HM TREASURY

Infrastructure UK

Infrastructure Cost Review:

Technical Report

December 2010

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Preface

The June 2010 Budget announced that Infrastructure UK would carry out an investigation into how to reduce the cost of delivery of civil engineering works for major infrastructure projects, to report by the end of 2010.

This detailed Technical Report and annexes sets out the methodology, analysis of findings and conclusions from the investigation. Together with the Main Report this Technical Report and annexes can be downloaded from the HM Treasury website.

This investigation has been led by Infrastructure UK in collaboration with wider government, the Institution of Civil Engineers (ICE) and industry. It was carried out between August and December 2010, over which period an Infrastructure UK team, supported by industry secondees, has gathered evidence on civil engineering infrastructure delivery from over 300 organisations, including over 120 interviews in this country and abroad. The investigation has been supported by a Steering Group chaired by Terry Hill of Arup. The investigation has also taken advice from an independent Stakeholder Reference Group, hosted by ICE, which included representatives from across the public and private sectors.

Contents

1 Introduction and approach

Introduction

1.1 The June 2010 Budget announced that Government would carry out an investigation, to be led by Infrastructure UK and chaired by Terry Hill (Arup) into how to reduce the cost of delivery of civil engineering works for major infrastructure projects, to report by the end of 2010.

1.2 This detailed Technical Report sets out the methodology, analyses of findings and conclusions from the investigation as described in Box 1.A below. Together with the Main Report this Technical Report and Annexes can be downloaded from the HM Treasury website.

Box 1.A: Structure of technical report

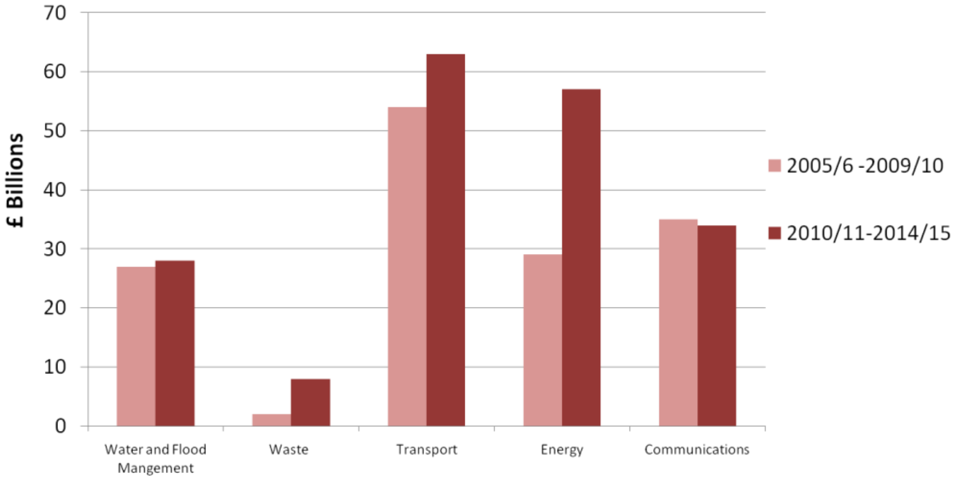
- Chapter 1: Background and approach - provides a brief background to the investigation and an explanation of the governance, stakeholder involvement and approach taken.
- Chapter 2: Infrastructure construction output in the UK - describes the scale of infrastructure construction output in the UK together with the key upward pressures on costs.
- Chapter 3: Macro overview of the industry - characterises the nature of the UK construction and civil engineering industry in the context of our wider European peer group.
- Chapter 4: International comparisons - builds on Chapter 3 and compares in greater detail the policy and regulatory frameworks, public and private sector structures and key processes within Western European countries that influence the outturn cost of civil engineering infrastructure.
- Chapter 5: Findings from non-cost data - summarises the investigation findings from the UK and international non-cost data collected, including the initial on-line survey undertaken in conjunction with the Institution of Civil Engineers, the key themes emerging from interviews and other non-cost evidence submitted in three thematic areas.
- Chapter 6: Findings from cost data and benchmarking – sets out a summary analysis of the quantitative benchmarking undertaken by the investigation including the top-down analysis of international benchmarks and the analysis of sample projects by sector (highways, flood-defence, high speed rail, rail stations and tunnelling). See also Annexes B to H.
- Chapter 7: Analysis of key findings - brings together the previous Chapters 2 to 6 in a summary analysis. It starts with a brief review of the key conclusions and recommendations from previous reports before providing a summary of the cost benchmarking analysis and conclusions from the Institution of Civil Engineers sub-groups (clients, supply chain, standards and tunnelling).

Context and background

1.3 The National Infrastructure Plan 2010[1] sets out the UK's infrastructure needs, challenges and a plan for infrastructure investment across sectors. The plan describes an investment requirement of some £200 billion over the next five years, principally in transport and energy with the investment in the energy sector almost doubling between 2010 and 2015 (see Chart 1.A).

[1] http://www.hm-treasury.gov.uk/ppp_national_infrastructure_plan.htm

Chart 1.A: Historic versus planned infrastructure investment



Source: Infrastructure UK

1.4 Enabling this scale of infrastructure investment in the current fiscal environment is dependent on identifying smarter uses of public funding, promoting private sector investment, better regulation and reducing waste and inefficiency in infrastructure construction and delivery generally.

1.5 In December 2009 work on the High Speed 2 (HS2) cost estimate identified specific evidence that infrastructure delivery in the UK is more costly than for similar projects in other European countries – UK unit rates for civil engineering works (e.g. tunnels and viaducts) for a high speed rail line appeared to be approximately double those in Europe [2]. The HS2 report went on to recommend that more work was undertaken to help understand the factors causing such differences in the costs of civil engineering infrastructure and to produce specific actions to "*...effect changes which may be necessary to realise cost reduction opportunities by bringing capital costs more into line with others in Europe*".

1.6 Initial analysis of other reports and studies[3,4,5] provided further evidence of higher costs and lower productivity[6]. In addition, there was also strong 'anecdotal' evidence of higher costs. Reducing the costs of investing in infrastructure is a priority for the Government.

Investigation scope and outputs

1.7 The scope of this investigation has been to collect evidence which identify the factors influencing the costs of delivery of civil engineering infrastructure in the UK. The investigation has focused on the main areas of economic infrastructure, namely highways, rail, water, waste and energy which traditionally have high civil engineering content, rather than other areas of social infrastructure (e.g. hospitals and schools) which often have a higher building content. However, it is anticipated that the finding and recommendations will benefit other areas of UK non-civil engineering infrastructure.

[2] High Speed 2 BSL comparison of high speed lines' capex, (November 2009)

[3] EC Harris and TRL report for the Highways Agency, (December 2009)

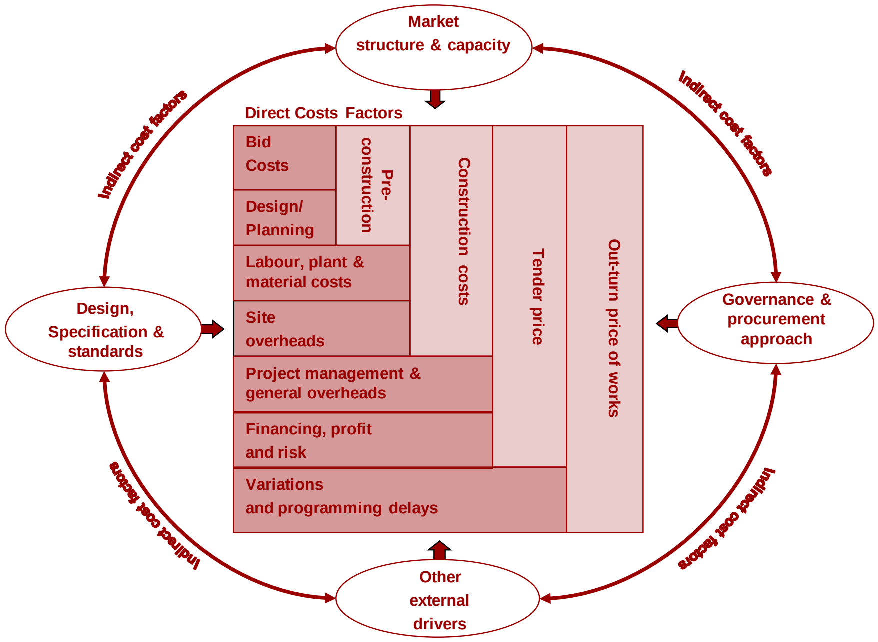
[4] Bent Flyvbjerg Comparison of Capital Costs per Route-Kilometre in Urban Rail, (March 2008)

[5] Study by the European Commission, (2007). Ranked the UK the fifth highest of the 27 Member States in terms of construction price levels.

[6] Study by Mark Gibson (former Director General at BERR), BIS 2009 - the study indicated that the productivity of engineering construction projects in the UK was very variable – up to 30 percent better or worse than the average.

1.8 Where possible, the investigation obtained both cost and non-cost data (i.e. reports, examples and structured interviews) enabling the investigation team to understand better both the direct and indirect factors which drive the outturn costs (see Chart 1.B below).

Chart 1.B: Direct and indirect drivers of infrastructure costs



Source: Infrastructure UK

1.9 Whilst the investigation focus has been to identify measures that can improve effectiveness and reduce the costs of infrastructure delivery in the UK, the investigation also sought to benchmark the UK's delivery performance against other European nations and understand those UK national factors that may drive a different approach or output, and how this national approach may influence costs.

1.10 The key outputs for the investigation were to:

- set out the key factors, both direct and indirect, that drive the costs of delivery;
- identify the key factors in the UK that differentiate infrastructure delivery here from other nations; and
- formulate a series of recommendations and actions for consideration within Government, regulators or industry that when implemented will help to improve infrastructure delivery and reduce costs.

1.11 The investigation is complementary to: the Department for Transport and Office of the Rail Regulator study being led by Sir Roy McNulty, which is looking more broadly at the totality of costs involved in the delivery of rail infrastructure; the ongoing work of the Department of Business Innovation and Skills' Low Carbon Construction initiative; and the Public Sector Construction Clients' Board, chaired by the Chief Construction Adviser.

1.12 Investment in infrastructure will play a crucial part in the UK's plans for economic growth. By taking action to reduce the costs of delivering infrastructure the UK will be able to construct more infrastructure for the same level of investment, which itself supports other economic growth. Efficiencies within the industry will help make it more competitive both domestically and internationally.

Investigation approach

Overview

1.13 The investigation has been led by Infrastructure UK in collaboration with wider government, the Institution of Civil Engineers (ICE) and industry. It was carried out between August and December 2010, over which period an Infrastructure UK team, supported by industry secondees, has gathered evidence on civil engineering infrastructure delivery from over 300 organisations, including over 120 interviews in this country and abroad. The review has been supported by a Steering group chaired by Terry Hill (Arup).

1.14 A key objective of the data gathering process has been to consult with a widely representative stakeholder group. With this in mind the investigation team has been working closely with other Government departments, ICE, industry and academia.

1.15 The ICE established an independent stakeholder reference group, chaired by ICE President Peter Hansford (Nichols Group). The aim of this stakeholder reference group has been to support the investigation, firstly by ensuring that the valuable contributions and input of all facets of the industry was actively sought and secondly by providing a channel through which the wider industry can contribute and comment on any emerging findings and actions. With the ICE, the investigation has also taken advice from specialist technical groups on client issues, standards, supply chain and tunnelling.

1.16 A full list of members of the Steering Group and ICE Independent Stakeholder Reference Group can be found in Annex A.

The Data-Gathering Process

1.17 As part of an initial literature review the investigation considered previous Government and industry reports. This included published reports and internal reports made available to the study by contributing organisations. Such reports and raw data were of great value to the study. A summary of the findings of the literature review can be found in Chapter 7.

1.18 The investigation data collection began with a high-level web-based survey undertaken in conjunction with ICE, the results of which are summarised in Chapter 5. The responses to this initial call for evidence precipitated face-to-face interviews with over 120 UK and non-UK organisations, undertaken in parallel with analysis of sample projects across a number of sectors.

1.19 Academic studies[7] suggest that case studies are generally better tools for understanding differences in construction performance between countries. The focus for this study has therefore been to rely more heavily on a case study approach, recognising some of the limitations of macro level comparisons.

1.20 As set out in more detail in Chapter 5, the initial web-based survey was brought to a close in September 2010. Following the ICE survey and a literature review, templates were developed for more detailed investigation of:

- industry as a whole (in a *generic non-cost questionnaire*); and
- sample projects (in a *project-specific non-cost and separate cost questionnaire*).

1.21 These questionnaire templates were then used as the basis for data collection in the interviews. The templates used can be found on the Infrastructure UK website.

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[7] Edkins,A., Winch,G.M., *The Performance of the UK Construction Industry: An International Perspective* (1999)

Data confidentiality

1.22 The information and opinions provided as evidence to this investigation were provided on a confidential basis and in the case of the interview evidence reflect the general views of the interviewees and not their respective organisation. Except where material has already been made public, for example published reports, it has been anonymised.

2 UK infrastructure construction output

Introduction

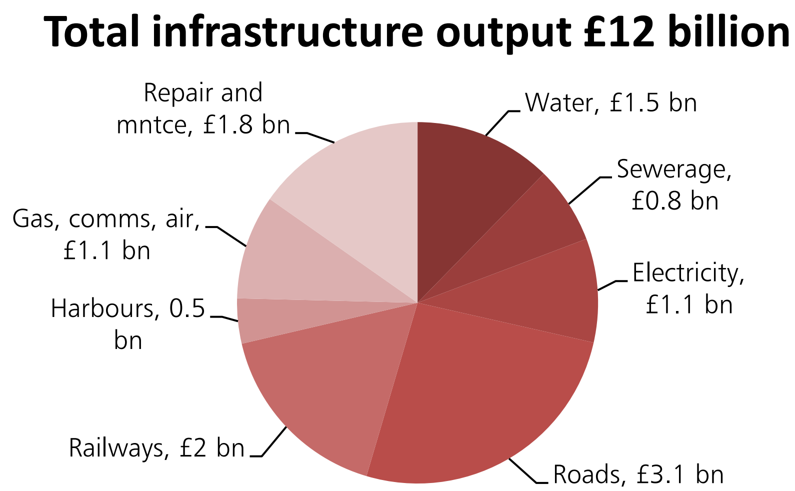
2.1 Chapter 1 briefly described the objectives of the National Infrastructure Plan 2010 and sets the context and approach taken to this investigation. The National Infrastructure Plan deals in general with the challenges and investment requirements for infrastructure in the UK. With this broader investment context in mind this Chapter aims to characterise current infrastructure construction output and challenges in the UK by:

- analysing the output levels of infrastructure construction in the UK;
- characterising the extent of investment in capacity enhancing new build infrastructure and asset renewals and maintenance; and
- providing an indication of the key issues likely to put upward pressure on infrastructure construction costs in the UK.

Civil engineering construction output

2.2 The Office for National Statistics (ONS) data indicate that construction output for 2009-10 is estimated at £12 billion including infrastructure repairs and maintenance (Chart 2.A below), of which sixty to seventy percent represents private sector investment. [1]

Chart 2.A: Construction civil engineering output 2009-10 (repairs/maintenance estimated)



Source: ONS Construction output data (2009 prices)

[1] *ONS Construction Output Statistics* (2009) http://www.statistics.gov.uk/pdfdir/oec0310.pdf

2.3 Infrastructure UK forecasts total infrastructure investment of circa £29 billion for 2009-10 and estimates up to £30 to £40 billion per annum over the next five years. This includes funding, non-civil engineering assets (e.g. rolling stock), land acquisition, compensatory payments and other additional non-construction costs that appear to be excluded from the ONS construction output data. There also appears to be a particular issue in relation to the energy and water regulated markets where the ONS construction data appears significantly lower than the Infrastructure UK data and regulator estimates of total investment (e.g. Ofwat data indicates total capital investment in the water sector at just over£4 billion for 2009-10).

Table 2.A: Construction output forecasts 2011-2015 (£ millions)

TOTALS	Infra-structure R & M	Water	Sewerage	Harbours	Electricity	Roads	Rail	Gas, Air and Comms
64,772	9,880	7,982	4,479	2,615	6,023	16,859	10,878	6,056

Source: ONS construction output forecasts (forecasts indexed using Experian data)

2.4 Table 2.A above inflates the ONS construction output data using infrastructure indexation forecasts from Experian[2]. On this basis infrastructure output including repairs and maintenance is estimated at £65 billion over the next five years from 2011-15 (£13 billion per annum).

2.5 Experian's forecasts of infrastructure construction output over the same period (2011-15) indicate a higher figure of £75 billion (£15 billion per annum).

2.6 Forecasts by the Construction Products Association (CPA) for 2010, based on the ONS output data, suggest that infrastructure renewals and capacity enhancement over the next four years will be £50 billion to £55 billion in total (£12.5 billion to £13.8 billion per annum).

2.7 As further evidence, the June 2010 New Civil Engineer (NCE) survey indicates UK based contractors alone turned over £13.5bn in the calendar year to December 2009.

2.8 These may be conservative estimates if the energy and water sector inputs have been under estimated in the ONS construction output data. Infrastructure UK's estimates of total investment in water and energy, taken from industry and regulator outturn data, are respectively a factor of three and ten times greater than the ONS construction output figures.

