed design. This is usually undertaken in the VE workshop where a separate review team from that which developed the outline design reviews the work to date. Since this review is generally undertaken at approximately the 30% stage, there is still a good opportunity to adjust the design before it proceeds to the definitive and detailed design stage.

The basic premise of VE is that a certain amount of unnecessary cost is inherent in every design. It is usually only possible to eliminate this by identifying another option, which provides the same function at lesser cost.

Specific causes of unnecessary cost include the following:

1. Cost of unnecessary attributes (attributes which provide no useful function);
2. Cost of unnecessary specification (due to needlessly expensive materials/components);
3. Unnecessary cost of poor buildability (failure to consider construction implications during design);
4. Unnecessary life-cycle cost (failure to consider future operational costs);
5. Unnecessary opportunity cost (the cost of losing potential revenue).

The VE workshop follows the broad principles of the VP workshop. The information phase usually involves a debriefing from the original design team to the VE team, who then consider, in the functional analysis, the function of each part of the proposed works. In the speculation phase, they have a brainstorming session and consider alternative methods of providing the same function.

There follows an evaluation phase in which the proposed alternative solutions to providing the function are analysed to determine the viability of each one. Where a suitably viable alternative is possible at a significantly reduced cost, it is included in the proposal phase.

Panel 7.1 Value engineering techniques

The different ways of delivering a client's requirements offer further potential for adding value to a project. With engineering services, examples of innovation that can have a significant effect on the overall project outcome include the use of ground-water cooling or gas-fired air-handling units.

Innovative solutions such as this need to be adopted at the earliest possible stage of a project. When the value engineering approach is applied at a later stage, it is difficult to introduce radical changes. However, opportunities to add value still exist, such as the use of manufacturer's standard components rather than bespoke products.

Source: www.davislangdon.com (accessed August 2005, value engineering cost model)
For a description of small-scale renewable energy systems see *Building*, 28 October 2005, pp. 54–57.

Panel 7.2 40-hour workshop

In the USA, the classic value engineering (VE) exercise is a 40-hour workshop attended by the value manager and an independent design team. The findings are reported to the client and project manager for further action/implementation.

While an independent design team has the advantages of providing a fresh and critical approach and an independent review, in the UK the disadvantages are generally believed to outweigh them. These include

- conflict with the existing design team;
- loss of time while the external team becomes familiar with the project;
- the additional cost of a second design team;
- delay and disruption to the design process during the review.

Also the external team may feel obliged to identify cost savings to justify their fee.

Source: CIRIA, 1996.

Ideally, every design decision should be subject to VE, but 80% of cost is often contained in 20% of the design decisions. On building projects, services in particular account for a very large percentage of the overall cost (28–40%). This element can be further broken down into mechanical services (17–28%), electrical services (6–13%) and lifts (0–3%). On road projects, the three highest-cost elements are typically earthworks (28–31%), structures (18–32%) and sub-base and surfacing (21–28%) (CIRIA, 1996).

7.6 Value reviewing (VR)

VR is applied at planned stages to check and record the effectiveness of the value process and its management.

The 'value manager' usually has a responsibility to review the value process throughout the project to ensure that the value identified in the VP and VE are actually provided within the executed works.

When to apply VM

Timing is of the essence. Fig.7.2 illustrates the substantial scope to reduce cost, and hence improve value, in the project definition and early design phases. This scope diminishes to point when the cost of change exceeds the saving.

Any construction project should only be commissioned following a careful analysis of need. Failure to carry out this analysis will cause problems at subsequent design and construction stages.

Many projects suffer from poor definition through lack of time and thought at the earliest stages. This is likely to result in cost and time overruns, claims, user dissatisfaction or excessive operating costs. VM can help to avoid these problems.

VP and VE are mainly applied in the concept and definition phases, and generally end when the design is complete and construction started. However, VE can be applied at the construction stage to address problems or opportunities which may arise.

At a later stage a tendering constructor may be expected to bring other value improvement ideas and techniques for consideration by the owner.

Finally, the project may run into practical, cost or time difficulties during construction, and here again solutions may be developed using VM.

7.7 Case studies

Case study 1: the Turner Centre in Margate

The Turner Centre in Margate, Kent, is an ambitious and futuristic art gallery. It forms one of the first steps in a much broader programme to help regenerate Margate. Numerous stakeholders groups are involved, including Kent County Council and Thanet District Council, that comprise the *client*, government departments and agencies, regulatory bodies, funding organizations and the eventual managers of the facility.

VM processes were used early on in the project to enable key stakeholders to build understanding and consensus regarding the goals of the project, how it related to the overall regeneration programme and to define the actions necessary to enable it to be realized.

Source: Dallas, M., 2005.

Case study 2: VM session, Midlands Hospital

The VM session was the first session of its kind involving the wider project team, which included the 'Procure 21' supply-chain members and a number of clinicians from various affected departments.

The purpose of the session was to review, reflect and to understand some of the key project issues as well as to determine spatial adjacencies and linkages required with the rest of the hospital. The session was led by an eminent VM practitioner.

The first tool in the session, the client's value system, was used to obtain ordinal measurement in the form of ranking for the client's values. The client's value system, based on a matrix approach, demonstrated that the three most important aspects to the client group were flexibility, comfort and community accessibility. The client's value system concentrates on 'inside the building', that is, the focus is how the building functions rather than its external appearance.

The service development group reviewed typical patient flows through the new facility. This detailed analysis helped to achieve a consensus on requirements and a degree of ownership of the final solution.

The project team then used a brainstorming session, using 'post-it' notes on a working wall to identify strategic needs and wants and technical needs and wants. The strategic functions identified the strategic mission for the project and the main functions that it requires to deliver for the client. The strategic wants were considered as non-essential or 'nice to have'. The technical needs and wants are the functions that form the brief for the project. The Procure 21 team agreed to incorporate the technical needs into the project brief as well as any strategic issues that were to be dealt with, by looking for a technical solution.

The VM exercise took the project team a step further in validating a conceptual model for the new facility. Once this was finalized the Procure 21 supply team members could draw up the 'project execution plan'.

Source: VM Session undertaken in October 2002 (private source).

Case study 3: office building

The sketch design for the outside walls of an office building indicated the use of precast concrete-cladding panels. An analysis of the design showed a total of 450 separate panels of different types.

After a workshop review, which included a cladding manufacturer, the total number of panels was reduced to 280 with only 21 different types to cover the same area. Although an increased cost arose due to the need for a larger crane to hoist the panels, the net saving for the reduced number of moulds and perimeter waterproofing represented 10% of the total cost of cladding. The cladding element of the project amounted to 25% of the project's cost, and as a result of the workshop review, the overall saving equated to 2.5% of the project's capital cost.

Source: Reported in HM Treasury, 1996.

Case study 4: office building

The detailed design of a bolt-on cladding system indicated an internal wall lining of insulation and painted plasterboard. Following a brainstorming session, the cladding manufacturer was asked to provide a price for incorporating the insulation and providing a metal-finished panel on the inner face of the building. The plasterboard and its finish would be omitted.

The net effect was to increase the cost of the project by £125,000. However, omitting the plasterboard and paint meant fewer 'wet' trades on the project, saved three weeks on the overall construction period and increased the net lettable floor area by 2%. The *value* of the finished building was increased in the order of £2 million for an additional outlay of £125,000.

Source: Reported in HM Treasury, 1996.

Case study 5: hotel leisure facility

In a hotel development, the architect had included the main hotel swimming pool and a children's paddling pool. The design team had assumed that the function of the children's pool was to allow the children to swim separately from the adults, thereby providing a more suitable facility for each.

In fact, the function of the pool was to keep much younger children safe while others swam and there was no real objection to competent child swimmers using the same pool as the adults.

As a result of correctly defining the function, the VM team was able to generate ideas for alternatives providing a safe environment for the children. The small pool was replaced with a spray at a tenth of the cost. When constructed, the spray proved to be a huge success.

Source: Reported in McGeorge and Palmer, 1997.

Case study 6: speculative office block, London

A developer proposed to construct a speculative office building in London with a net lettable area of 4,500 m^2 and at a cost of £5 million. Initial studies indicated that providing the necessary space within the site and cost constraints would be challenging.

The developer decided to use VE and employed a facilitator to work with the design team to find the most effective solution. The facilitator convened a workshop during which it became clear that the relationship between net lettable area and the size of the service cores was crucially important to the viability of the design. Although the designers had already evaluated this, the combined efforts of all the parties working together creatively in a facilitated workshop environment identified a number of improvements to the outline design proposals. Potential improvements were also identified in the proposed wall-cladding system, and these were subject to a more detailed study outside the workshop.

As a result of the workshop, the building cost 2% (£110,000) more than the original budget. However, the increase in benefits of some £3.4 million more than paid for this.

Source: Reported in the CIRIA, Special Publication 129.

Case study 7: Dudley Southern Bypass

In 1998, Kvaerner won the project in competition with an exceptionally low bid of £14.3 million; the contract was based on the ICE 5th with a 'partnering agreement'. After a joint evaluation of the risks, the Dudley Metropolitan Borough Council felt able to negotiate a target price which would still be below the second-lowest bidder and a target cost of £16.7 million was agreed. Dudley MBC agreed with Kvaerner that it would split 50/50 any 'pain' or 'gain' over or under that target price and Kvaerner would be paid an agreed maximum management fee of £900,000. The project was completed five months ahead of schedule within the target cost and the budget agreed with the DETR.

VE did identify savings. For instance, the original specification required the removal of 50,000 m^3 of waste to be replaced with quarry material. Much of the material was contaminated, but by working together and involving the Environment Agency in developing solutions, they were able to reuse most of the material within the project. By the end of the project, they had only taken 1,500 m^3 to tip, this prevented 25,000 lorry movements around Dudley.

Source: Reported in *Modernising Construction*, NAO, 2001.

Case study 8: the Scottish Parliament Building

Construction work began in July 1999. In September 1999, a VE exercise was implemented in order to reduce the construction cost by £25 million. The exercise identified several hundred recommendations, the vast majority of which could be dealt with by the project team. Some of the recommendations required a high-level decision from the Scottish Parliament Corporate Body (SPCB). Table 7.2 gives an indication of the issues considered by the SPCB.

Source: Reported in *The Holyrood Inquiry*, 2004.

Table 7.2 Examples of VM savings considered on the Scottish Parliament building.

Item	*Potential saving*	*Decision of the SPCB*	*Actual saving*
Reduce car parking provision from 129 to 50	£750,000–£1,500,000	Reduce to 65 spaces	£667,000
Rationalize bar/lounge/restaurant	In excess of £1 million	Maintain existing provision	—
Delete wash-hand basins in MSP rooms	£210,000	Agreed to be deleted	£209,160
Reduce standard of media accommodation fit out	£235,000	Agreed	£236,140

Note: Developed by author based on CIRIA, 1996.

Lord Fraser reports that the exercise failed miserably in achieving its stated goal of achieving the £25 million required. The workshop never identified achievable savings of the magnitude required. Likewise, when the client realized that these decisions would have a significant impact on the quality of the building they did not face up to the reality of the situation. Lord Fraser comments that 'to some extent the Value Engineering exercise could be interpreted as a knee jerk reaction to a budgetary crisis.'

Case study 9: refit project for Pizza Hut

In 1997, Pizza Hut was anticipating a programme of 25 refit projects (Pizza Delivery Units). At an estimated/budget value of £145,000 each, the programme value amounted to over £3.5 million. In order to review the projects before going on site, a series of three half-day VM workshops were convened comprising client representatives (area manager and property manager) and the consultants (designer, QS and services engineer). An experienced VM facilitator from outside the project team facilitated the workshops.

The three workshops followed a traditional format of information exchange, functional analysis, brainstorming of alternative solutions, evaluation of alternatives, acceptance and implementation. As a result of nine hours of workshop and a similar amount of time outside the workshop a total of £14,000 per project was saved equivalent to £350,000 capital cost on the whole programme. In some areas standards were actually raised, and longer-term maintenance was reduced. A shorter contract period was also established and shorter delivery times for certain longer lead items.

The total cost of the VM exercise was estimated at less than £10,000, giving a return of 35:1 on the investment.

Source: Reported in *Value Management Fact Sheet* (www.constructingexcellence.org.uk [accessed 12 December 2006]).

7.8 Conclusion

The above case studies demonstrate that real benefits and cost savings can be secured by implementing a VM approach. Case study 1 identified that VM helped bring the key stakeholders together in order to build an understanding and consensus.

Case study 2 identified how the VM approach enabled an NHS client to determine special adjacencies and linkages and identify the client's value system as a basis for validating a conceptual model for a new hospital facility.

Case studies 3 and 4 showed how significant savings could be achieved by redesigning an alternative size and type of cladding. As shown in Case study 5, Dr Angela Palmer brilliantly illustrated the classical benefit of the VM approach by giving an example in which the project team questioned the fundamental purpose of a children's paddling pool.

Case study 6, the 'speculative office block', illustrated how the VM exercise showed that a little extra expenditure would result in a significant greater net lettable area.

Case study 7 demonstrated the benefit of VE within a partnering approach on the Dudley Southern Bypass which resulted in a considerable saving in the removal of excavation waste.

Case study 8 demonstrated the difficulty of achieving real savings through VE on the hugely controversial Scottish Parliament building.

Finally, the Pizza Hut case study (Case study 9) demonstrated how VM, when used by an enlightened client resulted in cost savings, improved standards and shorter delivery times on 25 refit projects.

7.9 Questions

1. Consider the function of an external wall in an office complex.
2. Give specific examples of potential unnecessary costs identified in items 1–5 in Section 7.5 on 'value engineering'.
3. The University of Metropolis is planning a new state-of-the-art teaching facility for the School of the Built Environment. As the client's chosen project manager, write a 500-word report to your client, explaining the key concepts and benefits of including a VM approach and state what will be required from the client and when.

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Useful websites

www.constructingexcellence.org.uk
www.IVM.org.uk

8 Risk management (RM)

8.1 Introduction

Max Abrahamson, the eminent construction lawyer, considered risk management (RM) 'the most delicate and dangerous subject I could find' (Abrahamson, 1984). This comment indicates the potential difficulties of attempting to manage risk. Indeed, sometimes it seems as though it is not a science but more an art based on years of experience and 'gut-feelings'.

Risks and their interactions can emerge at anytime: at the front-end, during construction, or at operation stage and build-up to shatter carefully laid plans. Indeed, the only certainty is that unforeseeable events will materialize. Uncertainty springs up as issues are brought to the fore, dormant tensions emerge, and interdependent links are triggered (Miller and Lessard, 2000).

Sir Michael Latham considered that 'No construction project is risk free. Risk can be managed, minimized, shared, transferred or accepted. It cannot be ignored' (*Constructing the Team*, 1994). Everyone should be concerned with RM, because risk and uncertainty could have potentially damaging consequences on a project. For a property developer in the pre-feasibility stage it may lead to the question of whether to undertake a marginal project particularly if there is likelihood of the project finishing late and of over-budget. For a contractor or subcontractor, unforeseen risks may mean incurring losses that are not recoverable.

British Standard 4778 Section 3.1: 1991 defines RM as:

> [T]he process whereby decisions are made to accept a known or assessed risk and/or the implementation of actions to reduce the consequences or probability of occurrence.

The process must have the aim of identifying and assessing the risks. RM and risk assessment as techniques will not remove all risks. The aim must be to ensure that risks are assessed and managed in an effective manner to achieve the overall objectives of the project.

The 1999, NAO report *Modernising Construction* highlighted inadequate use and understanding of value management (VM) and risk management (RM) as major barriers to improvement in construction performance as discussed in *Achieving Excellence in Construction Procurement Guide 04* (OGC, 2003).

There may be formal requirements for risk analysis (RA) for many reasons including: economic viability assessment, financial feasibility assessment, insurance purposes, accountability, contractual purposes, tendering, regulatory purposes and communication purposes (Cooper and Chapman, 1987).

Thomson and Perry (1992) identified that RM may involve:

- identifying preventative measures to avoid or reduce a risk;
- proceeding with a project stage-by-stage to reduce uncertainty though better information;
- considering risk transfer in contract strategy, with attention to the motivational effects and the control of risk allocation;
- considering risk transfer to insurers;
- setting and managing risk allowances in cost estimates, programmes and specifications;
- establishing contingency plans to deal with risks when they occur.

Traditionally risk in construction was either ignored or dealt with in an arbitrary way, for example, by including a 5% contingency factor in the estimate. Project contingencies provide an allowance to cover a client's risk exposure but make little contribution to its management; indeed this approach may contribute to the 'variation culture' (Rawlinson, 1999).

RM is an ongoing process throughout the life of the project, as risks will be constantly changing. RM plans should be in place to deal quickly and effectively with risks if they arise. It is important to work as an integrated project team from the earliest possible stages on an open-book basis to identify risks throughout the team's supply chains (OGC, 2003).

RM can be considered to have three stages: identification, analysis and response.

8.2 Risk identification

The initial step is the identification and assessment of the risks associated with a proposed construction project or contract at the early stages of the project's life. The identification process will form the basis whereby risks, uncertainties, constraints, policies and strategies for the control and allocation of risk are established.

Perry and Hayes (1985) suggest that the burden of responsibility for the identification of risks lies with the client, as they will be keen to achieve the overall objectives of completion within time, within budget and to an acceptable quality. The contractor will also need to be able to identify the risks in the contract in order to prepare the tender.

The potential risks in construction projects are many and varied. One of the most comprehensive lists of risks, identifying over 100 potential issues, was produced by Perry and Hayes (1985) classified into physical, construction, design, political, financial, legal-contractual and environmental.

Rawlinson (1999) identified that the principal categories of risk that the client may face resulting from a major capital project are potentially much wider than additional construction costs and could include the following (see also Table 8.1):

1. project risk – concerned mainly with time and cost;
2. consequential risk – the knock-on effects of project shortfalls on the client's business/organization;
3. benefits risk – the effect of the project delivering more or less than the expected benefits;
4. The effect on share price or public perception of the business/organization due to public success or failures.

The above list is not of course definitive, indeed it would be foolhardy to think that it was. Some key issues are never considered as risk factors by client organizations. For example, on the Scottish Parliament building, the deaths during the early construction period of two key players – the First

Table 8.1 Sources of risk to client's business from construction projects.

Heading	*Change and uncertainty due to*
Political	Government policy, public opinion, change in ideology, dogma, legislation, disorder (war, terrorism, riots)
Environmental	Contaminated land or pollution liability, nuisance (e.g. noise), permissions, public opinion, internal/corporate policy, environmental law or regulations or practice or 'impact' requirements
Planning	Permission requirements, policy and practice, land use, socio-economic impacts, public opinion
Market	Demand (forecasts), competition, obsolescence, customer satisfaction, fashion
Economic	Treasury policy, taxation, cost inflation, interest rates, exchange rates
Financial	Bankruptcy, margins, insurance, risk share
Natural	Unforeseen ground conditions, weather, earthquake, fire or explosion, archaeological discovery
Project	Definition, procurement strategy, performance requirements, standards, leadership, organization (maturity, commitment, competence and experience), planning and quality control, programme, labour and resources, communications and culture
Technical	Design adequacy, operational efficiency, reliability
Human	Error, incompetence, ignorance, tiredness, communication ability, culture, work in the dark or at night
Criminal	Lack of security, vandalism, theft, fraud, corruption
Safety	Regulations (e.g. CDM, Health and Safety at Work), hazardous substances (COSHH), collisions, collapse, flooding, fire and explosion

Source: Godfrey, 1996.

Minister for Scotland, Donald Dewar and the Architect, Enric Miralles – had a significant impact on the project.

The CIRIA report 125 (Godfrey, 1996) states that 'It is impossible to identify all risks. To believe you have done so is counter-productive to RM and dangerous. Always expect the unexpected.'

It is worth reflecting on some of the unforeseen risks that have affected construction projects in the UK over the past 30 years:

- Power strikes/3-day working week/lack of materials, for example, steel (1970s);
- Widespread industrial action (1970s);
- 25% annual inflation (1970s);
- Civil unrest/miners strike (1980s);
- Poll-tax riots (1980s);
- IRA terrorism (1980s);
- Petrol-tax protestors (2000);
- Widespread flooding (2000 and 2007).

Likewise when considering risks likely to be encountered by contractors and specialists other risks may occur which are never anticipated, for example, a tower crane may collapse or the weather may make a significant impact. For example, on Foster + Partners' new high-rise Willis building in London, the wind stopped the tower cranes from operating for 40–50% of the time during the winter compared with the 20% anticipated (Lane, T., 2007).

Building magazine (16 February 2007) reported that Bovis Lend Lease had announced that it would change its tendering policy after taking a £48 million loss on work in Britain, primarily on its Manchester Joint Hospital PFI scheme. Bob Johnson, Bovis' global chief executive, said that 'the firm had taken it on without fully understanding the risks and did not price it correctly.'

Panel 8.1 Particular risks for main contractors and specialist contractors

- Poor tender/briefing documents;
- Client who will not commit;
- Inexperienced client;
- Non-standard contract documentation;
- Ultimate client failing to sufficiently acknowledge and reward quality and value for money;
- Poor design for construction, for example, when 'buildability' is not addressed;
- Unexpected problems relating to the site, such as contamination or unusual ground conditions;
- Co-ordination problems – this could be a particular problem for specialists;
- Component and/or materials suppliers unable to meet delivery and/or cost targets;
- Faulty components and/or materials;
- Accidents and injuries to staff;
- Weather interrupting work;
- Delayed payments;
- Poor documentation of records;
- Lack of co-ordination of documentation;
- Poor guidance for operatives;
- Poorly trained or inadequately trained workforce;
- Industrial disruption.

Source: *Constructing Excellence* 'Risk Management' Fact sheet (www.constructingexcellence.org.uk/ [accessed 20 July 2006]).

8.3 Risk analysis techniques

The purpose of risk analysis (RA) is to quantify the effects on the project of the risks identified. The first step is to decide which analytical technique to use. At the simplest level each risk may be treated independently of all others with no attempt made to quantify any probability of occurrence. Greater sophistication can be achieved by incorporating probabilities and interdependence of risks into the calculations but the techniques become more complex. The choice of technique will usually be constrained by the available experience, expertise and computer software.

Whichever technique is chosen, the next step requires that judgements be made of the impact of each risk and in some cases of the probability of occurrence of each risk and of various possible outcomes of the risk.

The main objective of RA must be to assess the effects on the project by the risks identified (see Table 8.2). The techniques range from subjective assessments through to the use of sophisticated techniques using computer software. The approaches can be categorized under two broad headings:

1. The summation of individual risk exposures to calculate a project risk allowance; techniques include expected monetary value (EMV) and Monte Carlo simulation;
2. The statistical calculation of average and maximum risk allowances; techniques include application of the central limit theorem and multiple estimating using the root mean square (RMS) method.

Identification of the potential risks can be achieved by:

- interviewing key members of the project team;
- organizing brainstorming meetings with interested parties;
- using the personal experience of the risk analyst;
- reviewing past project experiences.

Dr Steve Simister (2000) identified the differences between a qualitative and quantitative approach.

In the qualitative assessment, which is recorded and analysed in the 'risk register', it is necessary to ask the following questions: what is the risk? how might it occur? how likely is it? (probability) how good/bad might it be? (impacts) does it matter? what can we do? when should we act? who is responsible?

In contrast, in a quantitative assessment, the computer model, for example, a model developed based on spreadsheets and @Risk software is used for the following purposes: modelling uncertainty; simulating combined effects of risks; predicting outcomes, range min/max expected; testing scenarios; setting confidence limits; identifying criticalities and determining options.

Calculating risk allowances

Method 1: expected monetary value

The assessment identifies the impact of risks in terms of both the *impact* and the *probability of occurrence*. This can be expressed as the simple formula:

Risk exposure = Impact × Probability

It is important that all the potential risks and uncertainties which can affect the project and are likely to act as constraints on the project be identified as early as possible.