2.9 **For the purposes of the investigation a conservative estimate for infrastructure renewals and capacity enhancement output of £15 billion per annum has been assumed**.

2.10 Based on the same data the investigation suggests that public sector expenditure (mainly for roads, rail and flood defences) is in the range of thirty to forty percent of total infrastructure output. The under estimate of output figures for water and energy (i.e. increasing the private proportion of cost) means that the lower figure is likely to be more realistic. This is also consistent with the analysis of infrastructure investment in the National Infrastructure Plan 2010 which indicated public sector investment over the next five years of about 30 percent of the total investment requirement of £200 billion.

Renewals vs capacity enhancements

2.11 The boundaries between infrastructure renewal (maintenance) and capacity enhancing (new build) are often blurred. However, it is important to differentiate between renewals that are often repetitive programme based activities (e.g. track renewal or road resurfacing) and one-off capacity enhancing infrastructure projects such as Crossrail. Definitions and approaches to

[2] *Experian construction demand/capacity model* (July 2010 update for ERG)

delivering renewals and capacity enhancing projects vary significantly by sector. Similarly, the extent of additional efficiencies achievable and means by which they are achieved are also distinct.

Table 2.B: Publicly funded transport infrastructure 2010/11 budget (£ millions)

Asset	TOTALS (£m)	Renewals (£m)	Enhancements (£m)
Rail (excluding TfL)	**3,296**	1,846 (53%)	1,450 (47%)
Strategic Road network	**1,501**	645 (43%)	856 (57%)
Local transport infrastructure	**1,986**	832 (42%)	1,154 (58%)

Source: HM Treasury

2.12 The ONS construction output data suggests that infrastructure repair and maintenance costs are roughly a fifth of the total civil engineering construction output. Sector specific evidence in transport (Table 2.B) suggests a higher ratio of renewals, ranging from forty to fifty per cent of total public spending on rail and roads infrastructure.

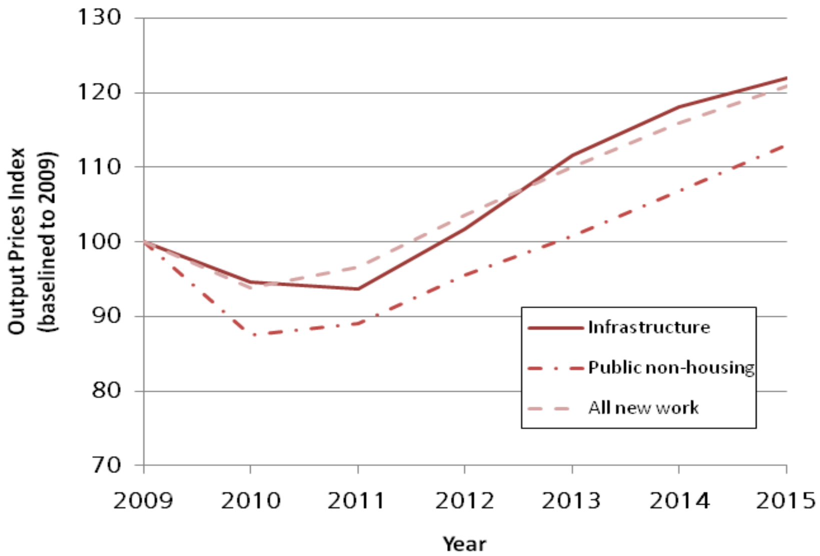
2.13 For the purposes of this investigation it has been assumed that renewal (maintenance) infrastructure costs are on average about forty percent of total infrastructure costs.

Potential upward pressures on infrastructure costs

Construction inflation

2.14 In 2009 the output price decline in the infrastructure sector was much less severe than in some other sectors and this is likely to be the case again in 2010. Infrastructure output prices are expected to fall again in 2011. All other sectors are forecast to record output price rises. The reason for this is that price fluctuations lag output trends further in the infrastructure sector, possibly due to the duration of projects[3].

Chart 2.B: Infrastructure and public works output prices



Source: Experian construction demand/capacity model (July 2010 update)

2.15 When prices do return to growth they are forecast to come back more strongly than output prices for all new work (Chart 2.B). In both 2012 and 2013 prices in the infrastructure

[3] *Experian construction demand/capacity model* (July 2010 update for ERG)

sector are forecast to increase significantly. This is likely to be the result of rapid output expansion in the next few years driven by increased activity in energy, transport and carbon reduction markets. This output growth levels out in the medium term, leading to slowing output price growth from 2014 onwards. The Experian benchmarks indicate year on year construction indexation may be as high as four to five percent per annum on average across the next five years, as the UK moves back into a period of growth. Other benchmark indices examined suggest slightly lower figures.

2.16 Infrastructure clients and commissioners need to ensure that their commercial strategies recognise the impacts of a potential rapid upswing in infrastructure cost and the dangers of low pricing by contractors, which are likely to be unsustainable and which may result in an increase in claims and litigation. In the medium and long-term the objective should be the achievement of sustainable efficiencies which will in part be delivered through taking forward the actions of the Infrastructure UK cost investigation.

Carbon reduction

2.17 Energy prices and carbon reduction measures affecting the civil engineering sector will also introduce upward pressure from the suite of domestic and international policies that address climate change. However, it is difficult to estimate the impact of this on infrastructure costs.

2.18 The BIS construction Innovation and Growth Team (IGT) included infrastructure as a sub-sector within its review of the construction industry's ability to deliver a low carbon future.[4] The review sought to bring the industry together to identify how best to meet the challenges of a low carbon future and capture the opportunities from the Government's policies to reduce CO_2 emissions. The IGT report was published in November 2010.

Adoption of Eurocodes

2.19 The UK has been adapting to the new Eurocode design standards.[5] Some areas, notably bridge design have been delayed by the late publication of the National Annexes and Published Documents.

2.20 In preparation for the changeover, both the Highways Agency and Network Rail have been commissioning trial designs of elements of bridges to Eurocodes. The research suggests that long-term there should be no difference in design cost between Eurocode (BSEN) and BSUK. For bridges the overall cost of construction may be up to five percent less when Eurocodes are encompassed for composite bridges. However, there may be some short-term upward cost pressure on design costs of up to thirty percent as UK companies "gear up" to the new codes.

Summary conclusions

2.21 Based on the Office for National Statistics (ONS) construction output data and other sources a conservative estimate of infrastructure renewals and capacity enhancement construction output is about £15 billion per annum, of which approximately thirty percent is public sector and seventy percent is attributable to regulated and private sector construction. Renewal (or capital maintenance) costs represent about thirty to forty percent of this total. In addition to significant increased investment requirement for infrastructure, as set out in the National Infrastructure Plan 2010, there are other upward pressures on infrastructure

[4] An IGT is an industry led group drawn together to develop a future plan for the industry and to make recommendations to Government and others on how to achieve this. The Construction IGT is led by Paul Morrell, the Chief Construction Adviser, and will be undertaken by a mix of industry experts and those with wider business experience. The IGT main page is at http://www.bis.gov.uk/policies/business-sectors/construction/low-carbon-construction-igt.

[5] The Eurocodes are a new set of European structural design codes for building and civil engineering works. The Eurocodes are intended to be mandatory for European public works and likely to become the de-facto standard for the private sector – both in Europe and world-wide.

construction costs, including construction inflation rises as the UK moves out of the current fiscal downturn, the adoption of new Eurocodes and the potential impacts of carbon reduction and energy efficiency legislation and standards.

3 Macro overview of the industry

Introduction

3.1 This Chapter considers the structure and performance of the UK's infrastructure construction market relative to international benchmarks. Estimates by Eurostat and the construction industry are consistent in their ranking of the UK as one of the most expensive places to build within the EU but given their methodology problems, these results are generally viewed as indicative and not conclusive. This Chapter describes:

- key cross-country comparisons of infrastructure construction costs and relative productivity, capital intensity and input cost levels;
- the relative structure and characteristics of the UK infrastructure industry; and
- systemic factors influencing UK infrastructure costs including urban density and the regulatory environment.

International cost, productivity and input measures

3.2 Cross-country cost comparisons are notoriously difficult in the construction sector and need to be treated with caution. The problems with finding a commonly accepted methodology are covered extensively by academic papers[1].

3.3 Comparison of international costs requires adjustment for currency conversion. Using exchange rates can be misleading due to their sensitivity to currency speculation that is unrelated to the relative costs of construction. Purchasing Power Parities (PPP) is the preferred method of comparison across countries, because it measures the ratio of costs of a set of identical goods.

EUROSTAT/OECD

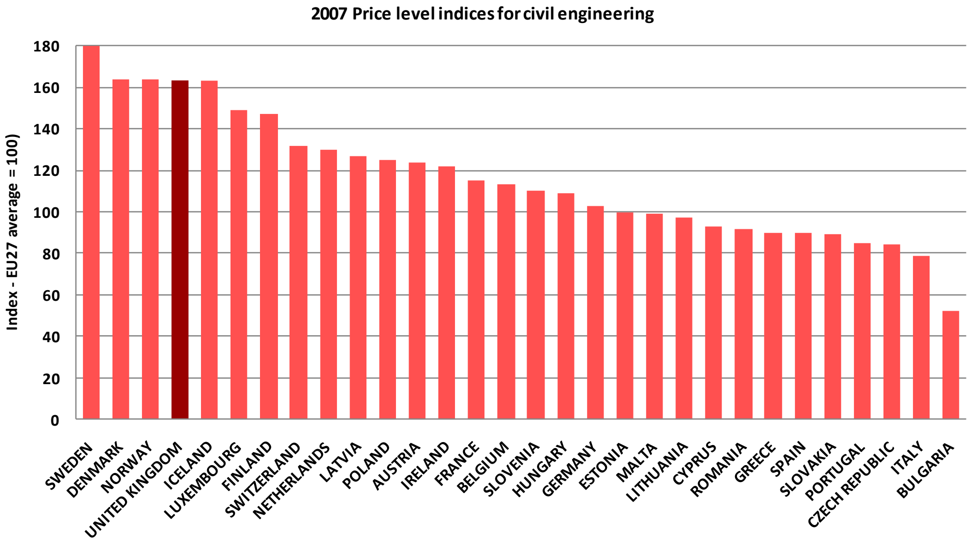
3.4 Notwithstanding the difficulties of international comparisons, Eurostat carry out a survey of construction prices every two years as part of the Eurostat/OECD Purchasing Power Parities (PPP) program. Countries are asked to collect purchasers' prices for a list of *bills of quantities*. These are notional projects that consist of a number of chapters or major components (such as earthworks, concrete, masonry, etc.), which are made up of items or elementary components (such as excavation of the terrain, dumping and compacting of spoil, etc.), i.e., prices actually paid in the markets for the elementary components that make up those bills of quantities. Price collection is carried out by the national statistical institutions, often assisted by external experts on construction.

[1] International Comparisons of Construction Industry Performance: Further Investigations, Rick Best, University of Technology Sydney and Craig Langston, School of Architecture and Building, Deakin University, Academic Paper, 2005

3.5 The price level indices provide a comparison of the countries' price levels with respect to the European Union average: if the price level index is higher than 100, the country represented is relatively expensive compared to the EU average.

3.6 Eurostat also price three different types of construction projects: residential buildings, non-residential buildings and civil engineering works[2]. Chart 3.A below shows that based on the 2007 survey the UK was 4th most expensive country in terms of civil engineering works. Previous surveys have consistently place the UK in the upper quartile of costs.

Chart 3.A: European price indices for civil engineering (2007)



Source: Eurostat/OECD PPP survey (2007)

Private sector indices

3.7 Gardiner and Theobald, EC Harris and Faithful and Gould are amongst the prominent companies that carry out their own estimates of international construction costs, mainly gathered from the general building sector (Table 3.A below). Their methods differ from the Eurostat Purchasing Power Parity approach, but are similar to each other in that they each estimate the cost of a specific construction project via the companies' international networks.

Table 3.A: Summary of construction cost indicators

	Eurostat/ OECD 2007	Gardiner and Theobald 2010	EC Harris 2007	Faithful and Gould 2007
UK Construction Cost Ranking	4th most expensive	2nd- 4th most expensive (across sectors)	3rd most expensive	2nd most expensive

3.8 Whilst these indices are published and cited, they are exposed to the same methodological problems as the Eurostat measure, whilst being less comprehensive. They also convert to a common currency using exchange rates, which are less preferable to construction PPPs. Given

[2] The residential building category contains one or two dwelling buildings and multi-dwelling buildings. For non-residential buildings, countries priced agricultural buildings, industrial buildings, commercial buildings and other non-residential buildings. The category civil engineering works is made up of transport infrastructures, pipelines, communications and power lines and other civil engineering works.

that their methods are imperfect, the results can also only be interpreted as indicative of international construction costs. Nevertheless, all three private sector indices are also consistent in ranking the UK amongst the most expensive places to build.

3.9 **The economic indicators and independent industry benchmarks described above consistently rank the UK amongst the most expensive place to build infrastructure in Western Europe, whilst suffering methodological problems, they are consistent with the evidence set out in the subsequent Chapters of this report that there are significant opportunities to reduce costs in the delivery of UK infrastructure.**

Productivity

3.10 Comparisons of international productivity levels are also problematic because, as with international costs comparisons, converting to a common base requires the use of exchange rates or Purchasing Power Parities (see paragraph 3.3 above). There does appear to be some consistency in statistical evidence that construction labour productivity in some countries, particularly the US, is relatively higher than in the UK (NIESR 2008[3], EBS 2004[4]), however, these studies differ on the relative performance of the UK construction against EU competitors.

3.11 Evidence undertaken by Independent Project Analysis (IPA) in the BIS review of Engineering Construction 'Changing to compete' 2009[5], contained a detailed analysis of international levels of productivity specific to the engineering construction sector. Engineering construction project productivity in the UK was identified as being highly variable - up to twenty or thirty percent better or worse than average. The IPA work compared sixty projects within the UK to hundreds of comparator projects from the US and EU. It showed that UK productivity was eleven percent lower than the US and five percent lower than Continental Europe.

3.12 **The investigation did not find any conclusive evidence that civil engineering construction productivity is systemically lower in the UK than other EU countries, however, evidence set in subsequent Chapters of this report suggests some project and sector specific instances of lower productivity in the UK.**

Input costs

3.13 Eurostat also produces a Construction Cost Index which indicates relative construction input costs. It indexes construction costs in countries domestic currency, which allows comparison of growth rates and as a result it is viewed as being relatively robust.

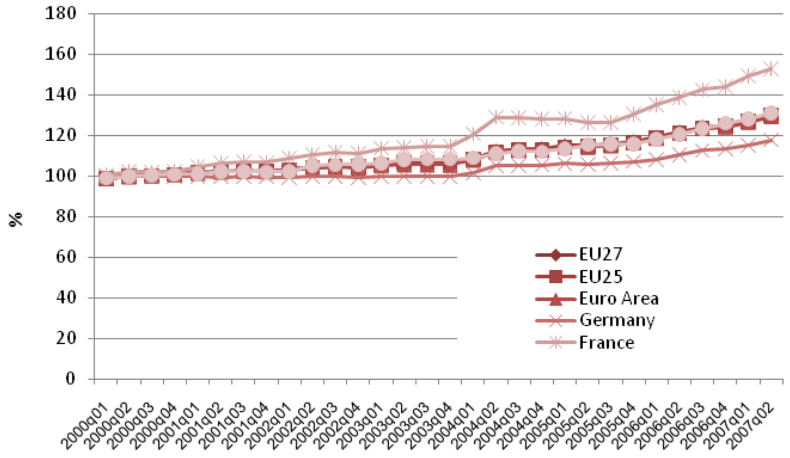
3.14 The UK growth in material prices (Chart 3.B below) has historically been very close to the EU average suggesting that variances in the UK's construction costs are unlikely to have been driven by increasing costs of raw materials.

[3] Cross-Country Productivity Performance at Sector Level: the UK Compared with the US, France and Germany, BERR Occasional Paper 1, NIESR, (February 2008)

[4] EBS (2004), Blake, N., Croot, J. and J. Hastings (2004) *Measuring the Competitiveness of the UK Construction Industry*, Vol. 2, *Industry Economics and Statistics*, DTI, http://www.dti.gov.uk/construction/stats/productivityexperian.pdf

[5] *Review of Productivity and Skills in UK Engineering Construction (the Gibson Review)* , BIS, 2009, Mark Gibson

Chart 3.B: Input prices for materials (in national currency)



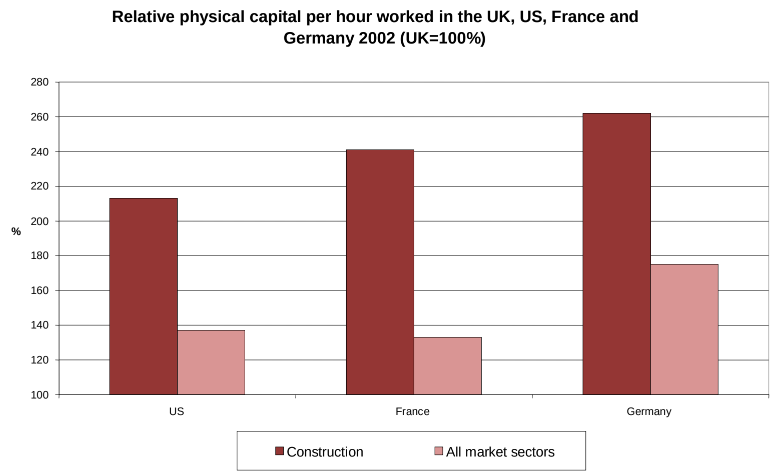
Source: Eurostat

3.15 This investigation has not found any statistical evidence that materials input costs are a significant driver of higher UK infrastructure costs, this is supported by other evidence set out in Chapter 6 which looks directly at comparable materials costs provided from a number of UK and non-UK contracting firms. [6]

Differences in the levels of capital intensity

3.16 Some evidence suggests that the UK has a relatively lower level of capital intensity (i.e. lower investment in say capital plant and equipment) in construction than, for example the US, France or Germany. [7]

Chart 3.C: Comparisons of relative physical capital per hour worked (UK=100 percent)



Source: NIESR (2008)

[6] This is in contrast to the investigation interim report, published on the IUK website, which suggested that based on one published source aggregate costs appeared to be higher in the UK. Subsequent information provided by the Construction Products Association (CPA) and a number of contracting firms suggest that the differences in costs are not significant.