Once the risks have been identified, the risks are then subjected to an assessment that categorizes the risks into a subjective probability of occurrence and into three categories of impaction on the project – optimistic, most likely and pessimistic outcome. Two rules should be obeyed in the calculation: first, the most likely outcome must have the highest value, and second, the total value of probability for the three outcomes must always equal 1.

This method is simple and transparent and allows the consideration of more than one risk. However it has the disadvantage that it is unable to consider linkages between risks.

Consider the calculation of the risk allowance to be made for the potential increased lengths to the piling due to the uncertain ground conditions.

	Outcome £	*Impact (I) £*	*Probability (P) %*	*(I × P) £*
Cost plan allowance	1,350,000			
Optimistic outcome		150,000 (saving)	0.30	(45,000)
Most likely outcome		150,000 extra	0.50	75,000
Pessimistic outcome		250,000 extra	0.20	50,000
Expected monetary value				80,000

So £80,000 should be added to the cost plan allowance for the piling.

Depending on the size or complexity of the project, it may be necessary to carry out a *secondary* RA to identify consequential secondary risks.

This same technique can be used by contractors in order to establish an allowance for risk factors when compiling a tender or a quotation for a variation. David Neale, director of May Gurney (Construction) Ltd, described the difficulties in identifying the risks in a design and build (D&B)

highway project which involved widening and upgrading the existing carriageway. In his paper, Neale (1994) described the development of a crude risk model (similar to the above cost plan) in which the contractor calculated an explainable sum to be added to their tender.

In the event, none of the risks identified occurred, and instead the contractor encountered a totally unforeseeable event where the design responsibility was the contractor's and this cost more than the total allowance.

The author (Potts, 2003) also described a similar situation in connection with a quotation for a major variation submitted prior to the work being executed. The risk allowance proved inadequate to cover the substantial additional cost which was considered the contractor's risk once the quotation was accepted.

Decision trees

Decision trees (see Fig. 8.1) can be useful where the scenario is more complex. They are graphical representations useful in assessing situations in which the probabilities of particular events occurring depend on previous events, and can be used to calculate expected values in these more complex situations.

The decision tree shows two risks: A (Adverse weather at the contractor's risk) and B (Potential claim from the client of delay damages – acceleration is thus required to make up lost time).

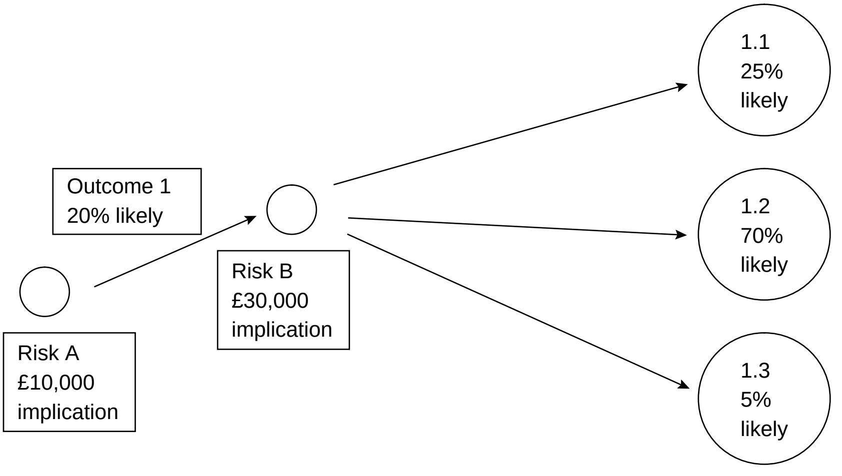
Risk A has a 20% chance of occurring with a monetary value of £10,000. If outcome A occurs, a second risk B is introduced and there are three likely outcomes:

1. pay bonuses to own labour;
2. import additional labour;
3. subcontractor's responsibility.

The monetary value of Risk B is £30,000.

Using the decision tree the following financial risks are identified:

Outcome no. 1 has a financial risk of (£10,000 × 0.2) + (£30,000 × 0.25) = £9,500
Outcome no. 2 has a financial risk of (£10,000 × 0.2) + (£30,000 × 0.70) = £23,000
Outcome no. 3 has a financial risk of (£10,000 × 0.2) + (£30,000 × 0.05) = £3,500



8.1 Simple decision tree.

So if possible you should try to achieve outcome no. 3 (subcontractor's responsibility!), as this has the least potential cost. This example shows how these calculations can easily become complex and highly theoretical. Some might argue that this conclusion could have been identified by inspection of the facts, common sense and gut feeling. Indeed this whole scenario may well rebound onto the main contractor if they try to implement harsh terms in the subcontract with the eventuality that the subcontractor's personnel walk off site.

Indeed this was the scenario in Hong Kong when the giant Gammon Kier Lilley JV (GKL) tried to impose tendered bills of quantities (BofQ) rates onto the local labour used by the architectural subcontractor. Due to a shortage of skilled workers the subcontractor was beginning to make a financial loss on the rates quoted in his tender and requested additional payments. GKL insisted that he should do the work at the rates quoted at tender and which were included in his subcontract agreement. The subcontractor's reaction was to take his men off site and the owner disappeared into China for two weeks. GKL soon realized who was carrying the risk – it was them, not their subcontractor!

Sensitivity analysis

The basis of a sensitivity analysis is to define a likely range of variation for elements of the project data. The final project cost or duration is then assessed for each variation in the data. In effect, a series of *what-if* estimates is produced.

The results of sensitivity analyses are often presented graphically, on a spider diagram, which readily indicates the most sensitive or critical areas for management to direct its attention towards.

One weakness of sensitivity analysis is that the risks are treated individually and independently. Caution must therefore be exercised when using the data directly to assess the effects of combination of risks.

Method 2: Monte Carlo simulation

Sophisticated analysis techniques are sometimes used to quantify the occasion of risks. Mathematical models and analytical techniques are often useful indicators of trends and problems. However these techniques should not be relied upon as the sole guide to the decision-making process.

The Monte Carlo simulation method relies on random calculation of values that fall within a specified probability distribution. The basic steps are as follows:

1. assess the ranges of variation for the uncertain data and determine the probability distribution most suited to each piece of data;
2. randomly select values for the data within the specified range taking into account the probability of occurrence;
3. run an analysis to determine values for the evaluation criteria for the combination of values selected;
4. repeat steps 2 and 3 above a number of times. The resulting collection of outcomes is arranged in sorted order to form a probability distribution of the evaluation criteria. The accuracy of the final distribution depends on the number of repetitions, or iterations, usually between 100 and 1,000.

Since the outcome from the Monte Carlo analysis is a collection of, say, 1,000 values of each evaluation criterion, it is unlikely that the same value for the evaluation criterion will be calculated more than a small number of times. The values are therefore grouped into class intervals. The results are presented as frequency and cumulative frequency distribution.

It is common to carry out a probabilistic time analysis with the aid of a CPM network to model the project schedule. The same method can be used for probabilistic cost analysis especially when the cost estimate can be broken down into the same categories or activities as the schedule and when cost risks are related to time costs (Norris, Perry and Simon, 1992).

Monte Carlo simulation enables linkages to be established between risks and is based on widely available computer software. However the calculations can easily become highly complicated.

Method 3: central limit theory

This is a simple technique used for calculating the overall risk allowance for projects, which provides a confidence limit of 90%. The model has three elements:

1. A base estimate which should be risk free;
2. A calculation of the individual risk allowances calculated using the formula: Risk allowance = Impact (I) $\times$ Probability (P) (the sum of these risk allowances should provide a 50% risk allowance);
3. Calculation of a 90% risk allowance using the formula:

   $X = 1.3 \sqrt{} \Sigma(I^2 \times P \times (I - P))$

The 90% risk allowance is essentially a lump-sum contingency. The technique is easy to calculate on a spreadsheet and only one outcome needs to be considered; however, linkages between risks cannot be considered.

Method 4: multiple estimating using root mean square

This technique has been used extensively by the Ministry of Defence and other public sector bodies. The calculation requires the calculation of three estimates:

1. the base estimate which should be risk free;
2. the average risk estimate – defining the project contingency;
3. the maximum likely risk estimate – calculating the 90% risk allowance.

The risk estimate is derived from the formula: Risk allowance = Impact $\times$ Probability

The maximum risk allowance (MRA) is calculated using the following formula:

$$MRA = \sqrt{} \Sigma \left((I_{max} \times P_{max}) - (I_{ave} \times P_{ave})\right)^2$$

(Where:
I_{max} = the maximum risk impact
P_{max} = the maximum probability, typically a 90% confidence limit
I_{ave} = the average risk impact
P_{ave} = the average probability, typically 50% confidence limit)
The calculation of both average and maximum risk allowances also requires the distinction between fixed and variable risks.

The multiple-estimating technique provides a thorough appraisal of the project risks. However the process requires a complex calculation requiring two estimates and the distinction between fixed and variable risks. The example above is based on an actual calculation used by the client's project managers/cost consultants when establishing the lump-sum contingency on a major complex building project in Birmingham.

Table 8.2 Project manager's risk analysis report at feasibility stage.

University of Metropolis
Project manager's report
Risk analysis – client project risks (feasibility stage)

Ref	*Description of risk element*	*Type*	*Average risk*			*Maximum risk*		
			Base value of risk element (£K)	*Probability factor (F) or confidence limit (V)*	*Value (£K)*	*Probability factor (F) or confidence limit (V)*	*Value (£K)*	*Square of the deviation*
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*
B010	Fitting out of school	F	70	0.9	63	1	70	49
B021	Teaching block 1	F	1,400	0.9	1,260	1	1,400	19,600
B023	Private finance initiative	V	N/A	50%	750	90%	1,500	562,500
B030	Equipment purchase	F	3,500	0.5	1,750	1	3,500	3,062,500
B043	Retail units main entrance	F	100	0.1	10	1	100	8,100
B046	Library	F	100	0.25	25	1	100	5,625
B050	Fixtures	V	N/A	50%	50	90%	100	2,500
B051	Existing boiler house	F	250	0.25	63	1	250	35,156
B061	Board room	F	T.B.A					0
				Average risk allowance	3,971	Square root of the sum of the deviations		1,923
						Add to the average risk allowance		3,971
						Maximum risk allowance (£K)		5,894

Notes
F = fixed (expressed as a ratio)
V = variable (expressed as a percentage)

If (b) is 'F' then (e) = (c) x (d) and (g) = (c) x (f)
If (b) is 'V' then both (e) and (g) are estimated costs reflecting the levels of confidence, that is, there is no 'Base Value' (N/A = not applicable).

Explanation of probability ratios for fixed risks:

Unlikely	0.10
Could happen	0.25
As likely not	0.50
Very likely	0.75
Almost certain	0.90
Certain	1.00

Explanation of confidence limits:
Average risk is always 50% confidence
Maximum risk is always 90% confidence, that is, there is only 10% chance of this being exceeded

8.4 Risk register

In the past decade or so the use of the risk register as a key control document (see Table 8.3) has gained acceptance with leading clients. The risk register lists all the identified risks and the results of their analysis and evaluation and information on the status of the risk. The risk register should be continuously updated and reviewed throughout the course of the project.

The UK Government's *Green Book, Appraisal and Evaluation in Central Government* identifies best practice for public sector bodies and notes that the risk register should contain the following information: risk number (unique within register); risk type; author (who raised it); date identified; date last updated; description; likelihood; interdependencies with other sources of risk; expected impact; bearer of risk; countermeasures; and risk status and risk action status (http://greenbook.treasury.gov.uk/annex04.htm [accessed 12 March 2007]). The risk register is important for the following five reasons:

1. monitoring and, if necessary, correcting progress on risk mitigation measures;
2. identifying new risks;
3. closing down expired risks;
4. amending risk assessment for existing risks;
5. approving the drawdown of project contingencies by the client when required.

The author, Potts (2003), identified that the key to the successful management of risk throughout the project cycle on the Severn Trent Derby Sewage Works project was the compilation of a joint contractor/client risk register with regular reviews and modifications. This D&B target-cost project with a pain/gain arrangement was carried out under a five-year framework agreement. Under this project, the first attempt at identifying the risks was based on an unstructured methodology without constraints. The resulting risks were then listed on the risk register; the process was repeated with the aid of a risk matrix, checklists and past experience.