[7] *Cross-Country Productivity Performance at Sector Level: the UK Compared with the US, France and Germany,* BERR Occasional Paper 1, NIESR, (February 2008)

3.17 Capital intensity is an area within UK construction generally where higher levels of investment could help drive up relative productivity performance through greater mechanisation and other innovations.

Differences in industry structure and subcontracting

3.18 According to various recent rankings, the top twenty construction companies in Europe are concentrated in just ten Western European countries: Spain, France, Germany, Netherlands, Sweden, UK, Austria, Italy and Norway. Spanish and French firms account for five and four, respectively, of the top twenty European construction firms, while British companies are represented by Balfour Beatty and Carillion.

3.19 The UK market has been consistently mentioned by the interviewees as the most open and one of the most transparent construction markets in Europe. Whilst most of the top twenty European contractors are present in the UK market, many of the other European construction markets investigated are overwhelmingly controlled by domestic companies.

3.20 The largest French and Swedish construction companies tend to be more vertically integrated than their counterparts in Spain, Germany, Netherlands and the UK. The largest Spanish, French, German, Dutch and Swedish groups tend to be more diversified, by geography and by sector, than UK contractors. Companies such as Bouygues, Vinci, Ferrovial, Hochtief, BAM and Skanska are active globally and achieve an important part of their turnover abroad. Some of these firms are no longer pure construction companies but engineering and infrastructure management companies that provide development, construction and maintenance services for different infrastructure sectors.

Table 3.B: Comparison of European contract rankings

Comparison of European contractors (France, Germany, Italy, Spain and UK)		Ranking (2008/09)				
		1st	2nd	3rd	4th	5th
Comparative Market Size (Annual Country Output, €)	In contrast to UK's ranking in GDP and population, UK construction market is the smallest of the 5	Ger	Italy	Fr	Sp	UK
Comparative Organisation Size (Annual Turnover, €)	Euro Top 20: Total Turnover UK contractors are under represented	Fr	Sp	Ger	UK	
	Euro Top 100: Total Turnover UK contractors well represented	Fr	Sp	UK	Ger	Italy
	Euro Top 100: Average Turnover UK contractors on average smaller	Fr	Sp	Ger	UK	Italy
Comparative Cross Border Activity	European Journal of Projects UK contractors less active within rest of Europe than their counterparts in other countries	Fr	G	Sp	UK	
Comparative Industry Performance	Euro Top 100: Profitability UK contractors are least profitable	Italy	Fr	Sp	Ger	UK

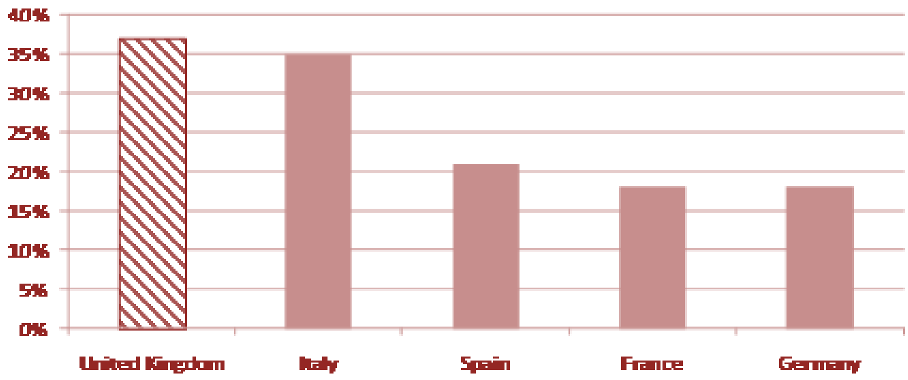
Source: European Top 200 Contractors and Housebuilders, Building Magazine, January 2010

3.21 According to a number of comparisons, in recent years UK contractors have tended to be neither the largest nor the most profitable (Table 3.B above). However, the data also indicates that, through high levels of subcontracting, they are able to maintain comparatively good returns on capital employed.

3.22 In a separate analysis Ernst and Young[8] also compared the European Top Twenty Contractors and House Builders in relation to their 2008-09 results generating an assessment based on: a combination of performance (sales, net profit); and order book and financial position (gearing, net debt to EBITDA[9]). In this assessment two of the top three overall best performers were from the UK.

3.23 Through the sixties and seventies, a number of changes occurred that have driven increased fragmentation and self employment in the UK construction sector, making the industry less highly operationally geared.

Chart 3.D: Proportion of self employed in total construction industry employment



Source: Eurostat

3.24 Sub-contracting, to different degrees, is quite common in all the construction markets studied. Most large construction projects could not be efficiently completed without some degree of sub-contracting. However, the evidence suggests higher levels of subcontracting and greater competition at all levels to be a particular feature of the UK construction market. There are also comparatively higher levels of self employment in the UK (see Chart 3.D above).

3.25 Higher levels of subcontracting and self employment have, however, helped make the UK industry more flexible and responsive to stop-start investment. Evidence suggests that during the construction recession in the early nineties, it was falling self employment that addressed over capacity.

3.26 **In summary, the UK infrastructure construction market has become the smallest of the big five European countries. The cyclical nature of infrastructure investment in the UK has contributed, over several decades, to a significant shift from fixed to variable resources, relative to many European contractors which tend to use less subcontracting and are more vertically integrated. The UK infrastructure supply chain has tended towards a relatively large number of medium sized construction companies acting as main contractors in contrast with the rest of Europe.**

8 Top 20 Contractors and House Builders 2009: Ernst and Young European Construction Group (September 2010).

9 EBITDA (Earnings Before Interest Tax Depreciation and Amortisation)

Other systemic issues

Urban density and ageing infrastructure

3.27 The UK is a comparatively densely populated country[10] with urban areas representing just over eight percent of total land use and with increasing concerns about bio-diversity, climate change and resource constraints may lead to a change in views about where development is best located (see also Table 3.C below).

Table 3.C: European population densities

Country	UK	Germany	Italy	France	Spain
Population Density (People/km2)	246	231	195	111	87
Source: Eurostat Data, 2007					

3.28 Over seventy percent of infrastructure capacity enhancement in the UK is on 'brownfield' land as opposed to just over fifty percent in the rest of Europe. Seventy percent of Network Rail bridges are over 100 years old compared to an average of twenty six percent averaged across Europe.

Regulatory and process compliance issues

3.29 Within Europe the UK is a top performer in relation to construction health and safety [11]. Interpretation of requirements in the UK appears to impose additional costs on UK contractors compared to their continental counterparts. These impacts are described in Chapter 5.

3.30 There is strong anecdotal evidence that the regulatory structure around infrastructure construction, as applied in the UK, is relatively more costly than international peer groups. A study carried out by the World Bank consulting 5,000 local experts looks at the ease of undertaking a construction project (relative complexity of processes) in different countries. [12] According to this study, the UK was 54th out of 178 countries. Other countries such as France (17th), Germany (16th) and the USA (24th) scored better. The UK cost of procedures represents sixty five percent of income per capita whereas in other countries like France or USA it only represents twenty five percent or thirteen percent of income per capita respectively.

Land use planning and consultation

3.31 In 2006 the Barker review provided recommendations addressing concerns about the UK's approach to land use planning and more specifically about delays to the giving of consents to nationally significant infrastructure that impacted economic growth. Six major transport decisions were illustrated which ranged from twenty seven months to eighty six months (for the M6 Toll Road).

3.32 Inefficiencies in the UK planning system lead to more expense. Planning lead-times and inconsistencies between different areas of the country are particularly onerous. Uncertainty and time-lags due to the planning system contribute significantly to delays and have been cited as

[10] *Barker Review of Land Use Planning Final Report – Recommendations*, (December 2006)

[11] See Chapter 5 Chart 5.E

[12] World Bank "*Doing Business*" Project: www.doingbusiness.org

key reasons as to why UK major scheme outturn costs are in excess of those seen in other European countries[13].

3.33 As a consequence a fast-track planning approach for nationally significant infrastructure projects was established through the Planning Act 2008. In order to reduce the time delays and costs associated with planning and consultation, the Government has prioritised the establishment of the new Major Infrastructure Planning Unit established within the Planning Inspectorate.

Summary conclusion

3.34 Considering the factors above it is clear that the UK construction industry has a higher degree of supply chain fragmentation. This leads to increased internal transaction costs, caused in part by the highly cyclical investment approach in the UK, consistent with a developed infrastructure asset base that is in the cycle of renewal and redevelopment. Project complexity is further compounded by a high population density necessitating brown field development and extended public consultation processes, due to higher levels of public impact. Overlying this is an approach to regulatory compliance and health and safety controls that probably adds the most cost in Europe.

[13] *Construction Demand Capacity Study, Deloitte / Experian*, unpublished OGC report (2006)

4 International comparisons

Introduction

4.1 Chapter 3 provided a macro overview of the UK construction industry as compared to other European countries. It set out key economic indicators of outturn costs, productivity, labour plant material and other input costs, as well as key differences in industry structure.

4.2 In order to understand other countries' approaches to infrastructure planning and delivery, the investigation team conducted structured interviews with central government bodies, client organisations and construction companies, principally from Spain, France, Germany, Netherlands, Sweden and Denmark.

4.3 The aim of this Chapter is to narrow the focus to some of the more specific policy, regulatory, infrastructure prioritisation and delivery differences that might result in lower costs outside of the UK. This Chapter describes key differences relating to:

- policy and regulatory frameworks;
- organisation of the public and private sectors; and
- processes for planning, prioritisation and delivery.

Policy and Regulatory Frameworks

4.4 Common features in most of the countries investigated were:

- strong political commitment to invest in infrastructure;
- a clear regulatory framework; and
- well structured long term investment plans that give client bodies, the industry supply chain and financiers the confidence to invest.

Strong Political Commitment

4.5 According to the interviewees, political support for infrastructure development in road, rail and urban transportation has been very strong in most continental European countries.

4.6 In France, Spain and Germany, for instance, there has been strong public and political support for the development of the high-speed rail network. As pointed out in a report prepared for the Commission for Integrated Transport, in the 1980s and early 1990s for most Western European countries the basic rationale for investment in high speed rail extended well beyond commercial considerations into political and strategic objectives and wider transport plans.

4.7 In France, for example, the decision to construct the first TGV (*Train à Grande Vitesse*) line between Paris and Lyon (completed in 1981) stressed the importance of technological progress and national prestige. The success of this first line has led to an impressive expansion of the network, with new lines built in the south, west, north and east of the country, and three more lines planned.

4.8 Similarly, the Spanish government has embarked since the early 1990's on a very extensive high-speed rail construction programme, and has promised that all regional capitals will be within four hours of Madrid and six hours of Barcelona by high-speed train. As a result of this political commitment, the purpose of the economic appraisal of high speed projects has been to prioritise schemes, amongst one another, rather than to determine whether the investment should be undertaken at all. In contrast, in the 1980s and 1990s rail projects in the UK were only authorised if they were expected to generate a return on a commercial basis[1].

4.9 In Denmark, the government passed a construction act for the Copenhagen-Ringsted Rail project, due to be completed in 2018. The political commitment of the Danish government to this project has eliminated considerable uncertainty and risks and has given increased confidence to the market.

4.10 **Political support not only provides confidence to the market but can acco*unt for substantial s*avings in construction costs by preventing unnecessary delays**. A study commissioned by the World Bank comparing the first extension of the Madrid Metro with the extension of various Latin American Metro systems, showed that full commitment at political level, ensuring project financing, on-time payments and full confidence from the contractor on getting a profit, combined with a highly experienced project management team can account for 15-20 million US$/km in savings. [2]

4.11 . The effect of such commitment was confirmed by the general manager of the Madrid Metro, who mentioned that "The Madrid Metro has always had the political support of the Mayors of Madrid and the Ministers of Public Works and the technical support of a very competent and small management team" This political and technical support has been at the heart of the impressive extension of the Madrid metro network since 2005.

Clear Regulatory framework

4.12 In the report "Rethinking Construction", Sir John Egan commented that "the interpretation and application of regulations is inconsistent across the UK, making it more difficult to implement a construction project speedily and efficiently. Significant costs and delays are often incurred in the design and planning of projects by the variability of enforcement of regulations, and by the duplication of processes between agencies"[3].

4.13 Although this report was produced in 1998 and part of Egan's conclusions may no longer be valid, some of his views on the UK regulatory framework are still shared by some construction organisations in continental Europe. Inconsistency in the interpretation of the legal framework and the resulting need to employ consultants to clarify directives was a recurring critique of the UK system presented by some of the interviewees.

[1] High Speed Rail: International Comparisons, (February 2004)

[2] Implementation of Rapid Transit, BB&J Consult S.A., (December 2000)

[3] Egan Report, Re-thinking construction, (June 1998)

4.14 For example, the head of the international department of one of the top construction companies in Europe commented that in his opinion, "the UK legalistic and bureaucratic approach to building infrastructure is the result of its Common Law system, based on a continuous interpretation of directives. Everybody is therefore scared of making a wrong interpretation so both the public and the private sectors spend significant resources in public consultations and then they need to validate their opinion with an army of legal, financial and operational advisors, which results in ever-increasing costs."

4.15 **Most continental European countries follow the Civil Law system, which although it may seem more rigid than the Common Law system, has the advantage of codifying the legal framework in written laws and manuals.** This reduces both the length of the contracts and the necessity of hiring legal advisors. As the International Director of one the main Spanish construction companies put it "In Spain we use very few legal advisors because the legal framework is very clear and is codified in laws and manuals…the Government has a standard contract for public works based on Public Procurement Law. Our contracts tend to be very short, because they refer to specific laws that the whole industry knows".

4.16 This was echoed by one of the major construction companies in Sweden where "only 2 standard forms of contracts (AB and ABT) are used by ninety five percent of clients, which limits the use of lawyers to understand contractual risks".

Well structured long term investment programmes

4.17 **Most of the countries investigated have infrastructure plans that set out their Government's long-term investment programmes.**

4.18 Denmark, Spain, Germany, Austria, Netherlands and Italy produce ten to fifteen year federal infrastructure plans [4] to develop a coherent long-term infrastructure investment programme. These federal investment plans are generally accompanied by five year sector-specific (rail, urban transport, etc) investment plans defining a list of potential projects.

4.19 In France, for example, the law "*Grenelle de l'environment*" gives priority to environmentally friendly modes of transport, like rail (currently three High-speed rail lines in construction), to the detriment of the highways sector. The economic stimulus plan has accelerated the timetable of some projects through the release of additional funds by the French Government.

4.20 As a senior French civil servant commented "there is a clear policy and programme of investment from the Government", adding "the Government must show a clear pipeline of projects to keep the companies engaged and allow them to invest in their own capacity and machinery…companies will not invest in machinery unless they are absolutely sure that they will be able to amortise their investment through a good utilisation of their machines."

Organisation of the public sector

4.21 **One of the common key factors reported by the interviewees in the development of successful projects is the existence of competent public sector in-house technical teams who are able to manage the relationship with the contractor, manage the private sector's capacity and make good use of competition.**

[4] *Investeringsplan* (2010), *Plan Estratégico de Infraestructuras y Transporte* (2005), *Bundesverkehrswegeplan* (latest 2003), *Generalverkehrsplan-Österreich* (2002), *MIRT* (latest 2010) *and Piano Generale dei Trasporti e della Logistica* (2001).

Competent Technical Teams within the Public Authority

4.22 The Independent Project Analysis report "Productivity in the UK Engineering Construction Industry", prepared for the Department for Business, Innovation and Skills in September 2009 mentions that the single most important defect in UK projects is the lack of key functions such as operations and construction management in the owners' project teams.

4.23 . This lack of technically competent in-house teams oblige the UK public authorities to spend more on legal, technical and financial external advisors than their counterparts in continental Europe.

4.24 For example, the Strategic Rail Authority (SRA)[5] estimated that professional staff costs associated with project management, planning, design and legal issues were twenty five percent of the total Channel Tunnel Rail Link (CTRL) costs. By comparison, the total project planning and management costs for the Madrid-Lérida High-speed rail line were two to three percent of total scheme costs.

4.25 The public sector thus has a vital role to play in leading development of a more technically sophisticated and demanding customer base for construction[6]. In this respect, a Danish client organisation mentioned that for them "having in-house technical expertise is essential to be a knowledgeable and informed client organisation".

4.26 This is in line with the comparative study on metro systems, which noted that a small and technically competent team of public administration officials can contribute to important cost reductions in technical support, supervision and management. In the case of the Madrid Metro, the study mentions that "a small and highly experienced project management team of six Civil Engineers with full power both for technical and financial on-the spot decisions was key for reducing substantially management and administration costs… strong involvement and direct regular presence in the field of the client technical team allowed for direct knowledge of work progress, anticipation of problems and assessment of possible solutions in discussions with all parties involved…This saved time and avoided expenses for legal advice on contract interpretations and legal disputes"[7].

Management of the private sector's capacity and good use of competition

4.27 **A key common skill of successful public authorities in continental Europe is their ability to manage the private sector's capacity and make good use of competition in the delivery of projects and programmes of investment**.

4.28 One of the interviewees in Spain commented that "The public sector in Spain is very good at managing the private sector's capacity. The Government, in particular the Ministry of Public Works (*Fomento*), knows which company is doing which project and at what stage, and understands the capacity constraints in the market. So they try to select for new projects those companies that have the capacity to complete the project without any delays."

4.29 In France for instance, the earthmoving industry is quite concentrated, so the Government needs to be very careful in managing capacity and competition between the three or four big specialised earthmoving companies (*compagnies de terrassement*).

[5] Following the passing of the Railways Act 2005 the SRA was wound up on 1 December 2006 and its functions transferred to the Department for Transport Rail Group some to Network Rail and some to the Office of Rail Regulation.

[6] Egan Report, *Re-thinking construction*, (June 1998).

[7] *Implementation of Rapid Transit*, BB&J Consult S.A., (December 2000).

4.30 "These *compagnies de terrassement* are extremely busy with the current pipeline of simultaneous High Speed Rail projects in France, so we need to manage their capacity carefully, otherwise their prices can go up very quickly", pointed out a senior public sector contract manager. Similarly, he added, "the preventive archaeology must be managed very closely as there are not enough archaeologists to work on all our projects. We have signed an agreement with the Association of Preventive Archaeology to make sure that we can have a number of man/days available per year for our infrastructure projects".

Organisation of the private sector

4.31 The construction industry in Western Europe is characterised by a small number of strong and large construction companies with big market shares and a large number of small and medium enterprises (SMEs).

4.32 Most top tier SMEs tend to specialise in particular activities according to location, the size of projects, and the type of work undertaken. However, concentration levels, vertical and horizontal integration levels and the nature of competition vary among the different construction markets investigated.

Stronger larger contractors

4.33 As noted in Chapter 3, the interviewees concurred that that the UK construction industry is characterised by fewer large tier one contractors, by comparison to other countries and many more small and medium sized tier one contractors.

4.34 The advantages of fewer, larger contracting organisations were considered to be in their efficiency in tackling larger contract packages, less fragmentation of the supply chain, and lower costs of bidding to shorter tender lists.

4.35 The investigation found as well that in most of the main construction markets in Europe, industry bodies and professional associations collaborate to represent the interests of the construction industry to Government and other key stakeholders. Some of the top continental construction companies were surprised to see that such unified channels of communication did not exist in the UK.

Competition and Collaboration

4.36 According to the interviewees, in most continental markets, competition and collaboration between companies is not mutually exclusive. Some of the largest construction companies have long-term partnering relationships with their top-tier subcontractors.

4.37 The head of the international department of one of the most important lobby groups in Spain commented that "...the Spanish construction companies compete against each other but know as well how to collaborate with each other. If you take any big project in Spain, at least six of the big companies and ten to fifteen subcontractors will be working together in the delivery of this project."

4.38 Similarly in Denmark, according to one of the interviewees, Danish companies tend to form JVs to bid for projects of £22to £25 million (DKK200million) and above.

4.39 In both Spain and Denmark, the investigation found some cases where the authorities decided to divide large projects into smaller ones to promote competition and a good allocation of work amongst the different construction companies.

4.40 A public sector contract manager mentioned that his team tend to divide big projects into smaller contracts to diversify risks and maintain a competitive pressure on every segment of the project. "We do not have to worry too much about integration of the different segments, as all the companies know how to work together", he concluded.

4.41 Similarly in Denmark, as a client organisation noted, some large projects in excess of £57 million (DKK500m) have difficulties in attracting an appropriate level of competition. "For example, the Copenhagen orbital motorway initially attracted only two bids. As a consequence a Danish road client organisation decided to divide the project into smaller packages of work, by technical specialism and geographical boundaries, and manage the project in-house to attract more interest from smaller players. Work thus tends to be let out in smaller but planned packages to increase competition".

4.42 This Danish road client organisation is currently considering the development of a "parallel bidding model" whereby bidders can bid both for one of the smaller packages or for the total project. The organisation believes this bidding model can secure optimal value for the client by creating good competition on market.

Capacity of the companies to attract and retain competent engineers

4.43 **One of the common themes behind the view of efficiency of the construction industry in Western continental Europe is the high quality of the engineers trained by universities and the capacity of the private sector companies to attract and retain these talented engineers**.

4.44 Formal education and on-going training for engineers in Spain, France and Germany was considered excellent by interviewees.

4.45 Civil Engineers in these countries (*Ingenieros de Caminos, Canales y Puentes* in Spain, *Ingénieurs de Ponts et Chaussée* in France and *Bauingenieure* in Germany) study on average between 5 and 6 years at university. As a result of a longer formal education, as one of the interviewees mentioned, "Civil Engineers in Spain and France tend to be well-rounded and multi-skilled and have a very good understanding not only of the technical aspects of a project, but of the legal, administrative and financial aspects of a programme". And he added "in the UK engineers study for three to four years and tend to be more specialized on the technical aspects".

4.46 Some of the interviewees mentioned that a major problem in the UK civil engineering labour market is the high level of staff turnover in the construction companies. This high level of staff turnover is the result of, amongst other things, a lack of clear career development paths for Civil Engineers in construction companies, better compensation packages for Civil Engineers in other industries and perceived pressure from the market not to stay in the same company for more than three to four years.

4.47 The head of one of the top continental European construction companies with operations in the UK mentioned that "in the UK the loyalty of engineers to the contractors is very low. If an engineer stays more than five years in the same company, this is seen as a failure, so there is pressure on engineers from the market to constantly move to a different company…and this turnover is at all levels, I have seen a lot of staff turnover over the last 3 years at my level (senior director level) in my partner British companies".

4.48 Another interviewee commented that "engineers in the UK prefer to work for consulting firms or banks that pay much more than construction companies". And he added "although this is progressively changing, engineers in France, Germany and Spain still like to build their careers with one organisation, typically in a construction company or in the Government….this gives a lot of certainty and stability to the French, Spanish and German construction markets. I think this is in part thanks to the good career management practices of the construction companies in these countries combined with relatively good compensation packages".

4.49 Good quality formal education, on-going training, good career progression prospects and competitive packages have contributed to enhance the technical expertise of continental European contractors. Furthermore, the increasing use of design and build contracts in countries like France, for example, has led contractors to develop in-house design teams. By having in-house designers, the communication between design and construct functions encourages far more constructible, lean designs.

4.50 This communication is also aided by professional training schemes within the large European contractors which aim to move engineers between the functions, to gain an appreciation of the entire lifecycle of a project. A French contractor mentioned that "in the UK this would be impossible simply due to the higher turnover of staff, driven by poorer loyalty between companies and employees".

Processes for planning, prioritising and delivery

4.51 **According to the interviewees in continental Europe, the time period associated with planning and construction of major transport projects is much greater in the UK than in some of the other countries, in part as a result of slower and sometimes more bureaucratic processes.**

Planning Process

4.52 The process of planning and developing major transport projects appears to be faster in countries like France and Spain than in the UK. In the case of high-speed lines, for example, for the TGV Sud Est, only ten years elapsed between the initial studies and the opening of the first part of the line.

4.53 Similarly in Spain, the high speed rail lines Madrid-Barcelona and Madrid-Sevilla took no more than 10 years from conception to operation and the Madrid Metro network doubled its length in only 8 years (with two major extensions of 4 years each in simultaneous lines).

4.54 According to some interviewees, faster planning processes can be partially attributed, at least in France, to a far more authoritarian, less consensual, approach to decision making in project teams as compared to the UK, leading to smaller, cheaper project teams, and thus shorter durations of planning and project management.

4.55 It is fair to say however that the planning times have increased for recent projects in both France and Spain for various reasons, including:

- adoption of a more formalised decision making process;
- use of more complex delivery and financing structures (like public private partnerships); and
- development of more technically complicated projects.

4.56 Nevertheless, the process of planning major infrastructure projects is still higher in the UK than in France and Spain given some key differences in the expropriation and authorisation processes.

4.57 In France and Spain, as opposed to the UK, the expropriation of property is automatic once the Declaration of Public Utility (*Déclaration d'utilité publique* in France and *Declaración de Bien Público* in Spain) is announced. Property owners have no right of appeal although they may be able to secure an increase in the price.

4.58 On this subject, one of the interviewees commented "In France and Spain, the public good is more important that the individual's good. In these countries if the Government decides that a project is done for the public good, and thus declared a Public Utility, then no individual can stop it. For instance, the land acquisition process in France and Spain is based on this principle, so their Governments do not need to sweat blood like in the UK, every time they need to acquire land for a project".

4.59 Furthermore, some interviewees gave examples where the management of the expropriation process was transferred to the contractor, who is closer to the problem (principle of subsidiarity) and has the capacity to manage and re-allocate its resources.

4.60 The head of the international department of one of the top Spanish contractors mentioned that "the management of the expropriation phase by the private sector gives a lot of visibility to the contractor on potential time overruns in the expropriation process and allows it to re-allocate its resources to other parts of the project that may not be affected. So by transferring this responsibility to the contractor, the public authority is further integrating the planning, expropriation and construction phases".

4.61 The authorisation process seems to be much faster as well in some Western continental countries than in the UK. The approval process in France and Spain, for example, typically takes three to six months for a medium sized project although it involves extensive analysis and consultation at central, regional and local government levels.

4.62 In France, for instance, the public enquiry and approval process of a major High Speed Rail project such as the TGV Est only took three months. This compares with public enquiries and approval processes in the UK which can last for years.

4.63 Interestingly, the Spanish public sector has managed to improve the planning and consents regime with the creation of State-owned companies for the regeneration of urban areas (*Sociedades Estatales para la Regeneración Urbanística*). These companies manage relations between central, local and regional authorities and are in charge of facilitating the granting of the different permits / authorisations in metropolitan areas by the three levels of Government (Federal, Autonomies and Municipal).

4.64 In the Netherlands, planning of major projects used to take up to thirty years. This period is now down to fourteen years on average and the Government is trying to reduce this further to seven years thanks to a recently introduced "Faster and better" (*Sneller en Beter*) approach.

4.65 Measures under this approach include: less complicated and faster (parallel not sequential) implementation of environmental procedures, limitation to the first phase of the project of the consultation process and of the right to appeal against the project, and necessity to start the planning process only once funding is in place in order to avoid wasting time and money on projects that may not be undertaken.

Bidding Process

4.66 **The bidding process for infrastructure projects seems to be shorter in most Western European countries than in the UK, according to the interviewees.**

4.67 The head of the international department of one of the biggest lobby groups in Spain commented that "in Spain, the bidding process lasts six to eight months on average. The Ministry of Public Works, *Fomento*, provides reasonably well defined specifications and drawings (*pliegos*), the companies have four to six months to present their offers and *Fomento* has two months to review the technical and economic offers and award the contract."

4.68 One of the main differences with the UK, is that in Spain contractors are involved at an earlier stage of the specification of the project and the final project design is completed after the award of the contract.

4.69 One of the directors of a top Spanish construction company commented that "...in Spain, the authority goes to the market with an eighty percent defined project and gives the contractor the margin to fine tune the remaining twenty percent during the construction phase. So the bidding process is faster and cheaper, contracts are awarded sooner and it is easier to make changes to the initial specification. In the UK, the Public Sector expects to have extremely well defined project specifications before awarding a contract, so any changes after the contract award are extremely bureaucratic and expensive".

4.70 Similarly in France, the government is increasingly procuring "Design-and-Build" (Conception-Realisation) projects, where the public authority goes to the market with a Preliminary Design (*Concéption préeliminaire*) and the contractor does the Final Design (*Concéption Detaillée*) and builds the infrastructure.

4.71 As a result, the contractor is engaged at an earlier stage in the design of the project and it completes the specifications taking into account all the technical difficulties of building the asset. A French senior civil servant mentioned that "a Design and Build model allows a better allocation of risks between the client and the private sector, reduces the interface risk, encourages a better consultation process and helps to keep costs down".

4.72 **Other continental countries are as well developing and implementing different approaches to allow earlier involvement of the contractor in the definition of the project.** Some of the interviewees mentioned that their companies have successfully enabled the early involvement of the supply chain in the planning and designing of projects and service requirements.

4.73 The head of the UK subsidiary of one of the top continental European construction companies mentioned that "...early contractor involvement allows for more scope in innovation, better risk management and forward planning of work programmes and resources. We have successfully used this approach in the past in North America and Europe. This model allows us to use our expertise to accelerate the planning process and the procurement process and provide differential value in infrastructure construction, offering a comprehensive end-to-end service to our customers".

4.74 Similarly, the Dutch government has now started to award contracts while the project is in planning, so that it can get contractors to help with the planning process.

Use of specific standards

4.75 **Most of the interviewees agreed that the UK has a tendency to use too many bespoke designs in the development of its infrastructure projects.**

4.76 As mentioned in the High Speed Rail study[8], some major UK transport projects have included elements that, rather than being merely functional, are unique and/or enable spectacular architectural achievements, examples of this include some of the stations on the Jubilee Line extension. These can be compared with the stations on the Madrid Metro, which are almost identical to one another, functional and compliant with European standards and much cheaper than most of the Jubilee line extension stations.

4.77 The general manager of the Madrid Metro commented that "the decision was made in Spain to design standard functional stations that comply with all the technical, health and safety, and comfort standards. Of course, we saved a lot of money in design, since we did not use any "museum-style" designs of many London underground stations like Westminster or Canary Wharf". Although the use of standard designs may be seen as uninteresting, lower costs have meant that Madrid has more than doubled its metro network over the last fifteen years.

4.78 Some of the interviewees confirmed that in countries like Germany, the Netherlands and Sweden, governments are increasingly using standard designs whilst still taking advantage of each projects opportunities (for example, in the case of stations, skylights, mezzanines, entrances, walls, floor and ceiling finishes, art work, etc), so standard design does not have to mean "all looks the same".

Health and Safety regulations

4.79 Although in the course of the analysis some interviewees suggested that health and safety and environmental regulations are more onerous in the UK than in some Southern European countries, the vast majority of the interviewees see the UK as "First Class" for all processes related to Health and Safety.

4.80 While the high health and safety standards used in the UK may have an impact on the total project costs as well as the unit costs of construction, these standards are seen as necessary to prevent accidents and problems during the construction and operational phase of the infrastructure, which in themselves can be costly.

4.81 Countries like Germany, Sweden, Denmark and Finland also implement very high Health and Safety and Environmental standards. A contract manager in one of the top continental construction companies mentioned that, for example, "in Sweden it is even more expensive to comply with environmental and sustainability issues than with Health and Safety issues – for example nothing goes to landfill, trucks are run on biofuels, all chemicals are tracked, harmful substances are replaced etc. However, in general, the UK and the Scandinavian countries tend to have an excellent record on Health and Safety: Accidents per one million worked hours are in the order of 3:7:30 for UK, Sweden and Denmark, respectively".

4.82 A client organisation in Denmark mentioned that "the UK has been a trend setter in Europe in the area of safety legislation, this has added cost but is an investment that can save lives, prevent accidents and save money in the future".

4.83 A key factor in UK health and safety is the Health and Safety at Work [etc] Act of 1974, which requires that risks are reduced to "as low as reasonably practicable" (ALARP). This approach does not have an equivalent in other EU countries, for which other (less onerous) tests could apply.

[8] High Speed Rail: *International Comparisons*, February 2004

Environmental regulations

4.84 In Germany, although public and political support for high-speed rail development has been very strong, there has been opposition from those living alongside proposed routes; partly as a result of this environmental mitigation measures have been more extensive than those in some other countries, which have also led to increased costs.

4.85 The High Speed Rail comparative study mentions that "in constructing the high-speed lines in Germany extensive use has been made of tunnels and cuttings in order to minimise noise and the effect on the landscape".

4.86 Similarly in France, as mentioned above, the law "*Grenelle de l'environment*" gives priority to environmentally friendly modes of transport, like rail, to the detriment of the highways sector, for example, encouraging some companies to re-allocate resources and perhaps invest in new resources to be prepared for this change in policy focus.

5 Findings from non-cost data

Introduction

5.1 Chapter 4 focused on the non-cost interview responses and evidence relating to other European countries, contrasted against the UK. This Chapter 5 summarises the evidence provided from UK organisations or UK subsidiaries of other European countries, including:

- the findings of the data collection from the initial ICE / IUK on-line survey; and
- a summary of the generic non-cost interviews undertaken which has been subdivided into three categories:

  a policy and systemic issues;
  b funder/client issues; and
  c supply chain delivery issues.