The *Contractor/Client joint risk register* was a dynamic control document which was evolved throughout the life by Seven Trent Water (STW) and the contractor during the life of the project. All the risks, including potential variations, were subject to continuous review and modification.

8.5 Risk response

The response to the risk will be appraised by the severity of the risk to the project. There are four risk mitigation strategies that can be adopted by the client and project team in order to reduce the risk exposure associated with a project: avoidance, reduction, transfer or retention.

Avoidance

If the situation is assessed whereby the risk is judged to have such a serious consequence, then the situation may warrant a reappraisal of the project. It may be necessary to review the project's aims, either to reappraise the concept or to cancel the project.

Reduction

Reducing the risks may involve redesigning the project, changing the procurement strategy or undertaking additional soil investigation to minimize changes to the foundations, changing the specification or incorporating different methods of construction to avoid unproven construction techniques.

Table 8.3 Typical contractor/client joint risk register (part only).

	Description of risk	*Description of impact*	*Impact (£K)*	*Probability (%)*	*Owner*	*Included in target*	*Sum included in target*	*Comments*
A	General ground problems	Disposal costs of unforeseen contaminated material	20	50	50/50	Yes	£10K	200 m^3 max assumed
B	Weather	Adverse weather – additional cost and time	50	50	50/50	Yes	£25K	Additional temporary covers
C	External restraints	Land purchase on section – legal time delay	100	5	Client	No	£5K	Non-critical section
D	Contractual problems	Delay of framework suppliers	40	10	50/50	Yes	£4K	Consider acceleration
E	Design/survey	Removal of asbestos in existing structures	9	30	Client	No	£2.7K	Specialists required
F	Operational requirements	Delay in issue of permits	20	10	Client	No	£2K	1 week assumed
G	Site specifics	Site security – loss of equipment	50	50	50/50	Yes	£25K	Check details of insurance
H	Price build-up	Increased cost – Inflation	50	50	50/50	Yes	£25K	Steel/cement prices volatile

Source: Potts, 2003.

Panel 8.2 Risk registers

Details of the risks should appear in the risk register. However the detailed nature of the risk register means that it can be difficult to capture a meaningful summary of the current exposure to risk. A suggested approach is to assess each risk against a matrix of probability (high/medium/low probability) and impact (high/medium/low impact).

Risks that have a high score on both probability and impact, or a high score on one and medium on the other, are assigned a Red status (high risk requiring careful attention); those that are low probability and low impact, or low on one and medium on the other, are given a Green status (risks need watching but not a priority concern). Regular recording of the progress of risks is essential, because their status can change rapidly. A summary of Red risks could be reported at senior level via project board meetings, for example, so as to concentrate on the areas of highest risk.

Source: *Achieving Excellence in Construction* (2003), Procurement Guide '04.

Transfer

Perry and Hayes (1985) identified four common routes for the transfer of risk:

1. client to contractor;
2. contractor to subcontractor;
3. client, contractor, subcontractor or designer to insurer;
4. contractor or subcontractor to surety.

However it should be noted that implementing transfer of the risks to others may result in development of different contract terms, payment of higher fees or additional premiums.

If risks can be transferred, their consequences can be shared or totally carried out by someone other than the client. The client will be expected to pay a premium for this, so responsibility for initiating this form of risk response lies with the client. Abrahamson (1984) considered that a party should bear a construction risk where:

1. it is in his control, or
2. the party can transfer the risk by insurance, or
3. the preponderant economic benefit of running the risk accrues to him, or
4. to place the risk on him is in the interests of efficiency, or
5. if the risk eventuates, it is not practicable to transfer the loss to another.

Retention

Risks that are retained by either party may be controllable or uncontrollable by that party. Where control is possible it may be exerted to reduce the likelihood of occurrence of a risk event and also to minimize the impact if the event occurs. It will be necessary to include a project contingency fund.

8.6 Strategic risk management

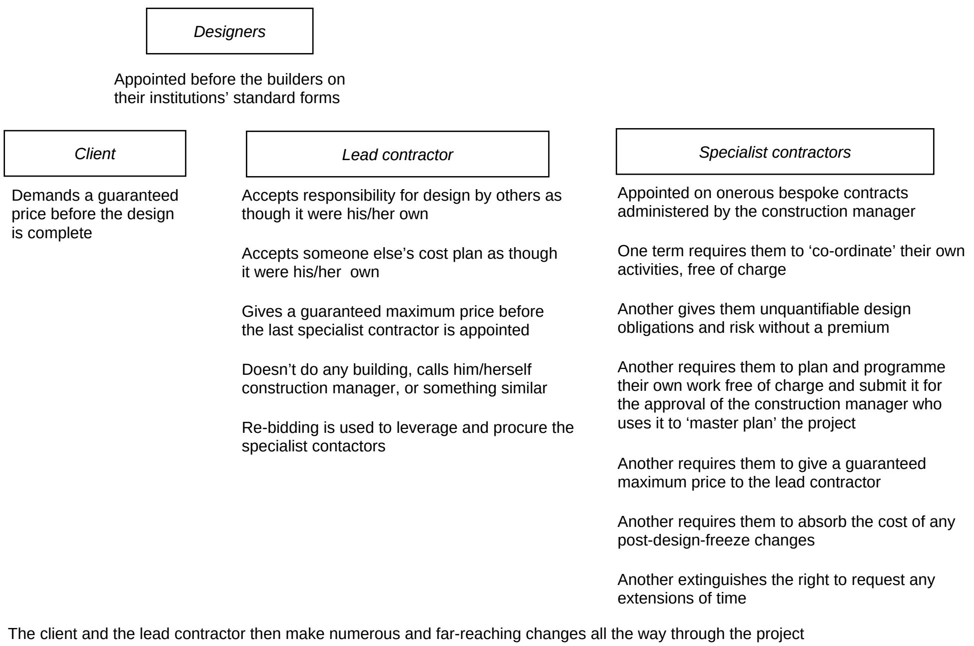
A most significant review of large engineering projects – defined as airports, urban transport, oil fields and power systems – was undertaken by an international team lead by Roger Miller, the Hydro-Quebec/CAE Professor of Technology Management at the University of Quebec at Montreal. The purpose was to benchmark 60 worldwide projects and identify best practice, to shape research issues and to share learning (Miller and Lessard, 2000).

The key findings from observing how sponsors wrestled with the risks inherent in projects, as well as those arising from possible conflicts among the various co-specialized partners or stakeholders, are that the lead sponsors have developed a strong repertoire of strategies for coping with risk. The ability to frame risks and strategies represents a core competence for them. This competence spans the five types of management philosophies:

1. obtaining and framing information;
2. designing a process with a long *front-end* before technical, financial and institutional details are locked in, followed by rapid execution of the project;
3. building coalitions that bring together varying information and skills and are structured to create strong incentives for performance and mitigate conflicts of interest;
4. the allocating of risk to the party best able to bear it;
5. transforming institutional environment risks through the creation of long-term coalitions that incorporate powerful influences on laws and rules.

These recommendations are very much in line with the OGC advice and the *Constructing Excellence* programme within the UK.

Fig. 8.2 has been developed based on a letter sent to *Building* magazine by Tony Clarke, Director of Management Services at Knowles, in July 2005. In this letter he listed the causes of disputes on projects such as the Millennium Stadium, the Scottish Parliament building, The Great



8.2 The real causes of disputes, or who carries the risk? (source: developed based on letter from Tony Clarke to *Building* magazine, 22 July 2005).

Eastern Hotel, The British Library, The Jubilee Line, The Royal Brompton Hospital and Portcullis House, and conjectured that these same issues may be the cause of the problems on the Wembley Stadium project.

This is a most important contribution to our understanding of RM on major projects. It shows that in many instances clients have attempted to dump the risk onto the lead contractor who in turn has passed the risk down to the specialist contractors. The case studies throughout this book demonstrate that in practice this approach does not work and may rebound onto the client with catastrophic consequences.

The words of Sir John Egan 'We should all rethink construction' ring somewhat hollow. It is necessary to go back to Sir Michael Latham's recommendations on the 13 essentials of a modern contract contained in *Constructing the Team* and embrace the philosophy of partnering, mutual trust and co-operation found in the NEC Engineering and Construction Contract.

8.7 Case studies

Case study 1: the Millennium 'wobbly' Bridge, London

The Millennium Bridge over the Thames, linking the newly opened Tate Modern Gallery at Bankside with the City of London at St Paul's, was the first pedestrian bridge built over the Thames for over one hundred years.

The bridge was intended to be one of the landmark projects heralding the new millennium. The innovative and complex structure that featured a 4 m wide aluminium deck flanked by stainless steel balustrades and supported by cables was designed by a joint venture comprising architect Norman Foster, sculptor Anthony Caro and structural engineers Ove Arup.

Such was the interest in the new bridge that when it opened to the public on 10 June 2000, an estimated 80,000 to 100,000 people crossed it. It soon became clear that all was not well as the deck swayed about and many reported feeling seasick.

After a prolonged series of tests, it was decided to adopt passive damping system which would harness the movements of the structure to absorb energy.

After nearly two years of testing, the alterations were deemed a success and the bridge finally opened to the public in February 2002. The alterations had cost an extra £5 million on top of the initial £18 million.

Postscript: The risk of design failure was not one of the ten principal risks identified in the pre-contract RM exercise!

Source: www.urban75.org/london/millennium.html (Rawlinson, S., 1999).

Case study 2: Royal Opera House, Convent Garden, London

The £200 million refurbishment of the Royal Opera House was one of the largest and most complex projects funded by the National Lottery Board. The project was executed using the construction management approach as this was considered an ideal process for managing risk.

The aim was to identify risks at the earliest possible opportunity and proactively manage them through the risk register. Actions were taken to contain and reduce the risks and to transfer the risks remaining through the contract to consultants and trade contractors. Project risks were therefore only transferred to trade contractors after they had been identified, analysed, quantified and minimized. The risks were clearly described in the tender documents and specific actions agreed with the trade contractors.

Cost risks on the project were minimized by the early award of those key trade packages, which have a large element of specialized detailed design, on a lump-sum design and construct basis. Around 70% of the total project value was procured prior to project construction; the remaining 30% was the subject of a detailed cost estimate.

Rigorous cost-control procedures were established to identify and obtain client approval to all post-contract variations before implementation.

Time risks on the project were minimized by detailed analysis of the programme, construction methods and sequences, resources and logistics. Methods included critical path analysis, resource analysis and resource levelling, 3D CAD modelling of construction phasing and construction programme. Detailed method statements were produced for each critical element and comprehensive RA undertaken of the programme linked to probability simulations

Source: Trotter, 1995.

Case study 3: RM on the Scottish Parliament Building

Risk management for the Holyrood project was not good practice. In my 2000 report I concluded that accounting for risk was insufficient. I showed that contrary to good practice there was no quantified allowance for the major risks facing the project. I recommended that this should be established and the results used as a basis for an action plan to manage the risks. Project management introduced a process for quantifying risks from October 2000 and then conducted a number of risk reviews.

Although by definition risk is uncertain, some 70% of the risk identified by the October 2000 workshop was for items that were categorized as 'highly likely' i.e. assessed by the workshop members as having at least a 95% probability of occurring. Each of these items carried with them varying levels of likely impact on programme.

Moreover the risk evaluation did not attempt to evaluate the monetary value attached to the risks to the time schedule. If it had it would have added further risk cost.

However, in the Holyrood project the general approach was to accept cost increases and include them in the forecasts as the risks materialized. Because there was no agreed budget limit after June 2001, there is little evidence that forceful action was taken to prevent or reduce the increase in cost.

Source: Auditor General for Scotland, Audit Scotland (2004).

8.8 Conclusion

We have reviewed some of the main techniques and methodologies for RM relevant for construction projects and identified that real benefits can occur with their use. However there is no panacea for successful management of risk; it should be viewed constructively and creatively. Rigid application of a set technique or procedure is not advocated or encouraged. Indeed methodologies are, relatively speaking, in their infancy and evolving with practice.

Interest in RM comes mainly from educated clients and is regularly adopted as integrated front-end service. Ongoing RM studies throughout the project are largely limited to the public and utilities sectors. Wood and Ellis's research found that the use of RM workshops and the production of risk registers is commonplace. The use of Monte Carlo simulation is widespread through the use of specialist software. However there seems some scepticism among the leading UK cost consultants regarding the usefulness of complex RA techniques and there is a predisposition to rely on judgement based on experience (Wood and Ellis, 2003).

The initiative for the application of RM lies with the client and their professional advisers, particularly the project manager and cost manager. Some changes in normal policy may be required, for example, building adequate time for RM into the project programme, training and perhaps experimentation with techniques.

8.9 Questions

1. Identify two unexpected events that have occurred on a construction project with which you have been involved. What was the impact on the project and how were they dealt with?
2. The University of Metropolis, together with the local City Council, is developing a brownfield site adjacent to an old gasworks in order to provide a large Science and Technology Park. It is anticipated that the project will be carried out in phases over a period of five years.
    a. Identify the main strategic risks for the client organization and how these might be avoided/mitigated.
    b. Identify the main risks for the contractor and how these might be avoided/mitigated.
3. John W. Hinchey, partner with King and Spalding LLP in Atlanta, Georgia, identified *Ten ways owners can avoid or mitigate construction risk*. Critically review this article making specific reference to your own market. (www.rics.org/Management [accessed 10 March 2007])

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Useful websites

www.constructingexcellence.org.uk
www.greenbooktreasury.gov.uk/annex04.htm

9 Whole-life costing

9.1 Introduction

Whole-life costing (WLC) is now established as an important tool which is changing the whole approach to design, procurement and construction and delivering major benefits. WLC is used to describe a form of modelling technique which can embrace a mixture of capital and running costs. *Life-cycle costing* is an older term for the same thing; *costs in use* is now an obsolete term.

The New Construction Research and Innovation Strategy Panel (nCRISP) defines WLC as 'the systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset' (Constructing Excellence, 2004).

The Building Research Establishment gives the definition: 'Assessment of the whole life performance and cost of an asset over its lifetime takes into consideration initial capital costs and future costs, including operational costs, maintenance costs and replacement/disposal costs at the end of its life.'

Many public and private sector clients now procure on cost of ownership, not on capital cost. Recent initiatives such as *Achieving Excellence* and the drive for *Egan compliance* among housing associations demonstrate this trend. Local authorities often adopt WLC as part of their response to their duty to deliver best value.

Consortia formed to undertake private-finance initiative (PFI) and Private-Public Partnership (PPP) also demand identification of whole-life costs in order to prepare detailed financial and risk management plans (RM) for projects. PFI and PPP contracts include non-availability clauses that may impose severe financial penalties on consortia running schools if, say, a maintenance problem leads to a classroom being unavailable for use. So choices about a roof finish should not just be considered in terms of installation and maintenance costs – the whole-life costs should take into account the risk of the roof leak, the cost of repairs and associated penalty.

In the report 'Better Public Building' (produced in 2000 by the Department of Culture, Media and Sport) the then prime minister Tony Blair states 'integrating design and construction delivers better value for money as well as better buildings, particularly when attention is paid to the full costs of a building over its whole lifetime.'

WLC is not an optional extra. The Treasury, the National Audit Office and the Audit Commission expect it. A new British Standard BS ISO 15686 – *Service Life Planning of Buildings and Constructed Assets* – provides the foundation for service-life planning and the use of whole-life costing.

9.2 Understanding the relevance of whole-life costing (WLC)

Whole-life costs are substantially greater than capital or initial costs – it is estimated that the operational expenditure will be 5–10 times as much as the capital cost. However these ratios are small when compared with the ratio of capital expenditure to the operating costs of businesses occupying the building which could be anything between 100 and 200 times as much as the their building's initial costs. These ratios indicate that a 1% improvement in productivity/output of staff would effectively pay the entire capital costs of the building (*Constructing Excellence*, 'Whole Life Costing Fact Sheet', www.constructingexcellence.org.uk/pdf/fact_sheet/wholelife.pdf [accessed 10 April 2007]).

The following are considered to be some of the major benefits in implementing WLC:

- Encourages communication between the stakeholders and leads to an improved project definition;
- Clarifies the cost of ownership and occupation;
- Optimizes the total cost of ownership/occupation;
- Enables early assessment of risks;
- Promotes realistic budgeting;
- Encourages discussion and decisions about materials choices;
- Enables best value to be attained;
- Provides actual figures for future benchmarking.

WLC should be included in the client's brief. It should be used as a decision-making tool throughout the procurement, construction and use of the project stages; for example, during initial investment appraisal, feasibility study of alternatives, outline and detailed design, tender appraisal, assessment of variations, handover and post-occupancy.

WLC has the potential for adding real value to a project. However it is critical to involve the whole supply chain early in the design cycle, as 80% of the future costs of running maintenance repair is fixed in the first 20% of the design process. Experts in building services and facilities management should not be overlooked during the early design assessment if the full long-term environmental and economic advantages are to be secured.

The concept of WLC was first introduced into the procurement assessment on the Ministry of Defence's *Building Down Barriers* projects. As part of the Defence Estates Prime Contracting Strategy, potential contractors who bid had to forecast the whole-life costs along a series of milestones. Part of the payment on the seven-year project was based on performance against the milestones.

9.3 The basic steps in whole-life costing (WLC)

WLC is one of three evaluation processes that need to be undertaken during the design phase of any project. The other two are technical evaluation and environmental evaluation. The final choice of scheme will be a compromise between these three. Before a WLC analysis can be undertaken, it is essential that a value engineering (VE) exercise is undertaken, and repeated as necessary, in order to remove all unnecessary costs from the functional/technical specifications.

The Constructing Excellence fact sheet *Whole Life Costing* identifies that the following four basic steps should be followed in order to identify the whole-life cost of an asset:

1. identify the capital and operational costs and incomes;
2. identify when they are likely to occur;

3. use discounted cash-flow analysis to bring the costs back to a common basis – items should normally be entered into the analysis at the current cost and a *real* (excluding inflation) discount rate applied. Normally this will be done on a commercial spreadsheet package, which includes equations for discounted cash flow;
4. undertake sensitivity analysis of the variables such as the discount rate, the study period, the predicted design lives of components, assumptions about running costs etc.

Expected life of a component

Predicting the life of a component is not an exact science. Numerous factors interact to determine the durability in practice. For example, there may be several levels of different specification within one component. Furthermore the actual replacement interval is often determined by economic, technical or functional obsolescence. It is notoriously difficult to assess when or how obsolescence might strike. Critical factors including changing land values on which the building stands, changing IT infrastructure/cabling requirements and changing safety requirements might contribute in rendering certain buildings obsolete.

Feedback from practice is an important source of durability data and includes the following:

- latent defects insurance schemes (e.g. NHBC, Zurich);
- condition surveys and defects investigations;
- maintenance records/repairs databases.

Published information on the life expectancy of building components is also available from the following sources:

- RICS Building Maintenance Information (BMI) a partner to the Building Cost Information Service (BCIS) and the Building Research Establishment (BRE);

Panel 9.1 Determining element life

Kirk and Dell'Isola (1995) identified three different definitions of the life of equipment, materials or other components.

Economic life – estimated number of years until that item no longer represents the least expensive method of performing functions required of it.
Technological life – estimated number of years until technology causes an item to become obsolete.
Useful life – estimated number of years during which an item will perform the functions required on it in accordance with some pre-established standard.
These headline statements are meaningless without some form of context. For example, the same water pump is unlikely to have as long a life when used in a hard water area compared to one maintained exactly the same way in a soft water area.

Source: *Elements needed for a Whole Life Cost Analysis* (www.bsria.co.uk/press/?press=345 [accessed 2 June 2007]).

- Housing Association Property Mutual (HAPM) *Component Life Manual* (E&F Spon, 1992);
- Building Performance Group (BPG) *Building Fabric Component Life Manual* (E&F Spon, 2000);
- Building Performance Group (BPG) *Building Services Component Life Manual* (Blackwell Scientific, 2000);
- Chartered Institution of Building Services Engineers (CIBSE) *Guide to Ownership, Operation and Maintenance of Building Services* (CIBSE, 2000).

Another useful resource for component durability is The BLP (Building Life Plans Ltd) *Construction Durability Database* (www.componentlife.com [accessed 3 September 2007]). This database is funded by the Housing Corporation which provides up-to-date durability and specification data for 900 building components and is based on a 15-year data collection and research. Access to the database and to the updated information is provided free of charge to employees of Registered Social Landlords.

Elements to consider

The following items should be considered in the whole-life cost model:

1. Lifespan of building or asset;
2. Construction: site, design, construction, health and safety, commission, fit-out, professional fees, in-house fees, statutory fees, finance etc.;
3. Facility: rent/rates, energy for heating/cooling/power/lighting, utilities, maintenance, repair/replace, refurbish, management, security, cleaning etc.;
4. Disposal: dismantle, demolition, sale etc.

The list is not comprehensive and will depend on the type of building or asset. However it gives some indication of the key issues to consider.

9.4 Money, time and investment

A sum of money received some time in the future will always be of worth that is less than the same sum of money today and the difference will depend on the following:

- the length of time involved;
- future risks;
- the probable interest rates.

Panel 9.2 Establishing maintenance and energy costs

Over the life of the analysis, the combined revenue cost of utilities and maintenance can easily exceed the original capital expenditure. For example, it has been estimated that a highly serviced healthcare facility could spend the maintenance and operations budget equivalent of the capital cost every 3–5 years.

Relying on rule of thumb data can lead to a high degree of inaccuracy. The maintenance costs on 'Hospitals' vary between a lower cost of £0.91/m^2 and an upper cost of £36.46/m^2 (1:40); while the difference on 'Offices' varies between £0.09 and £35.89/m^2 (1:400)!

Source: *Elements needed for a Whole Life Cost Analysis* (www.bsria.co.uk/press/?press=345 [accessed 2 June 2007]).

In doing the calculations it is a good idea to assume an interest rate that would reflect likely inflation and any special risks over the period concerned rather than a rate, which might actually be obtainable today.

In considering development finance we have three kinds of expenditure/income which we need to compare with each other:

- lump sums today;
- lump sums in the future;
- sums of money occurring at regular intervals during the period under consideration.

We cannot compare these, one with the other, unless we modify them in some way to put them on a common basis. There are two basic methods, and as usual they are just different ways of expressing the same thing – *present-day value* and *annual equivalent*.

Present-day value

All expenditure is expressed as the capital sum required to meet present commitments plus the amount which would have to be set aside today to provide for future payments, discounted to allow for accumulation of interest. Income is similarly treated; future income is discounted to the present day in the same way.

Table 9.1 shows that £1,000 received in one-year time (based on 5% interest rate) will have the present value of £952. Likewise, if £1,000 is received in a 10-year period, it will have a present value of only £614.

The concept of Net Present Value (NPV) – value at today's date – is important as it is used by major international clients, including the World Bank and the Hong Kong Mass Transit Railway Corporation, to evaluate contractors' bids. Thus if a contractor's lump sum tender was low but they require a greater proportion of payment in year 1, this would be reflected in the NPV calculation.

The UK government's recommended discount rate is 3.5%. Calculating the present value of differences between the stream of costs and benefits provides the NPV of an option. The NPV is the primary criterion for deciding whether government action can be justified (HM Treasury, 2003).

Table 9.1 Present value and discount rate (based on 5%).

Time (mid- year)	*0 (£)*	*1 (£)*	*2 (£)*	*3 (£)*	*4 (£)*	*5 (£)*	*6 (£)*	*7 (£)*	*8 (£)*	*9 (£)*	*10 (£)*
PV of payment (mid-year)	1,000	952	907	864	823	784	746	711	677	645	614

Panel 9.3 Observations on the discount rate

The change from 6% to 3.5% for the standard rate to be used (dictated by HM Treasury in April 2004) effectively puts a higher weight on future costs, with the aim of encouraging longer-term more sustainable development.