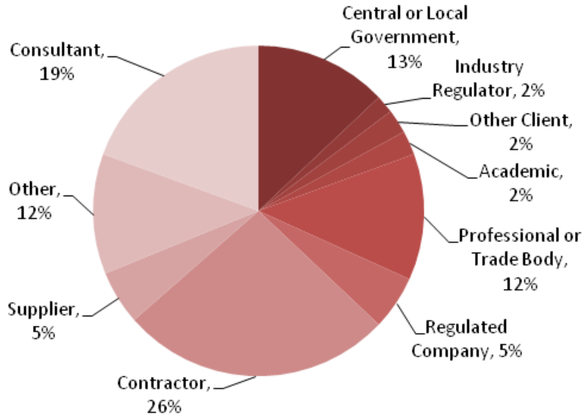
Findings from Infrastructure UK/ICE Survey

5.2 Between July and September 2010 Infrastructure UK and ICE solicited the views of over 300 target organisations and individuals via an online survey. 170 people registered an interest, of whom 138, representing 113 different organisations provided detailed responses.

5.3 The initial data collection came from the Infrastructure UK/ICE on-line survey and the results are presented below. The purpose of this survey was not only to inform early thinking but also to help compile the list of interviewees for the main data collection exercise.

5.4 A breakdown of the principal activity of respondents is captured in Chart 5.A below.

Chart 5.A: Infrastructure UK/ICE web based survey participants (organisation type)



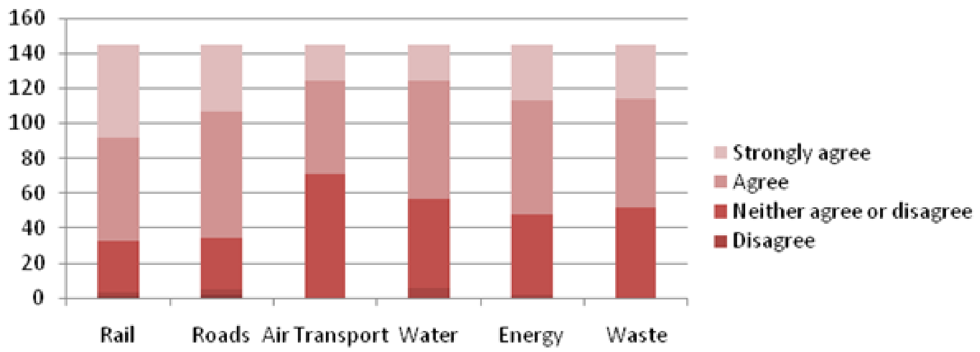
Source: Infrastructure UK/ICE Survey 2010

5.5 The "other" category was made up of responses from a range of interested organisations including quantity surveyors, lawyers, management consultants and other advisory firms.

5.6 The sample size is small and not weighted to reflect the relative size of industry segments or any other metric so the survey should not be considered as statistically significant. The results do however provide a snapshot of opinion amongst leading industry organisations.

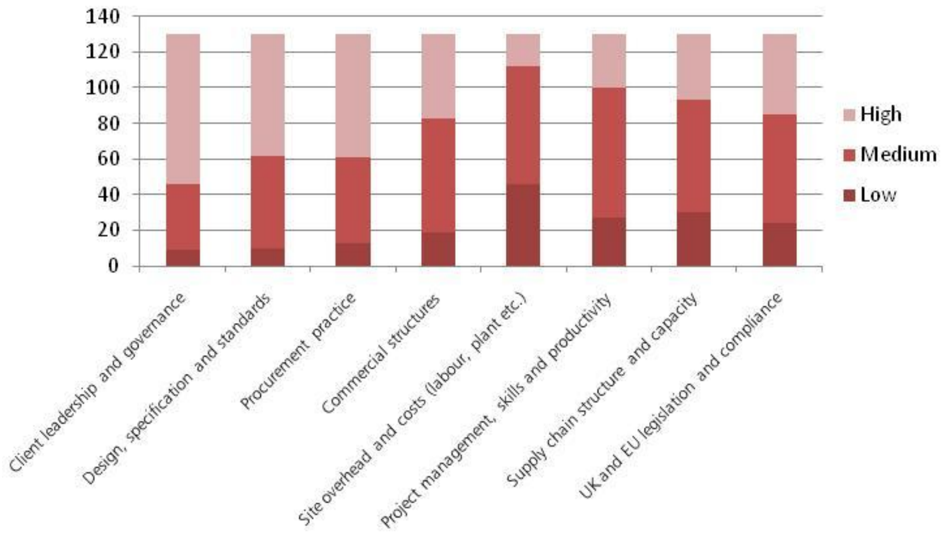
5.7 To test the main study hypothesis, respondents were asked if they agreed with the statement that "there are opportunities to significantly reduce the costs of infrastructure delivery in the UK across all major areas of infrastructure investment". Chart 5.B below shows that in all sectors bar air transport, a significant majority of respondents supported the study hypothesis. It is also notable that the level of disagreement with this proposition was negligible.

Chart 5.B: There are opportunities to significantly reduce the costs of infrastructure delivery in the UK across all major areas of infrastructure investment?



Source: ICE / Infrastructure UK survey

Chart 5.C: How would you rate the following aspects of civil engineering infrastructure projects in the UK in terms of their relative scope for improvement and cost reduction?



Source: ICE / Infrastructure UK survey

5.8 Respondents were also asked to identify the aspects of civil engineering projects with the greatest scope for cost savings. As Chart 5.C above demonstrates, **respondents identified client leadership, design, specification and standards, and procurement practice as having the greatest scope for cost savings** relative to other aspects. At the opposite end of the spectrum site overheads and direct costs were only identified by eighteen percent of respondents as having high scope and by forty six percent of respondents as having low scope.

Summary of interviews and other non-cost evidence

5.9 Following the web survey was the main evidence gathering activity in which the investigation team undertook over 120 formal structured interviews. In addition, a comparable number of informal meetings were held with participants to follow up on specific topics and areas of detail.

Overview of respondents

5.10 The responses represent the views of the industry, both domestic and international. The organisations involved in the study included:

Civil Engineering (Main) Contractors	29	(41%)
Design / Project Management / Commercial Consultants	16	(23%)
Public Sector Clients	16	(23%)
Private Sector Clients	5	(7%)
Professional Institutions	3	(6%)

5.11 According to the June 2010 NCE survey UK based contractors turned over £13.5bn in the calendar year to Dec 31st 2009 while consultants earned approximately £7.6bn from domestic markets in the same period, of which £4.2bn was public sector work. Therefore, the ratio of contractors to consultants above is broadly representative (based on turnover allocation) of the domestic public sector civil engineering market structure.

5.12 The specific organisations interviewed also span the majority of the industry. Ten of the top 12 contractors operating in the UK (according to the NCE "Contractors File") were interviewed, amongst other domestic and international contractors. Also the top five consultants were interviewed (according to the NCE "Consultants File"), amongst others including a number of specialist consultancies. Sectors covered by the respondents included aviation, energy, waste, flood defence, light rail, high speed rail, metro rail, utilities, roads and highways. Whilst not within the scope of this study, schools and sports stadia were discussed where there was relevance to economic infrastructure.

5.13 Twenty eight projects representing circa £70bn worth of value were investigated in the detailed project-specific research. Thirty percent of this expenditure represented projects from outside of the UK were investigated, to provide adequate comparison between practices in the UK and elsewhere. At least one hundred further major projects were researched to a lesser degree.

5.14 Detailed cost research was performed for twenty one projects, representing £33bn, some of which were also included in the non-cost research. Seventy nine percent of this expenditure was on projects outside of the UK. This analysis of the cost data is reported in Chapter 6.

5.15 In addition, four working groups were established by the ICE looking at Client, Standards, Tunnelling and Supply Chain issues. The output from these working groups is contained in Annex H and summarised in Chapter 7.

Summary of Findings

5.16 The generic questions asked fell into six categories. The key themes that emerged from these categories are summarised below in Table 5.A, and the following sections contain the detailed analysis of the data collected.

Table 5.A:

Question Category	Predominant Themes of Responses
Industry and Market Structure	Construction in the UK is a very competitive market. A shift towards vertical integration has occurred in other EU countries as a result of sustained investment in infrastructure. A steady, visible, secure pipeline of work in the UK would promote a similar shift leading to greater capacity to deliver major programmes at lower cost.
Project Teams	Clear leadership and timely decision-making by UK clients is considered to be of utmost importance. Professionals in the UK have more specialised and narrower roles whereas EU project teams are populated by fewer, multidisciplinary professionals.
Contract, Commercial and Change Control	Standard forms of contract are far preferred whereas bespoke forms lead to additional risk provision. Change processes must be workable as change is inevitable.
Design, Specification and Innovation	Early Contractor Involvement, Design and Construct, or DBFO-style contracts lead to more constructible design with greater adoption of innovation.
Regulations and Compliance	Flexibility in design to realise cost savings is key. The UK planning process is seen by foreign companies as the biggest cause of cost differences. UK health and safety practices may add minimal cost, but the tangible savings through reduced stand-downs following accidents and increased quality outweigh that.
Labour, Plant, Material Inputs	UK labour is generally viewed as slightly less productive (with no particular consensus) for a number of reasons. With a more visible pipeline, main contractors could invest in directly-employed labour and purchased plant.

Source: Infrastructure UK survey, 2010

Detailed analysis of findings

5.17 The key outputs and themes arising from the data collected has been analysed under three main headings, namely:

- Policy and systemic issues;
- Funder/client issues (further broken down as follows):
  - governance and work planning;
  - design and standards;
  - commercial and procurement issues;
- Supply chain delivery issues.

Policy and systemic issues

Land use planning and consultation processes

5.18 Planning lead-times and inconsistencies between different areas of the country have become particularly onerous. **Uncertainty and time-lags due to the planning system contribute significantly to delays and have been cited in the evidence gathered as key reasons why UK major scheme outturn costs are in excess of those seen in other European countries**. Early constraints imposed through planning and consultation processes can also lead to lost opportunities to benefit from contractor innovation, for example through design innovation or the use of pre-fabricated components.

5.19 As set out in the National Infrastructure Plan 2010 the Government continues to work towards ensuring the presumption in favour of development and the corresponding incentivisation of local communities to accommodate national infrastructure, including through the development of National Policy Statements for the major infrastructure sectors and by creating the new Major Infrastructure Planning Unit.

Third party requirements

5.20 **The majority of interviewees considered that the process of negotiating with, and obtaining approval from, third parties in the UK contributed significantly to cost.**

5.21 There are significantly more third parties involved in UK infrastructure projects and individual parties will have their own processes, standards and programmes to be followed.

Box 5.A: Crossrail consents and undertakings

Crossrail has three industry partners from the rail industry (Network Rail, London Underground and Rail for London) plus interests from the Office of the Rail Regulator. They have two Industry Partners from the private sector (Canary Wharf Group and Berkeley Homes) who contribute elements of the projects as well as major interfaces with the British Waterways Board, British Airports Authority and the City of London.

In addition Crossrail work with the usual round of statutory undertakers and have over 150 agreements with these parties, with many more in the pipeline. Through the parliamentary process Crossrail must comply with undertakings and assurances - there are 730 undertakings and assurances breaking down into 4000 individual commitments. The project is expected to require 1000 to 1500 planning related consents, plus a large number of highways and other consents, with 23 Local Authorities. At an individual level, about 40,000 individuals have registered an interest in the project.

5.22 Constraints imposed by the planning and consultation process can also lead to lost opportunities to benefit from later value engineering, as any changes which may deliver savings may have to go through all the approvals processes, including planning which will negate any potential benefit.

5.23 In spite of these uncertainties, many infrastructure projects seem able to assess the final impact of third party requirements within the initial evaluation – around seventy percent of respondents reported that third party impacts were in line with their expectations - though there are cases where this has not occurred. For example, for the A3 tunnel at Hindhead, the project was delayed through planning by five years, far beyond the initial estimation of the impact.

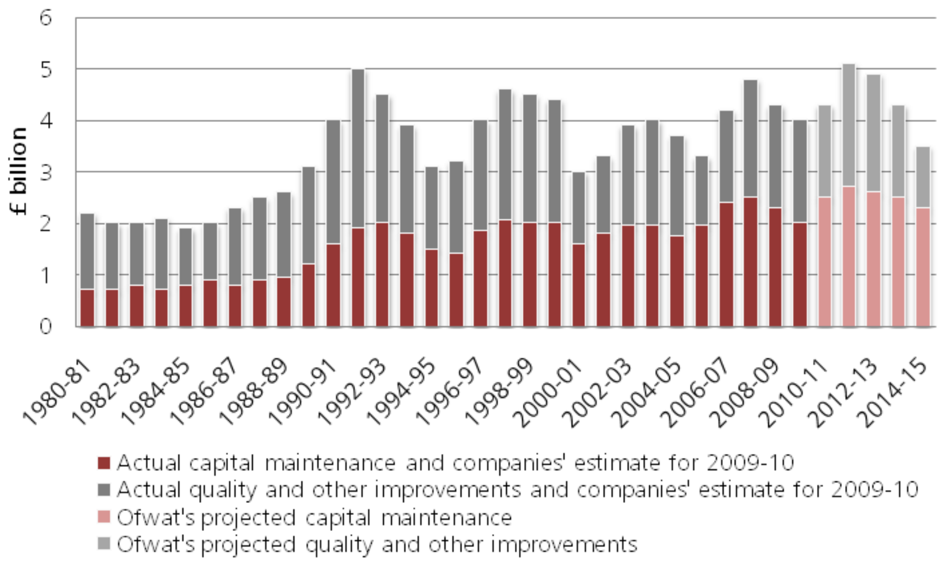
Funder/client issues: governance and work planning

Stop/start investment

5.24 Amongst the interviewees there was a consistent **belief that the lack of a visible and continuous pipeline of forward work in the UK, together with a stop-start investment, leads to higher costs of infrastructure, and in a significant number of interviews this was considered to be the biggest issue**. In fact ninety six percent of respondents who expressed an opinion agreed that the lack of pipeline in the UK leads to higher costs of infrastructure.

5.25 For example, in the water industry investment tends to be focused in the middle three to four years of the five year AMP period, since the first year usually involves detailed planning following the regulator's settlement, while the final year is characterised by closing out projects. This generates waste during the five year period, estimated to be ten to fifteen percent, since the contractor is required to maintain a core staff in readiness. This effect is demonstrated in Chart 5.D below.

Chart 5.D: Stop-start investment in the water industry



Source: Ofwat

5.26 However, this waste needs to be put in the context of other significant gains which have been achieved through a focus on efficiency within the regulated industries. Through the longer term relationships and investment in skills and process efficiency, facilitated by water sector frameworks, this has generated an estimated ten to fifteen percent savings on the capital programme in the water sector.

5.27 Waste is also seen in restructuring and abortive bids costs such as those relating to the cancellation of a recent project that had been tendered. One of the consultants involved in delivering two major highways projects cancelled reported that about seventy five full time equivalent staff were working on the two projects when they were stopped. This resulted in at least fifty posts becoming redundant, necessitating restructuring costs in excess of £0.5 million.

This is in addition to the £20 to 25m cost of abortive work borne by the Highways Agency on these schemes.

Box 5.B: Potential Impact of Structured Plan of Investment

"Sticking to a structured plan of investment, (i.e. no re-engineering, scheme certainty, constantly changing our minds) would eliminate inordinate amounts of inefficiency. For every 3 or 4 highways schemes completed, another could be done if it weren't for this. A 5 to 8 year planning horizon would lead to the large contractors self-performing leading to tight fees with low overall costs (bought plant written down over the period, labour direct employed into optimised organisations)". *(Director, Major UK Contractor)*

5.28 Ultimately public and private sector construction clients bear the costs of stop-start investment over the longer term, since for the most part these clients represent the only source of income for the construction supply chain

Client leadership

5.29 **Evidence indicates that a major driver of higher outturn costs is a lack of clarity and direction, particularly in the public sector, over key decisions at inception and subsequent design change points. The roles of client, funder and delivery agent – which are clearly and separately defined in private sector projects and programmes – tend to become blurred in many public sector governance structures.**

5.30 Successfully managed projects, such as the Olympics, tend to share common characteristics including: the funder's clear commitment to expenditure; a clear and fixed timescale; accountable, knowledgeable and incentivised leadership; single-point responsibility for delivery to budget and a strong culture and incentives to reduce costs; and effective placement and control of contingency and risk budgets.

5.31 Within the Olympics programme there is a very clear delineation of accountability for cost control and the management of contingency budgets. All contingency is clearly identified as either 'project' or 'program' and either 'in-scope' (available to the project) or out of scope (funder's contingency is not viewed, as is often the case, as available budget). A strong governance structure is built around the process for allocating contingency which, combined with effective incentivisation at all levels, has instilled a culture of cost awareness and accountability. The achievement of cost and risk reductions at the delivery level frees contingency for reassignment within the programme, subject to justification and approval by the DCMS Olympics Executive team (GOE). Success has in part been driven by the clarity of decision making and commitment to ensuring that GOE was set up as an effective and properly empowered client organisation.

5.32 From the survey and investigation, only fifty percent of projects reported that the project was led by a single controlling mind empowered to take decisions.

Poor asset information and cost data

5.33 Within some parts of the water industry and public sector there are attempts to understand how costs are incurred through the stages of constructing and operating infrastructure assets. Building on experience in the water industry, other public and regulated bodies are also attempting to use this data more effectively in setting target costs or affordability thresholds. Highways Agency commercial intelligence and data systems have already allowed them to save fourteen per cent in negotiating the target cost on one major project, and £70 million over three schemes. The tunnelling benchmark data compiled from the Infrastructure UK work has already been used to reduce cost estimates for High Speed 2 by £400 to £800 million.

5.34 **Improving the quality, understanding and transparency of infrastructure cost modelling and benchmark data is an essential prerequisite to effective use of alternative contracting approaches, in particular the use of target cost contracting and partnering models.**

Management of risk and contingency

5.35 The vast majority of projects recognised the importance of change and cost control mechanisms. Eighty percent of project respondents had standard change management processes, and ninety percent standardised cost management processes.

5.36 **Outturn costs rise because the processes of budget preparation, approval and management do not provide effective incentives to minimise the outturn costs. In particular, insufficient consideration is given to the assessment, placement and management of contingency and risk budgets.**

5.37 Many large infrastructure projects and programmes in the UK tend to be managed within a quoted budget, rather than aiming at lowest cost. If the budget includes contingencies (optimism bias) this tends to be viewed as available budget.

5.38 In total, seventy percent of all projects reported they had mechanisms for financial incentivisation of costs. The ration of projects with financial incentivisation measures was broadly similar in the private and public sector.

Funder/client issues: design and standards

Interpretation of EU laws and regulations

5.39 **A common view - expressed by seventy percent of respondents - is that the UK complies with EU legislation and regulations more vigorously than other European counterparts**.

5.40 EU laws and regulations are, by definition, the same for all EU countries. Eurocodes are the design codes used for the design of civil engineering infrastructure, and apply to the whole of the EU. National standards, however, do differ, and in general each country requires compliance with both.

5.41 **In addition to the EU and national standards, most UK infrastructure clients and regulators have their own standards governing civil engineering works**. Examples are standards set by LUL, Network Rail, Highways Agency and BAA.

5.42 The outcome is that the UK approach is different to our European neighbours. Where there is the option to interpret standards and regulations, our culture is to interpret in the most onerous way, with significant audit trails to support the process. The experience from the respondents is that engineers on the continent tend to treat the regulations as "guidance" or use first principles to put the standards into practice. For example, the UK implements regulatory requirements such as aggregate tax, and pollution licences that are not seen in other European countries.

5.43 There is conflicting evidence regarding environmental legislation, particularly around whether compliance is costing more in the UK than other EU countries. There is general agreement that very considerable resources were devoted in the UK to protecting wildlife, and respondents questioned whether this was good value for money. However, there are also examples of projects in France being delayed for measures to be taken to protect wildlife, and respondents with considerable experience of both countries observed no difference between them in this respect.

5.44 The overwhelming body of opinion *in the UK* was that significantly more attention was paid in the UK to environmental and ecological concerns when compared with overseas. **Opinion, however, was also very strong that *significant sums* were involved in meeting environmental requirements, often to limited perceived benefit**.

5.45 In the UK, the principal drivers for ecological protection were local requirements under Town and Country Planning Act, and the requirements of environmental organisations. It was considered that their remits did not particularly consider the cost of protection, with the result that considerable sums were expended in order to avoid conflict and consequent delays

5.46 The study has highlighted a number of examples, which suggest **decisions on the costs and effectiveness of ecological protection measures in relation to infrastructure projects may not always be transparent.** For example, the expense given to protecting the great crested newt, which though relatively common in the UK, is protected by EU legislation.

Box 5.C: Understanding Ecological Costs

Circa £100,000 was spent on monitoring and trapping a local (great crested) newt population on the project, during which approximately four were found by the employed ecologist. However, there were eyewitness accounts that some newts were eaten by local herons as they were not released quickly enough from the traps." (*Director, UK Consultant*)

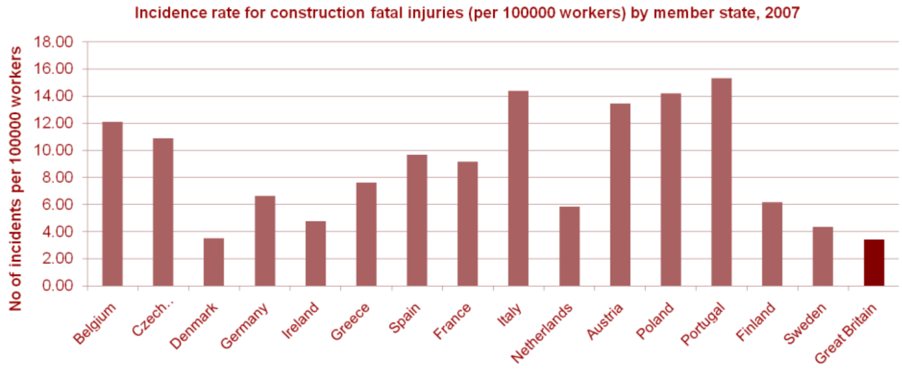
"Brize Norton project was delayed three months due to the presence of newts. On planned sites for new Prisons newt fences are sometimes erected and the sites monitored to ensure Newts are excluded."

Health and Safety

5.47 Health and Safety regulations are set down by EU law, and in the UK governed by the Health and Safety at Work Act and the Construction (Design and Management) Regulations.

5.48 **The UK has the best safety track record in Europe (Chart 5.E below), in terms of accident statistics. There is general agreement that a good health and safety record runs hand in hand with other success metrics such as budget and programme compliance**. Respondents considered that, in general, productivity improves with fewer accidents.

Chart 5.E: Incidence rate for construction injuries



Source: Health & Safety Executive based on indicative Eurostat data

5.49 A significant number of respondents reported that there is considerably more paperwork involved in delivering health and safety in the UK, and queried whether the amount of administration required for *demonstrating* compliance was cost effective.

Box 5.D: Contrasting national safety cultures

Safer sites are better run and more profitable. Does it add cost? If we compare with Germany, sites are culturally different. In Germany, workers are generally expected to take responsibility for themselves. In the UK management are required to prevent injury. It seems that in Germany if someone is injured the question that is most likely to be posed is not "how have management failed?", but "what did the person do wrong?" Having accidents in this country is expensive and management is held more accountable. The HSE is more proactive than its German equivalent" *(Director, Multinational Client)*

5.50 The argument that in the long run money spent on health and safety leads to overall savings is true for the UK where the consequences and cost of injury or death are high.

Design and specification standards

5.51 **A frequent opinion of the interviewees has been that the UK construction industry has a greater tendency for setting unnecessarily high design standards or specifications, higher than would be the case elsewhere in Europe.** Over fifty percent of respondents said that they had examples of the UK setting higher standards, ten percent said that there was no difference and only 3 percent said that they did not have examples. The remainder expressed no opinion.

5.52 Many respondents believe that elements of infrastructure are over-designed. However, in UK there are more stakeholders to satisfy, leading to a longer and more challenging approval process.

5.53 The phrase "gold-plating" has arisen on a number of occasions, in relation to additional costs of signature architecture; designers being content with a very robust design (e.g. thicknesses of concrete, amount of reinforcement) without challenge; selection of high-cost fittings when a lower priced alternative would have sufficed.

5.54 **Clients in the UK tend to have less in-house technical knowledge than in other EU countries, and are consequently less able to lead, discuss, interrogate or challenge designs.**

5.55 Performance (or "end-use") specifications allow more latitude for designers and constructors to find the most cost-effective way of delivering, and are widely considered to result in cost efficiency. However, they leave clients with less control over the final product, and this can be an issue for aesthetics and durability, and for seeking approvals from stakeholders and 3rd parties.

5.56 There are benefits from maintaining consistent design responsibilities through a project life cycle. Handing over designs from one designer to another (e.g. at each GRIP [1] stage) does not give best value.

5.57 The evidence suggests that in many cases, it is the in house standards that are considered to result in the majority of standards-related cost differences when compared to other EU countries and that **the people that are making the decisions about the standards are not the people that are bearing the cost of the decisions about standards.**

Box 5.E: Effect on Cost of UK Rail Standards

Network Rail have recently carried out a benchmarking exercise by taking four recently-completed renewal or upgrade projects and having them priced by a UK Civil Engineering contractor assuming that the work was not on a railway, and priced by a Dutch contractor assuming that the work was on the Dutch railway system.

The results consistently showed that the UK rail pricing was the highest, followed by the Dutch railway, and lastly the UK civils. Whilst the comparisons were not surprising, the benchmarking allowed the reasons behind the differences to be explored.

There were four significant reasons for the differences:

- The costs associated with taking possession of the railway, and working within the constraints of that possession (so-called Schedule 4 costs)
- Catering for the fear of programme overrun (so-called Schedule 8 costs)
- Meeting standards set for the railway
- Compliance with EU rules and regulations.

Standardisation, bespoke designs and innovation

5.58 **The general view from the study data is that increasing the use of standard solutions and designs and using off-the-shelf products where possible, but being more creative where appropriate, would lead to reduced costs.** This view is especially prevalent amongst clients and commissioners. However there are constraints, both in terms of regulations and programme, which prevent doing more in this area.

[1] Guide to Railway Investment Projects (GRIP)

Box 5.F: Standard Assets vs Asset Standards

- Most clients consider that standard solutions and off-the-shelf products are not used frequently enough, citing designers' desires to conceive bespoke solutions as the most frequent reason
- EU procurement rules can preclude the specification of standard or off-the-shelf products
- There is inconsistency in the way that infrastructure is specified from one authority to another, for example Local Authorities' specifications for roads
- In the UK we like bespoke solutions for aesthetic reasons, even if we can't see them - e.g. Lightning conductors, and airport bridges. There is a desire for a high quality built environment, but it comes at a cost.

5.59 **Innovation often requires investment across a programme rather than a one-off project in order to maximise the benefits.** An example was the stabilisation of railway embankment slopes, where innovative ideas could be developed and refined over a number of sequential contracts.

5.60 Higher profit margins from infrastructure delivery in other countries e.g. Sweden, provides the headroom for greater investment in innovation to reduce outturn costs. In the UK, the extremely competitive and short term nature of the current markets leaves contractors with too little margin or incentive for re-investment in sustainable improvements.

5.61 **Getting departures from standards (e.g. from Highways Agency or Network Rail) was reported as time-consuming, and therefore projects in a hurry are reluctant to challenge the standards or propose alternative solutions**.

5.62 There are cases where both standardisation and prefabrication have been used to good effect. For example, through incentivisation and the creation of a less risk-averse culture in their supply chain, Anglian Water, has been able to develop the design of a standard product, previously built on site, such that it can now be manufactured off site. Over a period of six years, the cost of delivery of this particular water treatment asset has fallen from £73,000 to £27,900.

Funder/client issues: commercial and procurement

5.63 Consistent with other areas of the data collection, the investigation has received a broad range of responses outlining different commercial and procurement approaches taken to deliver infrastructure projects. The investigation has also seen evidence of differing drivers and behaviours across all sectors and within sectors from differing client organisations.

5.64 In setting out these findings, it is helpful to draw a distinction between the assessment and understanding of the commercial drivers of or for a project and the procurement approach chosen to deliver these drivers. For example, there is evidence of the same commercial drivers for a project or scheme producing different procurement approaches between the public and private sectors.

Commercial drivers

5.65 The headline commercial drivers for projects vary between sectors. For example, in the **rail sector** London Underground assess the benefit / cost ratio for a potential project by quantifying the benefit to the travelling public through shortened waiting and journey times – that is by placing a value on improved passenger experience. A private sector energy company investing in an offshore wind project is seeking a return on his capital investment through selling of electricity, and will be assessing the risks associated with both the development and construction phases and the subsequent operational phase. Success for these different client organisations is evaluated and measured differently; this in turn can drive different commercial approaches.

5.66 However, irrespective of industry sector, or whether from the public or private sectors, respondents have broadly cited similar commercial considerations for their infrastructure projects, such as value for money, delivering cost certainty and programme certainty. It is the relative weight that is given to these different commercial considerations, and more particularly, the reasons behind this weighting that the investigation sought to understand through the evidence gathering exercises. This theme is further developed when drawing conclusions from the evidence.

Procurement Approach

5.67 Different commercial drivers can produce different procurement approaches. However, there is also evidence of the same drivers producing different approaches. This can be reflective of the corporate appetite to risk or the in-house capabilities of the client organisation to manage the technical or commercial risks associated with project delivery.

5.68 When asked what factors influenced their procurement approach, responses ranged from "limitation of risk" to "wanting to see alliances implemented". There is evidence of setting the size and number of packages to ensure competition and to manage capacity. Both long term and short term drivers were factors influencing the chosen route.

5.69 More than seventy percent of clients reported that their contractors or delivery partners were appointed at or before Concept Design stage, which was generally supported by contractors. Eighty percent of respondents felt that they were appointed at the optimum time, and seventy percent of contractors said that the stage at which they would be appointed was a factor in deciding whether to tender.

5.70 **The research has indicated that public procurement in the UK is more likely to use the competition paths of the OJEU process, whereas negotiated procedures are more widely used in Europe.**

5.71 However, this may not simply be attributable to national or cultural differences. For example, French municipalities have greater access to the revenue from their rate base and higher levels of control over their strategic infrastructure spend. This certainty has enabled them to invest in developing their in-house skills, and being better able to make informed decisions internally (rather than relying on external consultants and advisers). This in-house knowledge has led to an early identification of a preferred solution, and then early engagement with the contractor or provider through negotiated processes.

5.72 There are a number of local authorities that have been able to successfully invest in developing certain specialist skills to help them deliver local infrastructure. For example, in Leeds the local authority has broad experience in procuring projects through PFI. The volume of projects has enabled them to retain and develop good in house skills which can be deployed on a potential energy recovery project without the need to rely extensively on external consultants and advisors.

5.73 Elsewhere in the UK, there is also evidence of strategic procurement at a local level. In 2008, Hampshire County Council (HCC) set up long term construction frameworks to foster closer relationships with selected suppliers and gain efficiencies with delivery of construction projects. These frameworks incorporated incentives linked directly to performance targets, and broadly had projects delivered through the NEC forms of contract.

5.74 To determine whether their approach was delivering the desired outcomes, HCC undertook research into whether their framework approach had changed project performance. Initial analysis confirms that projects delivered with frameworks do produce higher levels of performance than those procured using traditional methods. In addition, it appears that suppliers within frameworks have a higher perception of the local environment - and this has improved public awareness of the construction process.

5.75 Clearly while these initial results show improved performance from this approach, the context of the projects undertaken for a local authority within a fixed geographic area mean that outcomes are not necessarily scalable. However, there is further evidence that the AMP frameworks delivering the water sector infrastructure have also delivered improved performance.

5.76 **A clear majority of UK respondents indicated increasing prevalence of the NEC suite of contracts being used to deliver infrastructure projects. There was also a broad consensus that this was improving both relationships and performance.** However, not all client organisations felt that NEC was consistently delivering the cost certainty they required, and were using other forms, such as FIDIC [2], which better met their needs.

5.77 Sixty percent or project respondents worked under open book arrangements and seventy five percent reported that contractor's costs were fully visible in the contract they were working under.

5.78 **There were very few examples of client organisations using un-amended standard forms or no "Z" (optional) clauses. Most contractors reported that this was adding cost, not saving money.**

5.79 A number of contractors responded that the form of contract and stage at which the contractor is invited to participate will influence their appetite to tender for work. Most reported that earlier involvement is more likely to improve the project outcome.

5.80 For example, **many respondents cited positive results from earlier contractor involvement, in building understanding and relationships, driving collaborative behaviours within the project team, and improved project outcomes**. One contractor operating in the highways sector suggested that the Highways Agency ECI (Early Contractor Involvement) model will deliver between £20 and £50 of saving for every £1 invested in contractor fees. Other major client organisations cited their own in-house construction skills as meeting this requirement negating the driver for ECI.

5.81 Overall, most respondents saw benefits from the collaborative behaviours engendered by the NEC form of contract. However, many also expressed a fear that the current economic downturn increased the risk of a return to more adversarial contracts and a "bid-low, claim high" tactic amongst contractors. No-one who reported this suggested this would improve the cost of delivery of our economic infrastructure.

[2] International Federation of Consulting Engineers

Insurance

5.82 Most major infrastructure projects are insured via an Owner Controlled Insurance Programme (OCIP), although the contractors typically also carry their own insurances for Public Liability, Employers Liability and Professional Indemnity. OCIP insurances frequently do not cover the designers' Professional Indemnity. The study interviews suggest that the cost of project insurance is typically higher in the UK than other western European countries, principally in response to higher risks of third party claims (both in terms of numbers and magnitude) and a view that UK projects in general put less emphasis on risk management. In France, for example, Employer's Liability insurance is not required as injured workers would be dealt with via their Workers' Compensation scheme, the costs of which would not be included in an analysis of the cost of a project.

5.83 **There is some evidence that Professional Indemnity (PI) insurance may result in risk-aversion on the part of designers. If this is the case, it is likely to be driven, at least in part, by the relative large amounts of PI cover demanded in the UK compared with other European countries which tends to make designers a large target for potential claims in projects where problems occur.**

Supply chain issues

Incentivising cost reduction

5.84 **There is a broad preference from the supply chain to working under Design and Build contracts due to contractors' willingness to adopt innovative ideas, collaboration in creating constructible design and clearer management of the design process.** In many European states this is the norm, as the European contractors often have large in-house design teams. European contractors also favour Design and Build as it allows them to take more project risk, which they feel well-placed to manage and hence capitalise on. Overall, 80 percent said that the contractors had responsibility for some element of design.