The choice of the discount rate (interest rate) used can have a dramatic effect on the outcome of the analysis. As an example, an annual energy bill of £100,000 over 30 years will have a present value of around £1.84 million if a 3.5% interest is taken, but only £656,600 at 15%.

Annual equivalent

Annual equivalent is the total of the following:

- any regular annual payments and income, such as wages, rents etc.;
- annual interest on items of capital expenditure;
- a sinking fund – the amount which would have to be put away annually to repay the capital cost at the end of the period.

Alternatively, the annual interest and sinking fund can be combined and expressed as the annual instalments which would be required to pay off the capital costs and interest over the term of years in question (rather like paying off a loan for a house through a mortgage).

Both of these methods will give a similar answer, and which one is used is purely a matter of convenience and depends on whether you are thinking in terms of capital finance or of annual income and expenditure.

9.5 Calculations

In the following formulae n represents the number of periods and i is the interest rate expressed as a decimal fraction of the principal, for example 5% = 0.05.

The following standard time value of money tables should be downloaded from the Internet (www.studyfinance.com/common/table3(table 4).pdf [accessed 10 January 2008]).

- Table 1 – Present Value Factors
- Table 2 – Present Value of Annuity Factors.

Formula 1 – Compound Interest = $(1 + i)^n$

If a sum of money is invested for some years it will have earned some interest by the end of the first year. Compound interest assumes that this earned money is immediately added to the principal and reinvested on the same terms, this process being repeated annually.

What will be the value of £5,500 invested at 9% compound interest for 5 years?

Formula $(1+i)^5$ and shows that £1 so invested will grow to £1.54.
£5,500 will grow to £5,500 × 1.54 = £8,470.
Formula 2 – Present value of £1 = $1 / (1 + i)^n$

In the compound-interest example, £5,500 invested for 5 years at 9% grew to £8,470. Conversely, the present value of £8,470 in 5 years' time at 9% interest is £5,500, that is, the amount that will grow to that sum at the end of 5 years.

What is the present value of £1,200 in 35 years time discounted at 10% per annum?

By the use of the formula the present value of £1 in such circumstances is 0.0356 (refer table 1 – Present Value Factors). The present value of £1,200 is therefore 1,200 × 0.0356 = £42.72.

Formula 3 – Present value of £1 payable at regular intervals
$[(1 + i)^n – 1] / [i(1 + i)^n]$

This formula shows the present value of future regular periodic payments or receipts over a limited term of years. It is, therefore, very useful for assessing the capital equivalent of things such as running costs, wages or rents.

What is the present value of £1,200 payable annually for 10 years assuming an interest rate of 8% per annum?

Example: it is desired to compare the whole-life costs of two different types of windows (type A and type B) to an office building, whose life is intended to be 40 years. The rate of interest allowed is 3% per annum compound.

Whole-life costs of windows – type A

Windows type A will cost £900,000; will require redecorating every 5 years at a cost of £20,000 and will require renewing after 20 years at a cost of £1,200,000.

	£
Initial cost	900,000
Present value at 3% of the following:	
Redecoration after 5 years £20,000 @ 0.8626 (present value of £1)	17,252
Redecoration after 10 years £20,000 @ 0.7441	14,882
Redecoration after 15 years £20,000 @ 0.6419	12,838
Renewal after 20 years £1,200,000 @ 0.5537	664,440
Redecoration after 25 years £20,000 @ 0.4776	9,552
Redecoration after 30 years £20,000 @ 0.4120	8,240
Redecoration after 35 years £20,000 @ 0.3554	7,108
	£1,634,312

Whole-life costs of windows – type B

Windows type B will cost £1,250,000 and will last the life of the building without any maintenance, although a sum of £300,000 is to be allowed for general repairs after 20 years.

	£
Initial cost	1,250,000
Present value at 3% of the following:	
Repairs after 20 years £300,000 @ 0.5537	166,110
	£1,416,110

Saving by using Windows type B is therefore £1,634,312 – £1,416,110 = £218,202. It would therefore appear to be justifiable to use the initially more expensive type B windows, as this will prove much cheaper in the long run.

Inflation

The discount rate is not the inflation rate but is the investment *premium* over and above inflation. Provided inflation for all costs is approximately equal, it is normal practice to exclude inflation effects when undertaking life-cycle cost analysis (OGC, 2003). In recent years, the annual inflation in the UK has been 2–4% per annum; however ten years ago it was in double figures and in the early 1970s following the Middle East crisis was over 25% per annum.

The solution to the example above did not take into account inflation. If the original windows were worked out on the basis of 10% annual inflation and 13% interest we would get much the same result as with no inflation and interest at 3%.

9.6 Problems with assessing whole-life costs

We have seen how WLC enables us to consider the long-term implications of a decision and provides a way of showing the cost consequences. The eminent researchers and authors Douglas Ferry and Peter Brandon identified that there are a number of potential fundamental problems in using a WLC approach (Ferry & Brandon, 1999), such as:

1. Initial and running costs cannot really be equated:
   a. The maintenance charges will fall upon the purchaser not on the developer;
   b. Even with public buildings, for example, schools, the bulk of the construction costs are paid for by one authority with another authority responsible for maintenance;
   c. Money for capital developments is often more difficult to find than money for current expenditure;
   d. Hardwearing materials may give an old-fashioned appearance and may be replaced before they are life expired.
2. The future cannot really be forecast:
   a. The cost of maintenance is pure guesswork;
   b. The amount of money spent on decoration and upkeep is determined more by the body responsible for maintenance; for example, new owners than by any quality inherent in the materials;
   c. Major expenditure on repairs is usually caused by unforeseen failure of detailing, faulty material or poor workmanship and is almost impossible to forecast;
   d. Interest rates cannot be forecast with any certainty, particularly over long periods. Would you like to guess what the Bank of England (or the European Bank) would do in say 20 years?

These comments seem to have been written prior to the introduction of PFI projects, which would seem to negate several of the above observations.

More recently, the National Audit Office Report *Improving Public Services through Better Construction* (NAO, 2005) identified four key barriers to successful WLC. First, the lack of clarity on what is meant by WLC. Second, a lack of robust historical data on running costs. Third, people making investment decisions need a tool not just based on cost but on other drivers such as time, sustainability, quality and return on investment. The calculations are done in a vacuum and there is no way of comparing and evaluating the options. Finally, there is a lack of tangible evidence of the benefits of WLC (Green, 2005).

In an effort to address some of these issues the Building Cost Information Service (BCIS) has developed a standardized approach to WLC. In 2007, BCIS launched *BCIS Occupancy Online*. Initially this service would provide information at the building level based on the estimates of maintenance and occupancy based on a range of building types and a profile for that expenditure based on the BMI occupancy cost plans. The user would be able to change the time period and the inflation or discount rate and adjust the costs for time and location to provide cash flow, at current or future prices and at NPV (Martin, 2007).

9.7 Whole-life value (WLV)

Increasingly major procurement in the public and private sector is being undertaken on the basis of not just lowest capital, or even whole-life costs, but *value* (Bourke *et al*., 2005). Whole-life value (WLV) encompasses economic, social and environmental aspects associated with the design, construction, operation, decommissioning and where appropriate the reuse of the asset of its constituent materials at the end of its useful life.

An important part of WLC is compiling the life-cycle assessment (LCA). This is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle.

However WLV includes more than WLC or LCAs, which are integral to the process. The application of WLV includes the consideration of the perceived costs and benefits of some or all of the stakeholders' relevant value drivers. The key techniques that are integral to WLV evaluations of building and infrastructure projects include:

- *WLC and LCA*: WLC deals primarily with financial costs, whereas LCA deals primarily with environmental impacts.
- *Multi-criteria analysis (MCA)*: MCA is used in conjunction with both WLC and LCA to evaluate alternative options based on criteria developed with stakeholders.
- *Group decision-making processes*: these processes include value management and risk management to engage stakeholders in the WLV process.

The WLV process will involve a number of iterations between the various stages and can be tailored to fit in with Gateway reviews such as the OGC *Gateway Process*.

The publication *Achieving Whole Life Value in Infrastructure and Buildings* (Bourke *et al.*, 2005) is a significant landmark in the subject of WLV. It has been compiled by eminent academics and practitioners and identifies how WLV is achieved, the techniques and methods thereof and includes four case studies. It should be recommended reading for all construction cost consultants.

9.8 Conclusion

The introduction of PFI contract requirements and high running costs has meant that WLV is gaining more acceptance within the construction/property sector. WLV is used early in the project cycle for feasibility and investment cases and for calculating budgets for maintenance.

The objectives of WLV are admirable, but in the past it often failed to deliver what it promised due to the absence of appropriate data. However more data is now becoming available and being incorporated into sophisticated models. For an excellent example of a whole-life cost model for two call centres, see Dudley and Derby, developed by Citex (now called Bucknall-Austin) see *Building* magazine, 23 July 1999, pp. 72–79.

With the development of the concept of WLV, which embraces not only costs but also environmental issues, value management and risk management, Kathryn Bourke at the BRE and colleagues have created a powerful new technique for the future.

9.9 Questions

1. Consider the typical cash flow over a 50-year life expectancy of the following components:

   a. Flat roofs: two-coat built up felt/asphalt;
   b. Floor finishes: carpet/quarry tile;
   c. Windows: UPVC/timber painted/aluminium.

2. A client is considering replacing his heating system. System A is the standard scheme whereas system B relies on additional insulation being provided. Evaluate the alternatives and make a recommendation.

	System A	*System B*
Initial costs		
Boiler	160,000	175,000
Pipework and units	48,000	42,000
Insulation	12,000	32,000
Recurring costs		
Repairs (per annum)	3,000	2,800
Replacement	40,000 (every 20 years)	32,000 (every 30 years)
Overhaul	15,000 (every 5 years)	15,000 (every 10 years)
Fuel (per annum)	15,000	11,000

The expected life of each building is 60 years and the discount rate to be used is 4%.

Author's comment: For the present value of a single sum and the present value of an annuity see '*Parry's Valuation and Investment Tables*' by A.W. Davidson (*Estates Gazette*), 2002.

3. Refer to the RICS Research Paper, vol. 4, no. 18, dated April 2003 'Whole Life Costing in Construction: A State of the Art Review' by Kishk, Al-Hajj, Pollock, Aouad, Bakis and Ming Sun.

   a. Plot the use of WLC on a typical project against the stages within the RIBA plan of work;
   b. Identify the characteristics of the available WLC software;
   c. Critically review the main findings of the Report.

   Source: www.rics.org/NR/rdonlyres/E4E31B2A-BC71–4C79-A73C-8280EF283EB2/0/whole_life_costing_in_construction_20030401.pdf (accessed 2 June 2007).

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Useful websites

www.bcis.co.uk
www.bre.co.uk
www.bsria.co.uk/press/?press = 345
www.constructingexcellence.org.uk
www.hm-treasury.gov.uk
www.ncrisp.org.uk
www.ogc.gov.uk
www.wlcf.org.uk/Links.htm

Part IV
Procurement strategies

10 Organizational methods (part A)

10.1 Introduction

> The contract strategy determines the level of integration of design, construction and ongoing maintenance for a given project, and should support the main project objectives in terms of risk allocation, delivery incentivisation and so on.
>
> (OGC, 2003)

The chosen strategy influences the allocation of risk, the project management requirements, the design strategy and the employment of consultants and contractors. The contract strategy has a major impact on the timescale and the ultimate cost of the project (see Fig. 10.1).

The following four sub-sections should be considered:

1. Organizational method, for example traditional, design and build management;
2. Type of contract, for example lump sum, admeasurement and cost reimbursable/target cost;
3. Bidding procedures, for example open, selective, two-stage, negotiated, EU regulations;
4. Conditions of contract, for example would include the following:
   JCT 05 (SBC/Q), JCT 05 DB, JCT 05 MP, JCT 05 CM/A, *ICE Measurement*, 7th edition, *ICE Design & Construct*, *IChemE lump sum (Red Book)*, *IChemE reimbursable (Green Book)*, NEC ECC, 3rd edition, FIDIC etc.