5.85 Design and Build contracts allow more design flexibility for the contractor as they will develop the design, in conjunction with their buildability considerations, from the scheme or concept stage. However some clients advance a design to the detailed stages, usually in order to obtain the necessary technical, funding and other approvals, then let design and build contracts, in which case only the detail design is in the hands of the contractor, and scope of innovation and value engineering is reduced.

5.86 Design, Build, Finance, Operate or concession-based models are used more in other European countries, and enable the private sector to consider whole life costs in a manner in which the public sector is often unable to do due to pressures on capital expenditure; the private sector may be freer to manage the operating expenditure and capital expenditure balance.

5.87 The effect of integration of the whole supply chain was a common theme. When objectives can be aligned, by being subject to the same terms and incentivisation, innovation can be harnessed reducing out-turn costs to clients and safeguarding returns for industry.

Skills and Resources

5.88 **Addressing issues of supply chain skills and resources to deliver improved performance was a key recurring theme from the interviews:**

5.89 Attraction, retention and training of key talent in engineering and management are hampered by the stop-start nature of the pipeline, as is the ability to keep high-performing teams together. There is evidence that sectors with stable and predictable pipelines or work have progressively up-skilled over time and are delivering improved performance.

5.90 There was some evidence to suggest that European engineers are trained to take a multidisciplinary engineering leadership approach, leading to smaller, cheaper project teams that need not rely on over-conservative design codes.

5.91 Respondents offered evidence that the numbers of professional staff in project teams has risen in recent years – particularly in sectors such as rail - exacerbated by UK consultants' and clients' man-marking, leading to a higher internal transaction cost.

There was a common perception that there is a need to increase the skills of front line supervision to improve management of safety, quality and productivity. Many contractors and client organisations have recognised this and have instigated in-house training programmes. Improving supervision skills was also a key recommendation from the Gibson report – Changing to Compete, published in 2009. However, at present there is no evidence that these individual programmes will by themselves deliver the industry wide improvements.

Productivity

5.92 In line with the inconclusive macro level evidence, **the contributors' views on UK's relative productivity performance compared to other European countries were evenly split.** Some of those who felt it was an issue highlighting particular sectors and areas of construction (e.g. rail maintenance, concreting) or the UK construction context as the cause (e.g. culture of legislative compliance and assurance increasing site staff levels; tendency in the UK to orchestrate more parallel activities in aggressive programmes; specific productivity issues with some inherited public sector direct labour organisation / TUPE staff; UK has a far higher staff turnover requiring re-training in each company's different procedures. In addition, as a lot of UK construction skills come from overseas, there is a risk that overseas employees adapt to the UK's low productivity environment).

Box 5.G: Managing Working Patterns

"When an operative is working, the productivity is the same, but in the UK there are more occasional breaks. A fifteen minute break actually loses three times that in time, since the time immediately before and after is less productive." (*Director, French Contractor)*

Though there is evidence that on some major UK infrastructure projects, this effect is being addressed.

"At Terminal 5 we thought about the location of canteens and spent £1m putting one central facility in the right place and improved productivity by twenty percent".

5.93 Productivity was perceived by some interviewees to be a bigger problem with professional staff than with labour. **The poor perception of the industry may mean that many high calibre students choose not to study engineering in the UK**, but in France for example it is a very prestigious career and therefore popular amongst high achievers.

5.94 Other respondents set out a more positive experience of UK labour productivity. However, even within this sample group, respondents saw opportunities for improving productivity or stated examples of differing performance in certain activities.

Box 5.H: Improving Productivity

"UK blue collar labour is fantastic value for money. Not the most productive, but not the best paid either, so an element of production per £ is higher than western Europe. However, if we could invest a little more money in our labour forces we could significantly raise the productivity". *Director, Major UK Contractor*

"Productivity is broadly comparable. Difference in productivity is in concrete work - nearly all buildings in France /Germany are concrete, whereas more mixed in UK. In France, concrete work is done on site to lower specification than in UK. In Germany they use precast concrete and offsite fabrication – but this requires demand." *Director, Multi-National Contractor*

6 Findings from cost data benchmarking

Introduction

6.1 Chapters 4 and 5 summarised the findings from the non-cost interviews and data collected. This Chapter presents the methodology and findings of the cost data collection from three main sources, namely:

- international top-down project benchmarks;
- interviews with respondents resulting in project cost questionnaires being completed; and
- input benchmarks on labour, plant and materials gathered through the interview process.

6.2 Following the online survey, the main body of data was collected from interviews and collated by means of cost questionnaires filled in at the time, and by additional information provided either at the time of interview or subsequently.

International top-down project benchmarks

6.3 Findings from the international data are analysed in detail in Annex B, and are summarised below. The international benchmark data used for this analysis were sourced from the following databases: Infrastructure Journal Online; the European Investment Bank (EIB); and the Road Traffic Technology website.

6.4 **Overall this analysis supported the hypothesis that building infrastructure is more expensive in the UK than elsewhere in Europe.**

6.5 The analysis separates Europe into three different cost zones; Southern Europe (Mediterranean countries such as Spain, Italy and Greece), North West Europe (including France, Germany, Scandinavia and the Benelux countries) and Eastern Europe (including Poland, Slovakia etc). The trend is for South Europe to have the cheapest infrastructure costs, and Eastern Europe the most expensive with North West Europe separating the two.

6.6 Geographically within the North West Europe zone, the data suggests the UK is consistently more expensive than other countries in this zone. These findings are further validated by the European Investment Bank data.

6.7 Whilst the international comparisons made in Annex B generally show higher costs in the UK, the confidence in this conclusion must be tempered with the small size of the databases, and it should be recognised that further data could change the conclusions. It is noteworthy that in areas where it has been possible to carry out a more detailed comparison between overseas and UK projects, such as in the transport sector (rail projects, railway stations, road projects, tunnels) the relative cost differences tend to reduce, and the reasons for the cost differences are better understood.

Benchmarking from sample projects

6.8 The cost data received was analysed on a sectoral basis. Findings from the data collection are presented by sector below. More detailed analysis can be found in the appendices as follows: Highways – Annex C; Flood defences – Annex D; High-Speed Rail – Annex E; Rail Stations – Annex F; Tunnels – Annex G.

Highways

6.9 Data was collected for (mostly) motorway widening schemes in the UK and similar widening schemes in the Netherlands.

6.10 It was found that, as would be expected, the complexity of a highways project directly affects the outturn cost with positive correlation.

6.11 When compared to a network that experiences similar levels of usage intensity, the costs of improving and widening the UK highways network are slightly higher.

6.12 The higher specifications imposed in the UK add to the construction cost. There may be scope to consider lowering the UK specification but whole life cost and the asset management plans must be considered.

6.13 By specifying high standards in the UK (for example, a long design life for structures) but operating within the spatial and planning constraints that prevent incorporation of flexible plans for future expansion, the UK is designing cost and long life into structures that may require replacement when future expansion is carried out.

6.14 The positive effects of economies of scale and introduction of standardised structures could deliver benefits in future widening and improvement programmes.

6.15 These effects are well recognised. The Highways Agency drew on the experience of the regulated industries, as well as submissions by their framework contractors and consultants, in presenting a case for twenty percent cost savings against a more certain pipeline and funding certainty for a programme of projects (five years plus). In stressing the costs of stop start investment and the benefits of continuity and continuous improvement, the Highways Agency's proposals address development of client cost intelligence to inform and standardise requirements and challenge consultants and contractors through re-baselining target costs downwards against each tranche of efficiency gains achieved.

6.16 Evidence from the Highways Agency's and Scottish Governments' existing long term road maintenance contracts lasting up to ten years, indicates that significant savings can be achieved through giving contractors a pipeline of work that incentivises investment in year on year improvement, for example, reducing labour rates by twenty percent.

6.17 These efficiencies are borne out by the recent experience of the Rijkswaterstaat in Holland where pipeline certainty has been used to generate savings in the order of twenty percent on Highways Maintenance Contracts, through extending the term from one to two years to five to seven years and by bundling more maintenance activities together in the same contract, in order to reduce possessions and increase availability.

Box 6.A: Highways: Higher Design Specification and Standards

It was found that The Netherlands provided a good comparison with the UK for highways projects as the two countries have similar population densities and volume of road transport. The study found that the average costs for highway construction are slightly higher in the UK than in The Netherlands. Reasons for this include environmental conditions such as geology and topography, but also include the UK having a longer design life, higher specifications (for example, for waterproofing, interchange design, signage lighting) and more frequent interchanges.

Flood Defence

6.18 Analysis undertaken by the Environment Agency (EA) on their flood defence portfolio (see Annex E) has demonstrated savings of at least nine percent on packages totalling £156m through providing continuity of work.

Box 6.B: Flood Defence: Economies of Scale

The study of costs from six UK flood defence schemes leads to the conclusion, also reached by the Environment Agency, that there are economies of scale to be achieved by aggregating or bundling individual schemes into larger projects, thereby saving costs (proven in this analysis at nine percent, estimated in the future at ten percent). This is related to management, design, value engineering, procurement, purchasing power, construction logistics and project management.

6.19 The flood defence (and highways) sector analyses looked at comparisons of project phasing, observing that those projects with an increased spending (as a proportion of total costs) in the early stages had a lower construction cost. The link between these two was suggested by a number of interviewees.

High Speed Rail

6.20 Following the cost study undertaken by the HS2 team, cost data was collected by Infrastructure UK for five international high speed rail projects, covering the countries: France, Germany, Italy and Spain; and the two sections of High Speed 1 (HS1) which were treated as separate projects.

6.21 A comparable average construction cost from the European projects considered (not total project cost) was £19.3m/km compared to HS1 Section 1 at £24.2m/km. Based on this measure the UK is twenty four percent more expensive.

6.22 A comparable average total project cost from the European projects considered was £21.2m/km compared to £26.7m/km for HS1 Section 1. Based on this measure the UK is twenty six percent above the average.

Box 6.C: High speed rail comparisons

High speed rail has been the subject of considerable research, both by the HS2 project team and Infrastructure UK, and indeed the HS2 work was one of the original drivers for the Infrastructure UK study. The study has confirmed the significant difference in cost between the UK and other European countries (around twenty five percent). Factors influencing costs for UK projects are: constructing shorter sections at a time in highly complex environments with relatively high population density; and having fewer lines already built. This is detailed in Annex E.

The construction of Section 2 of High Speed 1, from Ebbsfleet to St Pancras, was approximately four times the European benchmark rate, due to: its short length, urban setting and two major station developments including the central London terminal. Therefore HS1 Section 2 was not included in the benchmark comparison with the European projects.

Rail Stations

6.23 Data of mixed quality for stations on seven high-speed rail lines, ten underground central London metro stations and five other non-UK stations was received. The data for the metro stations in London and elsewhere was of higher quality and comparable, so was analysed further.

6.24 The data has shown that the UK stations studied are more expensive than the international stations studied, yet there may be mitigating factors which demonstrate better value for this capital cost (e.g. higher area/volume/passenger flow).

6.25 When compared solely to Europe though, the UK metro stations are still more expensive per unit area by fifty one percent.

Box 6.D: Rail Stations: Higher Design Specifications and Standards

The returned cost questionnaires allowed the comparison of a number of metro stations. Owing to the generally larger stations in the UK (to provide greater passenger capacity) the costs in the UK were unsurprisingly significantly higher, but when this was adjusted for size and capacity the differences became much smaller. However, by excluding the US benchmarks, UK stations are up to fifty percent more expensive than European and Asian comparators. The direct budget comparison example of a UK station that proposed by a private sector organisation for half the cost estimated by the public sector client demonstrates that costs can be significantly reduced without compromising size or quality of the finished product.

Tunnels

6.26 Tunnelling data was obtained through the Infrastructure UK cost questionnaires and was supplied by the British Tunnelling Society.

6.27 The average unit rates for tunnelling construction contracts in the UK are not significantly different to those in Europe. The average unit rate for tunnels of 3m diameter or greater is principally dependent on its diameter. Lesser factors influencing cost include overall length, ground conditions, tunnelling method and lining type.

6.28 However the benchmarking by the British Tunnelling Society (see Annex G) looking at the outturn costs of the tunnel contracts alone, suggests a figure of around £40m/km. This is for one two-lane tunnel, so needs to be doubled for comparison with the Chapter 6 benchmarking. Nevertheless, there is a factor of two between the "tunnel only" cost and the "finished project" cost.

6.29 Annex C contains analysis of road projects across Europe, from which the costs of tunnelling have been isolated. The figure in Annex C suggests that the cost of road tunnels in the UK, in 2007 prices, was around £190m per km, the second highest in Europe. The average for Western Europe was around £130m.

6.30 This trend can also be seen in railway tunnels, although to a lesser extent. The differences between the two benchmarks is considered to lie in the non-tunnel costs that are associated with the overall projects, including client's costs, fees, land acquisition, as well as the cost of the tunnel contents – road, rail, ventilation, communications, control systems and the like.

Box 6.E: Tunnelling

The BTS tunnelling study demonstrated that the direct costs of tunnel construction are wholly within the European benchmark range. However, when considering the top-down total project costs, as has been done in Annex B (International benchmarking), the UK does appear to have the second highest cost for road tunnels in Europe. This can attributed to the indirect cost factors surrounding the construction of tunnels in the UK.

Labour, plant and materials input cost benchmarks

6.31 Comparisons of UK labour costs with other north-western EU countries indicate that, on the whole, the UK has relatively low hourly rates, but a longer working week, summarised in the table below.

Table 6.A: Analysis of labour input costs

Comparison of UK Labour Costs and working Hours with other European Countries	**Ranking**[a] (most expensive/longest to least expensive/shortest)				**Comment**
	1st	2nd	3rd	4th	
Working Hours per Day	UK	FIN/SWE			UK 25% longer working days
Working Hours per Week	UK	FIN/SWE			UK 20% longer working weeks
Labour Cost - Qualified	SWE	FIN	DK	UK	
Labour Cost - Semi Qualified	SWE	FIN	UK		
Labour Costs - Unqualified	SWE	FIN	DK	UK	

Source: Infrastructure UK 2010

[a] SWE = Sweden, UK = United Kingdom, Fin = Finland, DK = Denmark

6.32 Materials costs have been studied in some detail, with a summary of a basket of material costs set out in the Table 6.B below.

Table 6.B: Analysis of a sample of material inputs costs

Comparison of UK Materials Costs with other European Countries		**Ranking[a] (most expensive to least expensive)**						
		1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**
Concrete Costs (GBP/m^3)	Note different concrete standards quoted (40N, C4 and C30)	SWE	FIN	UK	NL	DK	B	IE
Timber Costs (GBP/ m^3)		UK	NL	IE	DK			
Structural Steel Work Costs (GBP/tonne)		B	IE	DK	NL	UK		
Steel Reinforcement Costs (GBP/tonne)	Steel Reinforcement	FIN	NL	SWE	UK	B	DE	IE
Asphalt Costs (GBP/tonne)	Asphalt - 32mm Dense Base Course	UK	DK					
Asphalt Costs (GBP/tonne)	Asphalt – 12mm SMA Surface Course	UK	DK					
Aggregates Sub-Base Costs (GBP/tonne)	Type 1 description used for some costs	B	UK	DK	SWE	NL	FIN/IE	
Steel Sheet Piling Costs (GBP/tonne)	Either described as Hot Rolled or PU18@128kg/m^2	SWE	FIN	IE	NL	UK	B	DK

Source: Infrastructure UK 2010

[a] SWE = Sweden, FIN = Finland, UK = United Kingdom, NL = Netherlands, DK = Denmark, B=Belgium, IE = Republic of Ireland

6.33 The difficulties of obtaining accurate historical project data and relatively small data samples have led to significant variations in conclusions. However the limited data available suggests that overall there is little consistent significant difference between material costs in the UK and elsewhere, after taking transport distances and PPP normalisations into account.

7 Analysis

Introduction

7.1 The foregoing Chapters 1 to 6 set out the background to the study, the previous work in this area, comparisons between the UK and other countries, and the findings from the cost investigation cost and non-cost evidence and data. This Chapter presents an analysis of the study findings, quantifies the potential benefits and sets the framework for the study's conclusions and recommendations.

7.2 In addition to consideration of the key Infrastructure UK survey and study findings, the analysis considers a number of additional sources of data:

- a review of conclusions from previous reports;
- the output from the four ICE working group's reports; and
- a summary of examples of best practice savings across the public and private sectors (see also Annex H)

Capital expenditure on infrastructure

7.3 The information set out in Chapter 2 indicates that the level of capital expenditure on construction related activity in development, maintenance and renewal of infrastructure will be in the order of £15 billion per annum for the next five years. Whilst there is no firm forecast level for expenditure beyond five years, the implications of the requirements set out in the National Infrastructure Plan 2010 suggest that it is most likely to increase.

International comparisons

7.4 The weight of evidence from international comparisons set out in Chapters 3 and 4 confirm that the UK has higher costs than its European peer group and demonstrates that the UK is an expensive place in which to build infrastructure.

7.5 The international comparisons also highlight clear differences in certain aspects of infrastructure delivery in Europe (For example, the Civil Law system in Europe seems to provide a simpler and more cost-effective framework in which to conduct business by reducing the length of contracts and resulting in the need for less legal interpretation and advice) and indicate that there are endemic features relating to the UK's geography, socio-economic and legal systems that are either impractical or not possible to change in order to reduce the cost of infrastructure.