Overview of organizational method

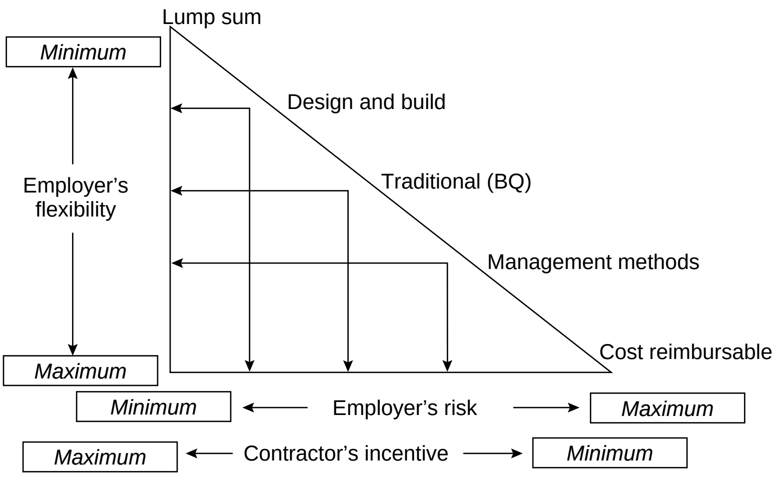
The RICS *Contracts in Use* surveys for building work in the UK have shown the following trends (by value):

	1991 %	*1995* %	*1998* %	*2001* %	*2004* %
Lump sum – firm BofQ	48	44	28	20	23
Lump sum – specs. and drawings	7	12	10	20	11
Lump sum – design and build	15	30	41	43	43
Target contracts	—	—	—	—	12
Remeasurement – approx. BQ	3	2	2	3	2
Management contracting	8	7	10	2	1
Construction management	19	4	8	10	1
Partnering agreements				2	7

The latest RICS *Contracts in Use* survey of building contracts in use during 2004 (RICS, 2006) showed that the decline in the use of the traditional Bill of Quantities (BofQ) identified in the 2001 survey appears to have been reversed. Likewise lump sum – spec. and drawings has declined to its 1998 level of 11% to be replaced with target contracts at 12% reflecting the use of the NEC family of contracts (now endorsed by the UK's HM Treasury's Office of Government Commerce and chosen for the 2012 London Olympics).

Design and build continues to be the most popular strategy in the building sector with 43% of the total contracts by value. The RICS survey for 2004 shows a steady increase in partnering agreements reflecting the increasing popularity of the PPC2000 contract with the Social Housing Associations.

In the UK civil engineering and infrastructure sectors, there has been a significant reduction in the use of the traditional ICE Conditions of Contract Measurement Version 7th edition. The NEC Engineering and Construction Contract family of contracts has swept all before it with most clients choosing the Activity Schedule approach (either option A – Priced Contract or increasingly option C Target Contract). This latter approach enables the sharing of risks and encourages innovation.



10.1 Characteristics of different types of procurement strategies (source: Barnes, NML (1983)).

Panel 10.1 Case study: Hong Kong airport and supporting rail and road infrastructure

The framework shown in Fig. 10.1 is important as it shows the various options available to clients depending on their attitude to risk.

The Hong Kong airport at Chep Lap Kok with supporting rail and road infrastructure was a true mega project; it comprised ten inter-related projects (over 200 works contracts) with four separate sponsors – Hong Kong Government, Airport Authority, Mass Transit Railway Corporation and Western Harbour Tunnel Company. The £155 billion project was completed in 1998 after six years of construction using a British–Chinese–Japanese JV – at its peak with some 35,000 workers.

In Hong Kong, the conditions of contract are normally onerous with clients wishing to transfer risk to the contractors. On the airport project the conditions of contract were extremely onerous with lump sum, fixed-price contracts adopted to the greatest extent possible to enhance certainty of final project cost. This approach is in direct contrast to the Heathrow Terminal 5 project where BAA have taken all the risk and managed the project through the use of integrated teams.

The important aspects of the Airport Core Programme (ACP) conditions of contract were as follows:

- Provision for lump sum, fixed-price form of contracts and an owner-controlled insurance programme;
- Provision for the employer, through the engineer, to make variations (additions or deletions of works) to benefit timely completion of other ACP contracts;
- Employer's ability, through the engineer, to order acceleration of work and to order contractors to recover their delays at no cost to the employer;
- Provisions for employer-referable decisions relating primarily to extensions of time and additional payment to allow a greater degree of control over the actions of the engineer on these matters;
- Stringent provisions for claim notification (which could result in the rejection of claims if not observed by contractors) so that the employer was informed of events likely to be disruptive to the programme and/or had cost implication at an early stage;
- Introduction of a tiered disputes-resolution process (mediation, adjudication and arbitration, with mediation mandatory) to help achieve significant time and cost savings when disputes arose.

Source: Lam, C.L., 1998.

10.2 Traditional method

The traditional method (see Fig. 10.2) of procurement is based on the rigid separation of design and construction. The client, usually after undertaking a feasibility study, appoints a team of consultants (led by the architect/engineer) to undertake the detailed design. The design team prepares detailed drawings, specification and often a BofQ. The tender documents are prepared and the contract awarded, usually to the contractor with the lowest bid. The contractor manages the construction using its own subcontractors together with nominated (under JCT98) or named (under JCT05) subcontractors.

The lead designer is usually in control throughout all stages of the project, from conceptual design through design development, tendering, contract administration, supervision of the works and finally to handover of the completed project.

The traditional route is readily understood but has become less popular as more clients become aware of the potential high risks carried by them if the design is not complete or the BofQ not accurate.

The traditional system

Strengths

The strengths of the traditional approach are well documented and include

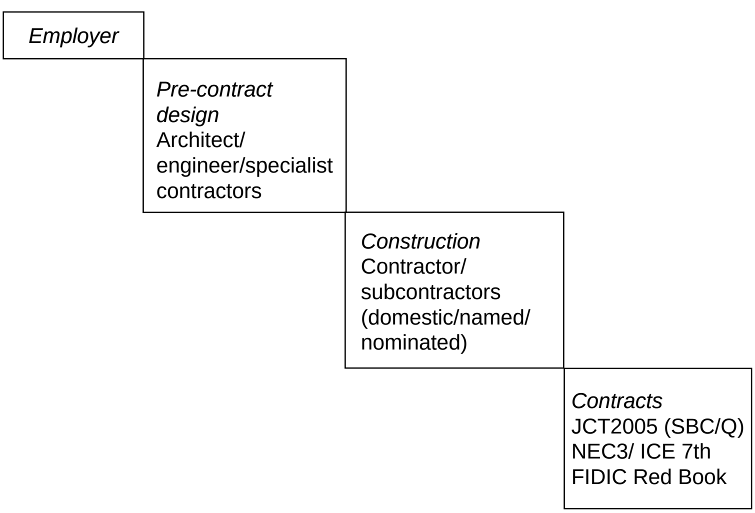
- generally a high degree of certainty on the basis of the cost and specified performance before a commitment to build; however, variations and claims can make this less so;

- clear accountability and tight control at every stage; again, variations and claims can make this less so;
- competitive prices between main contractors;
- opportunity to combine best design and contracting skills in well-understood relationships;
- scope for nomination of particular specialists by client;
- flexibility in developing the design up to the contract documentation stage, and if necessary varying the construction design; however, the costs can become less certain;
- well tested, in practice and in law;
- the client is able to recover costs from the main contractor in the event that the latter fails to meet contractual obligations;
- flushes out ambiguities in the documentation prior to tender.

Weaknesses

Some of the weaknesses of the traditional approach would include

- uneasy, guarded relationship between the parties – can easily become adversarial;
- engineer/architect has no liability for the performance of other members of the design team;
- client has no right of communication or instruction with the contractor;
- overall programme may be longer than for other strategies – alternative methods allow earlier commencement on site and completion;
- no opportunity for contractor to influence design or buildability during the design process;
- split responsibilities – client is in direct contract with many different parties which can be a serious weakness in the event of major defects arising;
- does not encompass Egan's recommendations: 'fully integrated design and construction team'.



10.2 The traditional system.

Panel 10.2 Case study: traditional procurement – Bath Spa

Initially estimated at £11 million, the Bath Spa project, a public leisure amenity, in the historic town of Bath in Somerset, England, has become one of the most delayed and disrupted projects in recent times.

The project was funded via a £7.78 million grant from the Millennium Commission who specified that the council must opt for a traditional JCT contract. The aim was to open for Christmas 1999; however, in the event the contractor Mowlem did not start on site until 2000.

When the architect Grimshaw produced designs with more clarity, the costs rose to £15 million then to £22 million.

In 2003 with construction complete, Grimshaw, as contract administrator, refused to certify practical completion because it had become apparent that the RIW Toughseal paint on the walls was peeling. In September it was reported that the steam room floors were also leaking.

Grimshaw claimed that the defects were construction related, while Mowlem claimed they were design related.

In February 2005 Mowlem offered to complete the project for £26.5 million under a design and build arrangement and drop all claims against the council. This proposal was never accepted.

In April 2005 following claims that Mowlem had refused to obey an architect's instruction requiring replacement of the floors in the steam room, Mowlem were told to leave the site.

A new project manager Capita Symonds was appointed to take the scheme to completion under an arrangement in which the council would have direct control of the contractors. Capita Symonds later said they found a series of significant structural problems from leaking floors, rusty and outdated fittings and £700,000 worth of windows which had begun to delaminate.

It is anticipated that the project will be completed in 2006 with an estimated final account of £40 million.

Sources: *Building* (11 February 2005, 18 February 2005, 8 April 2005, 13 May 2005); *The Times* 24 April 2006.

If speed is a priority it is possible, however, to use accelerated traditional methods, usually through the use of two-stage tendering or negotiated tendering procedures. These enable design and construction to run more closely, securing some time saving but giving less certainty about cost.

The advantages of accelerated traditional methods are as follows:

- Two-stage tendering allows early testing of the market to establish price levels and gives early contractor involvement resulting in speed of construction;
- Negotiated tendering allows early contractor involvement for *fast tracking*, that is, beginning work on site before the design is complete;
- Negotiated tendering also gives flexibility for design development as the construction proceeds.

The possible disadvantages are as follows:

- Less certainty on price before a commitment to build;
- Competition may be diminished in negotiated tendering;
- More concentrated client involvement required to ensure efficient planning and control throughout the process.

As a post script to the traditional procurement system it is worth mentioning procurement of public works in New York city which seems out of step with the general international trend towards the use of alternative contract strategies.

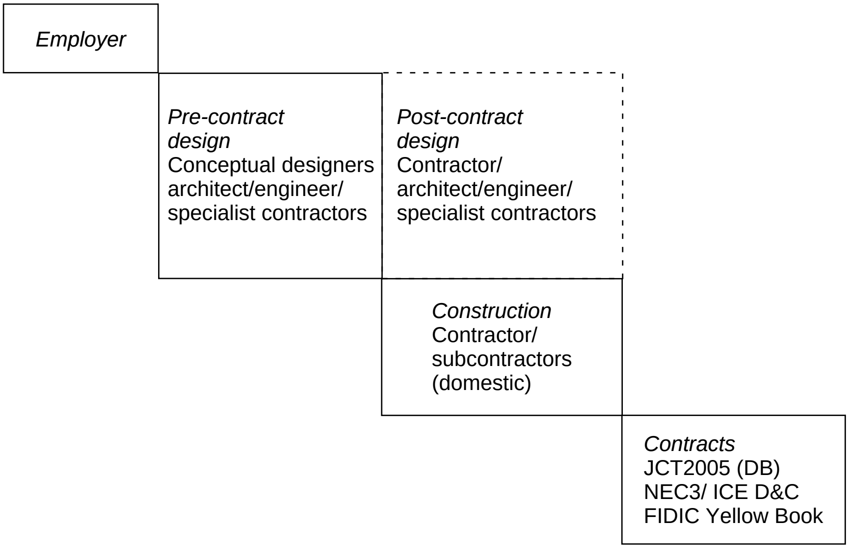
New York city statutes require that contracts by state agencies for construction work be awarded to the lowest responsible bidder based on open competitive bidding. These requirements essentially mandate the traditional design-bid-build (DBB) approach to public works procurement, since competitive bidding requires a completed design, meaning that design services must be procured separately and before construction work is procured, and that the selection process cannot be based on comparative evaluation of proposals (Raved, 2003).

Anecdotal evidence from an architect who has worked in New York identified the high level of corruption prevalent in the labour unions as a possible reason for the move away from a partnering strategy back to the traditional lump-sum, fixed-price approach.

10.3 Design and build

Back in 1964 the Banwell Report remarked that 'in no other industry is the responsibility for design so far removed from the responsibility of construction.'

Today the contractor-led design and build procurement route (see Fig. 10.3) is now established as the most popular procurement route. Furthermore, it is increasingly perceived as the appropriate answer for large and complex projects, sometimes designed by signature architects.



10.3 The design and build system.

The process

The design and build strategy requires the contractor to take overall responsibility for both design and construction in return for a fixed price lump sum. However, in practice, the client may appoint an independent project manager or quantity surveyor to safeguard their interests.

The client enters into a single contractual relationship with the contractor to design and construct the project in accordance with a performance specification prepared by the client. The contractor then enters into a series of separate agreements with consultants, specialist subcontractors and suppliers to deliver the project in accordance with the agreed performance specification. Since the contractor becomes solely responsible for all aspects of the project delivery process, most of the risks associated with design and construction are therefore borne by the contractor giving the client greater protection.

The client generally invites tenders based on an outline design, critical specification and workmanship standards, completion time and other key information. At the earliest stage of the construction period, the contractor completes the outstanding design development, thus generating an overlap between the design development stage and construction stage which should in theory reduce the overall duration.

In practice, there may be two separate design teams, one employed by the client to develop the client's brief and the other employed by the contractor to undertake the detailed design work. It should be noted that the former design team may not be contractually linked with the contractor though in some cases this design team may be novated to the contractor. Equally, the design team employed by the contractor is usually contractually remote from the client, and the client can only influence the output of the design through their intervention in the design-approval process. This often leads to variations and changes in the original requirements.

Contractor's expertise

The design and build approach allows the contractor's design and construction team to consider, at the earliest conceptual stage, site-specific construction issues which a consultant working in isolation is not normally equipped to deal with. For example, on a large marine project the team will be able to establish the following criteria: if the site is suitable for the use of large cranes; whether heavy floating barges can be used in a tidal location; how materials will be transported to the construction locations; whether there are suitable areas close to the site for setting up a precasting or pre-assembling yard; what skills are characteristic of the local labour force and how the local weather during the construction period will affect the construction methods.

The most economic type of structure and the most suitable method of construction will depend on the answers to the above questions, together with the contractor's specific expertise and the availability of construction equipment. It is at this stage when the combined team has at its disposal all the relevant facts and techniques that increased productivity may be considered – thus reducing the overall cost to the client.

Flexibility

The design and build route is extremely flexible and many different versions have emerged over the past decades. The major difference between them is the amount of design input by the employer's designers and the contractor's designers; for example; the client's contribution to the design may vary from 5% to 75%.

The amount of tender documentation provided by the client (known in the JCT Standard Form of Building Contract with Contractor's Design 2005 as the *Employer's Requirements*) can vary from little more than a written brief to a fully worked out scheme. The greater the priority

Panel 10.3 Case study: design and build – Cardiff Millennium Stadium

The main reason Laing lost so much money (£31 million) on the £99 million Millennium Stadium in Cardiff was that it guaranteed a maximum price on the basis of sketchy designs which were still undergoing change.

The original design had masts raking out at 45 degrees at the four corners of the stadium, but a row between the stadium operator and its neighbours Cardiff Rugby Football Club led to these being revamped to two vertical and two raking masts.

The load calculations for the £480,000–member roof had to be redone. The problem was that the design was still developing as Laing fixed its price and was still developing as the roofing contractor hit the site.

Cardiff Ruby Football Club also refused to allow Laing's tower cranes to swing over its air space, cutting off access to one side of the ground.

Claims came in from subcontractors, and under the contract Laing carried the risk and were left with the bill.

Shortly after the stadium opened Laing were required to install 74 giant metal props in order to make the cantilevered stands safe for a 'new year eve' rock concert. A legal expert close to the project said that the contract documents were an absolute mess and that the situation, on liability, could be hard to resolve.

After this project the Laing Group was reorganized with the construction arm being sold to concrete specialist O'Rourke for £1 million.

Source: *Building*, 17 September and 17 December 1999.

the client gives to design the larger the amount of information tends to be included in the tender documents. If a client's priorities are economy and speed then less design information will be included, leaving more scope to the contractor.

Three main categories of design and build approach can be identified:

1. *Direct:* designer/contractor appointed after some appraisal but not competition;
2. *Competitive*: conceptual design prepared by consultants, several contractors offer designs in competition;
3. *Develop and construct:* client's designers complete design to partial stage before asking contractors to complete and guarantee the design in competitive tender either with their own or using the client's designers (novation).

Responsibility for design

There are two standards of care which are relevant to the design and build strategy:

Reasonable skill and care

A duty imposed on a professional consultant who provides advice or a service. It is effectively a matter for professional judgement whether in providing that advice or service the consultant has exercised all the skill and care that can reasonably be expected. Only if professional negligence can be proven is the consultant liable for failure of the end product.

Fitness for purpose

A statutory requirement under the Sale of Goods Act and an implied term in any contract for the design and supply of a finished product. If the product is proved unfit for the intended purpose for which it was supplied, then irrespective of whether the provider of the product has been negligent or not, there would be a liability for any failure of that product to perform.

The risk of the design meeting the client's requirement would be spread differently depending on the contract strategy adopted.

Under the traditional, management approach:

- The consultant(s) who design the project would not be liable for the performance of the completed project unless it could be proved that the consultant had failed to exercise the level of skill and care reasonably to be expected. Before recovering damages, the sponsor must prove actual professional negligence by the consultant, often a substantial hurdle to overcome in any litigation.
- The contractor(s) who only builds the project using the design provided by the consultant(s) would be liable for fitness for purpose of the materials and components that were provided within the project. The contractor(s) would not be responsible for the performance of the works as a whole.

Under a design and build strategy:

- The contractor who designs and also builds a project would be liable not only for the fitness for purpose of the materials and components, but also for the completed project as a whole. Not surprisingly, it is unlikely that a contractor would be able to obtain professional indemnity insurance while taking on such a design obligation.

In the case of *Co-operative Insurance Society* v. *Henry Boot (Scotland) Ltd TCC 1 July 2002* the contractor was deemed to have effectively audited and adopted as its own, the design work of others. The fact that the piling, the offending elements of works, had been designed by

Panel 10.4 Case study: design and build – Hammerson

For large schemes, generally of more than £20 million, Hammerson use a two-stage bidding process. They invite a few major contractors to work with their designers to develop the scheme and select one of them based on issues such as preliminary costs and overheads. When the design is 80% complete, they will novate the design team to the contractor. The contract then becomes a design and build contract or one with a target price guaranteed.

Source: '50 top clients a building directory', *Building*, Supplement, February 2003.

consulting engineers did not protect the contractor who possibly unwittingly took on an obligation to complete the design. Following this case it is noted that the JCT Design and Build Contract (DB2005) now provides that the contractor is not required to check the design in the employer's requirements and will not be responsible for any adequacy in it.

The design and build system

Strengths

- Early completion is possible because of early commencement date and overlapping activities;
- Single-point responsibility for total design and construct process after the selection stage – one back-side to kick if anything goes wrong!
- The client can demand the quality and the performance specified;
- Price certainty is obtained before construction starts provided the client's requirements are adequately specified and changes are not introduced;
- Varying amount of client design input can be allowed;
- Input by the contractor can lead to more economic design;
- It is less adversarial than the traditional approach;
- Tender competition on alternative design solutions is possible;
- Direct lines of communication between subcontractor and designer is possible;
- Due to early collaboration between design and construction disciplines variations are reduced.

Weaknesses

- Competing schemes may not meet client's requirements unless specified in detail before the bidding begins;
- The cheapest building in terms of whole-life costs may not be produced;
- The client loses control over quality in design;
- Client's clearly defined brief required at commencement;
- Changes after commencement are expensive;
- Analysis of tenders may be subjective.

The employer's agent

Many cost consultants are now employed as the employer's agent (EA) under the design and build procurement route. The role taken by the EA must be clearly defined by the client and can vary from simple contract administration to a full project management service. Beyond specific contractual duties other areas in which the EA can contribute include the following:

- drafting the project execution plan;
- managing the briefing and scope-definition process;
- appointing design consultants, on a basis that facilitates the effective transfer of design responsibility;
- managing clients and third-party liaison;
- preparing employer's requirements and other tender documentation;
- implementing change control;
- supporting use of warranties to meet the requirements of third parties.

For a full discussion on the role of the EA, see Simon Rawlinson's detailed article in *Building* magazine (9 February 2007), pp. 58–61.

Panel 10.5 Case study: design and build – Wembley Stadium

When the contract to build the Wembley Stadium was first put out to tender in late 1999 on a fixed-price lump-sum basis Sir Robert McAlpine declined to bid, warning that 'The sums of money need to adequately cover (the risk of the builders running over budget) would be expressed in tens of millions of pounds.'

In February 2000, Multiplex, a major Australian contractor submitted a bid in joint venture with UK contractor Bovis and were appointed as the preferred contractor. Bovis refused to accept a price reduction below £339 million and on 30 August the client WNSL terminated the joint venture. Two days later Multiplex made a solo offer to build Wembley in 39 months for £326.5 million which was accepted ten days later by WNSL 'subject to board approval'. In the negotiations that followed, after funding was secured, the figure was increased by £120 million to a guaranteed fixed price of £445 million.

This 40-month design and build project had the advantage of a late start with a well-developed design and few changes were envisaged. Any savings made by the contractor would be retained by them; likewise they would carry all risks. Multiplex told their shareholders that they was confident of securing a profit on the project.

Wembley's great technical challenge was the structural design, construction and erection of its signature arch. Multiplex awarded steelwork specialist Cleveland Bridge an 81-week, £60 million lump-sum fixed-price subcontract to fabricate, supply, deliver and erect the arch and roof.

However, in 2004 the site was severely disrupted between March and August as a legal dispute developed between Cleveland Bridge and Multiplex. Cleveland Bridge were subsequently ordered off the site and replaced by Dutch steel subcontractor Hollandia working on a 'cost-plus' basis.

In a claim against Multiplex for non-payment, filed at the Technology & Construction Court, Cleveland Bridge alleged that 'by the Spring of 2003 there were serious problems arising from late and incomplete design by the civil and structural engineers, Mott Stadium Consortium (which had been novated to Multiplex), and delays in providing design information. The design changes and late information caused substantial cost increases, and delays and disruption to the subcontract works.'

Though Cleveland Bridge and Multiplex agreed on a plan for accelerating work, plus compensation for the resulting change in the subcontract terms, a legal row broke out, over alleged non-payment and contract breaches.

In May 2005 Multiplex announced losses of £45 million; their shares crashed and were suspended on the Australian stock market. These losses for Multiplex did not take into account the costs associated with claims from Cleveland Bridge (High Court writ claims £20 million) or from the other subcontractors claiming a 15-week delay and associated disruption (estimated at £20 million).

An announcement said the extent of the losses was dependent on five factors: the ability to successfully recover claims against third parties, the ability to meet the construction programme, costs associated with the project's steel work, the cost of the project preliminaries and, as required, acceleration and the weather. To date the project has so far generated seven court judgements.

After extensive delays Wembley Stadium was finally handed over to the client in March 2007. It was reported that Multiplex made a loss of £147 million on the project and the Australian family company was sold in June 2007 to a Canadian firm.

Source: Mylius, A. (2005) Supply Management, *Building* (31 May 2002, 11 October 2002, 29 October 2004, 3 June 2005, 4 November 2005, 15 June 2007); Conn, D. (2006); *Guardian*, 8 March.