7.6 However, some of the themes emerging from the international comparisons are useful to the consideration of how to reduce costs in the UK, For example:

- *Pipeline*: In most of the countries studied the existence of long-term investment plans, clear political support for infrastructure and confidence in the pipeline of work all led to efficiencies in the industry and consequential costs savings.

- *Capability of client bodies*: The relative technical competence and capability of the European public sector, enabling better management of the contracts and supply chain, better ability to understand and challenge technical and commercial issues.

- *Discipline in commissioning*: Lessons from western Europe include the cost-effectiveness of shorter bidding processes, shorter town and country planning processes but longer project planning periods, and earlier involvement with the supply chain.

- *Smarter use of competition*: The European construction industry has fewer, larger contractor organisations that can engage on major infrastructure contracts and engage a less fragmented supply chain than the UK.

- *Supply chain integration*: In most continental markets competition and collaboration between companies is not mutually exclusive. Some of the largest construction companies have long-term partnering relationships with their top-tier subcontractors.

- *Efficiency*: Efficiency in the construction industry overseas include the relatively higher levels of training at all levels which reduces duplication and inefficiency in site supervision.

7.7 While the data does not present a consistent picture of the UK construction industry productivity relative to mainland Europe, there is a wide belief that targeted investment by industry in key skills and capability is required to drive improved productivity performance

Understanding the drivers of higher UK costs

7.8 The results of the Infrastructure UK and Institution of Civil Engineers surveys and cost data benchmarking set out in Chapters 5 and 6 provide a detailed view of the issues that drive higher costs in the UK and indicate the main areas where there is potential to realise savings. There is no single overriding factor driving higher costs and evidence highlights a number of contributing factors:

- stop-start investment programmes and the lack of a visible and continuous pipeline of forward work;

- lack of clarity and direction, particularly in the public sector, over key decisions at inception and during design. Projects are started before the design is sufficiently complete. The roles of client, funder and delivery agent become blurred in many public sector governance structures;

- the management of large infrastructure projects and programmes within a quoted budget, rather than aiming at lowest cost for the required performance. If the budget includes contingencies, the higher total becomes the available budget;

- over-specification and the tendency, more prevalent in some sectors than others, to apply unnecessary standards, and use bespoke solutions when off-the-shelf designs would suffice;

- interpretation and use of competition processes not always being effective in producing lowest outturn costs, with public sector clients in particular being more risk averse to the cost and time implications of potential legal challenges;
- companies in the supply chain typically investing tactically for the next project, rather than strategically for the market as a whole; and
- lack of targeted investment by industry in key skills and capability limiting the drive to improve productivity performance.

7.9 In some instances, higher relative capital costs in the UK can be attributed to greater intensity of use in the UK. This is caused by factors such as the UK's greater density of population, compounded by higher land costs and the UK's ageing asset base. However, these unavoidable factors do not fully account for the high cost in the UK.

7.10 Infrastructure and maintenance costs are about a third of the total capital spend on civil engineering. These tend to be programmes of work that are of a repeating type rather than one off bespoke projects. There are potentially different areas for potential savings in relation to these programmes – for example through partnering - as highlighted by the evidence from the surveys.

7.11 In order to test further the validity of the study findings, Infrastructure UK considered additional sources of data:

- a review of conclusions from previous reports (review of reviews);
- the output from the four ICE working group's reports; and
- a summary of examples of best practice savings across the public and private sectors.

7.12 The principal issues and drivers of higher infrastructure costs are also summarised in Chart 7.A overleaf.

Chart 7.A: Summary analysis of key factors influencing infrastructure costs

Stage	1. Pipeline/Start-up	2. Define requirement	3. Design/procure	4. Develop (build)	5. Deliver/close
Policy/issues	***Planning & consultation:*** longer planning horizons and onerous consultation requirements → ***Standards and regulatory compliance*** **:** complex web of planning, consents, regulation, process and standards, which absorb time and add considerably to cost. → ***Urban environment:*** More brownfield development →				
Funder/ Commissioner issues	***Stop-start investment*** ***:*** Lack of certainty of budget commitment even for some committed projects/programmes → ***Infrastructure data:*** Poor asset data and limited availability/use of benchmarks → ***Poor commissioning leadership:*** Unclear stakeholder accountability and over-prescriptive specification & assurance → ***Competition /procurement issues:*** Risk averse culture favours competition over partnering - lengthy & onerous procurement processes → ***Ineffective cost & risk management:*** *Lack of* effective incentives to minimise outturn costs → ***Bespoke design:*** Culture of risk aversion & prescriptive design standards favour bespoke solutions →				
Deliverer/ Supply chain issues				***Fragmented supply chain:*** Margin on margin, poor skill development, lower productivity and little innovation/standardisation → ***Contractual approach*** **:** The UK generally adopts a more contractual approach →	

Conclusions and recommendations from previous reports

7.13 In parallel with the online Infrastructure UK / ICE Stakeholder Survey, IUK undertook a review of previous reports in the sector to examine the extent to which the analysis and conclusions of earlier studies are helpful in addressing the issues raised by the IUK Review. The following reports were examined:

- *a SWOT analysis of the UK Civil Engineering Industry* (Agile Construction Initiative, Bath University, March 1997)
- *The Jubilee Line Extension – end of commission report by the secretary of state's agent* (Arup report presented to the DETR, July 2000)
- *International comparison of water and sewerage service* (OWAT, 2008)
- *Never Waste a Good Crisis* (Constructing Excellence, October 2009)
- *Changing to Compete – review of productivity and skills in UK engineering construction* (Gibson review presented to BIS, December 2009); Report Annex: *Productivity in the UK Engineering Construction Industry* (Independent Project Analysis (IPA), September 2009)
- *State of the Nation: Infrastructure* (Institution of Civil Engineers, 2010)
- *Nuclear Lessons Learned* (Royal Academy of Engineering on behalf of Engineering the Future, October 2010)
- *UK Electricity Generation Costs Update* (Mott MacDonald, June 2010)
- *A Strategy for Sustainable Growth* (BIS, July 2010)

7.14 The main drivers of costs identified in previous studies were then mapped against those emerging from the Infrastructure UK / ICE online survey. There was found to be a high degree of consistency and correlation in identifying the key drivers as being:

- leadership, governance and commercial structures;
- market structure, capacity and integration;
- specifications, standards and estimating; and
- input costs.

7.15 *Never Waste a Good Crisis* also reviewed the timeline of earlier construction industry reports and highlighted particular recommendations that also map well against the themes identified by earlier studies and Infrastructure UK / ICE online survey, as is shown by the following Table 7.A below.

7.16 In addition to the above factors the Infrastructure UK review has covered issues relating to input costs. This analysis indicates that, whilst several industry and Government reviews have recognised the need for change, few of the targets and recommendations set out in these reports have been fully met or implemented.

Table 7.A: Summary of previous reviews

Report	Date	Market structure, capacity, integration	Leadership, governance, commercial Structure	Specs, standards, estimating
Constructing the Team (Latham)	1994	✓	✓	
Rethinking Construction (Egan)	1998	✓	✓	✓
Achieving Excellence in Construction (OGC)	1999	✓	✓	
Modernising Construction (NAO)	2001		✓	
Accelerating Change (Strategic Forum for Construction)	2002	✓	✓	
Construction Matters (Trade and Industry Select Committee)	2008	✓	✓	
Equal Partners (Construction Clients' Group)	2008	✓		

ICE working groups' recommendations

7.17 Four ICE working groups were formed as part of the study to focus and report on specific topic areas. These were:

7.17.1 Tunnelling: The British Tunnelling Society, an Associated Society of the ICE carried out an investigation to compare the costs of tunnelling in the UK and other Western European countries. The tunnelling group, have suggested that reasons for greater project costs in the UK include compliance with health and safety regimes, paperwork associated with procurement processes, relatively high levels of site supervision, relatively slow political decision-making, less ability to manage stakeholders and less control over funding arrangements.

7.17.2 Codes and Standards: The Codes and Standards Sub-Group was drawn from relevant ICE Expert Panels and was tasked with examining the impact of Health and Safety legislation and Eurocodes on project costs. The codes and standards group found that whilst the common EU standards should not result in cost differentials across Europe and UK, the additional in-house codes and standards of many client bodies and regulators could drive costs up. They also noted that the new health and safety legislation has helped UK to achieve the best safety record in Europe, but local in-house requirements, as before, add to costs.

7.17.3 Supply Chain: The Supply Chain sub-group was made up of senior representatives from major contractors, specialist sub-contractors and clients. The group examined issues affecting supply chain performance including structure, capacity and interaction with clients. The group reviewed cost and non cost data and previous studies on supply chain performance. The supply chain group recommended improving the definition of project requirements and reducing the number of subsequent scope changes. They also drew attention to the beneficial collaborative behaviour driven by the creation and signing of a project-wide joint statement at the outset, such as the 2012 Construction Commitments used on the London 2012 Olympic Park.

7.17.4 Client Group. Senior representatives from Thames Water, Highways Agency, Network Rail and Transport for London shared details of current work programmes aimed at improving their performance as clients. In the context of the web survey they identified client leadership, decision making, governance and project management as the aspects of civil engineering projects with the greatest relative scope for improvement and cost savings. The client group recommended sharing between themselves details of current work programmes aimed at improving their performance as clients. They also supported the key themes of this report and recommended further knowledge-sharing between clients.

Quantifying potential benefits

7.18 From the analysis and with an understanding of barriers to change, it is clear that there remains a significant opportunity for improved cost effective delivery of economic infrastructure in the UK.

7.19 Annex I sets out further specific example of individual projects that have been able to save substantial sums from budgeted costs by applying some of the practices highlighted in this report. These individual project savings range from about five percent to over thirty percent against original budget estimates.

7.20 The potential to realise savings is affected by:

- the different cost drivers that apply to programmes of capital renewal and maintenance – which accounts for one third of infrastructure spending - and one off projects that expand the network capacity;
- the fact that privatised utility companies – which account for some sixty percent of the capital spending on infrastructure – have already implemented some of the mechanisms recommended by this review and have, therefore, already made some significant levels of savings that are reflected in the baseline expenditure forecasts;
- differences between organisations in the public and privates sectors, and the types of infrastructure being delivered by them, where good practice is evident in some individual projects and programmes, but less so in others; and
- the extent to which government and industry are able to work together to change the way that infrastructure is commissioned and delivered in the UK, to reduce cost. Some of the actions required to implement change are already in hand, others can be achieved within the next year or so, whilst others may take longer to develop before the full benefits can be realised.

7.21 The evidence from individual cases suggests that savings potential savings vary between sectors and types of contract and range from below ten percent to above twenty percent. Taking into account the factors referred to above, Infrastructure UK, supported by the Steering Group and the Stakeholder Reference Group, concludes that savings of at least fifteen percent should be available over the next five years. Applying the potential savings of fifteen percent across the whole infrastructure sector, with capital expenditure estimated at £15 billion per annum suggests that savings of £2.25 billion per annum can be realised and that the range of savings is between £2 billion and £3 billion per annum.

The conclusions and recommendations that arise from this analysis, together with the actions that are proposed to support the realisation of the potential benefits, are set out in the Main Report document.

A Consultation

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BAM Group
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Essex County Council
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Fomento
Foster Wheeler Energy
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Gardiner & Theobald
GCP Infrastructure Investments
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Institution of Building Services Engineers
Institution of Railway Signal Engineers
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Kwik-Step
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Northumbrian Water
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Ofwat
Olympic Delivery Authority
Outside The Box
Ove Arup & Partners
Parsons Brinckerhoff
Partnerships for Schools
Pilots4Change
Pinsent Masons
PricewaterhouseCoopers
Renfe
Réseau Ferré de France
Royal Institution of Building Architects
Rijkswaterstaat
RWE
Sabre Consulting
SEOPAN
Sir Robert McAlpine
Skanska
Skanska Civil Engineering
Skanska UK
South West Water
Specialist Engineering Contractors' Group
Standing Committee on Structural Safety
Substructure
Tarmac
Tesco
Thames Tideway
Tubular Holdings
Union of Construction Allied Trades and Technicians
Unite the Union
University of Southampton
Vejdirektoratet
Vinci
Volker Wessels
VolkerFitzpatrick
Whole Life Consultants
WSP

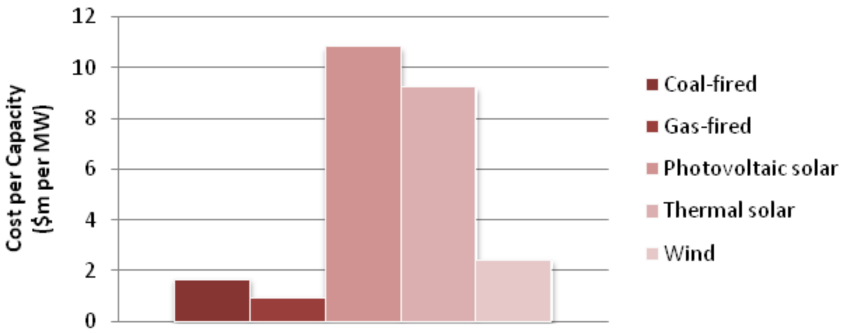
B International benchmarks

Introduction

B.1 A summary of the available international benchmark data for a selection of energy and transport projects follows. However, the study found that this data, whilst showing the UK projects as relatively high cost, did not by itself allow robust conclusions to be drawn and further investigation was therefore required.

Energy

Chart B.1: cost in millions of dollars per MW of energy provided

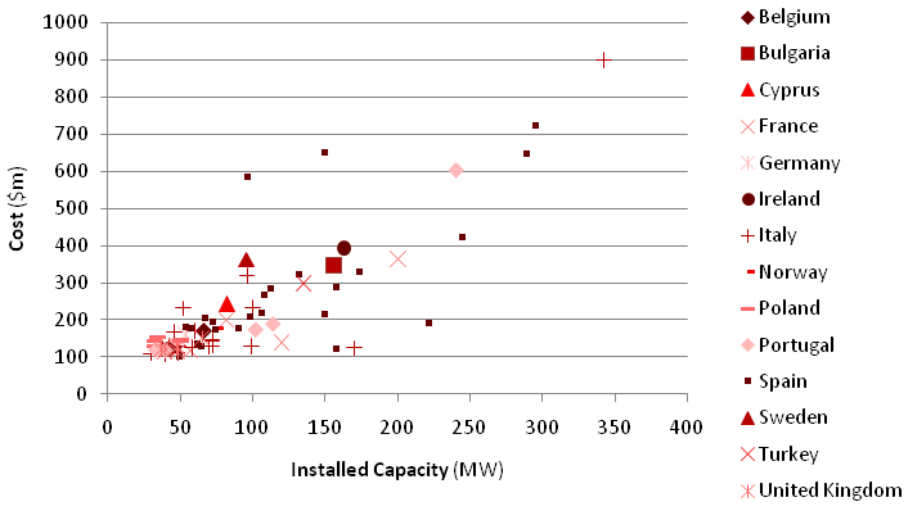


Source: Infrastructure Journal Online, online analysis, September 2010

B.2 When analysing the costs of construction of generation capacity, the most useful comparison is the cost per unit (mEUR/MW) of energy. Clearly the construction costs vary significantly for differing generating types, demonstrated in Chart B.1 above. The levelised cost of generation, often measured as MEUR/MWh, includes the operating costs of generation, including fuel, operational lifecycle and maintenance etc. Low carbon technologies such as onshore wind power have a high capital cost of construction, which is balanced in part by low operating costs. Higher carbon generation technologies such as CCGT have lower unit construction costs balanced by a high proportional fuel cost.

B.3 Chart B.2 below shows that the cost of a wind farm is, in general, directly proportionate to its capacity. This means that it is possible to compare the unit cost of different sizes of wind farm across different geographical territories.

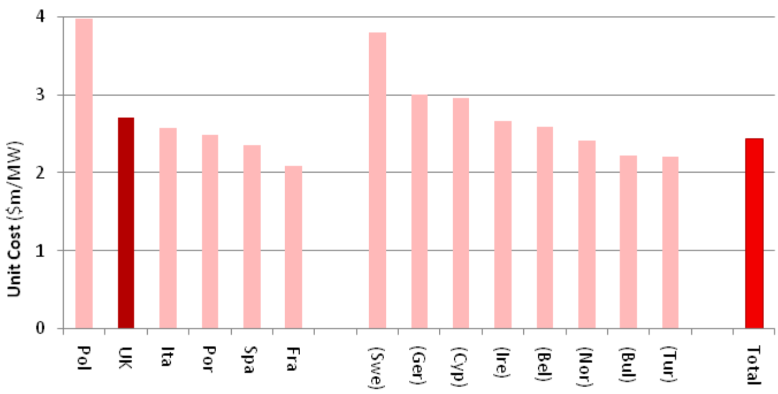
Chart B.2: Cost of onshore wind turbines in the Europe



Source Infrastructure Journal Online, online analysis, September 2010

B.4 Chart B.3 below shows the cost of wind power installations in millions of dollars per MW for different countries. The countries in brackets are those with very small sample sizes. It shows that the UK has the second highest unit cost for wind energy of those with reasonable sample sizes. It is 30 percent more expensive than France and 16 percent more expensive than Spain, but almost a third cheaper than Poland.

Chart B.3: Relative costs of onshore wind turbines in the EU



Source: Infrastructure Journal Online, online analysis, September 2010

B.5 A separate study by the European Investment bank also found the UK to be 18 percent more expensive than Norway and 29 percent more expensive than Denmark.

Transport

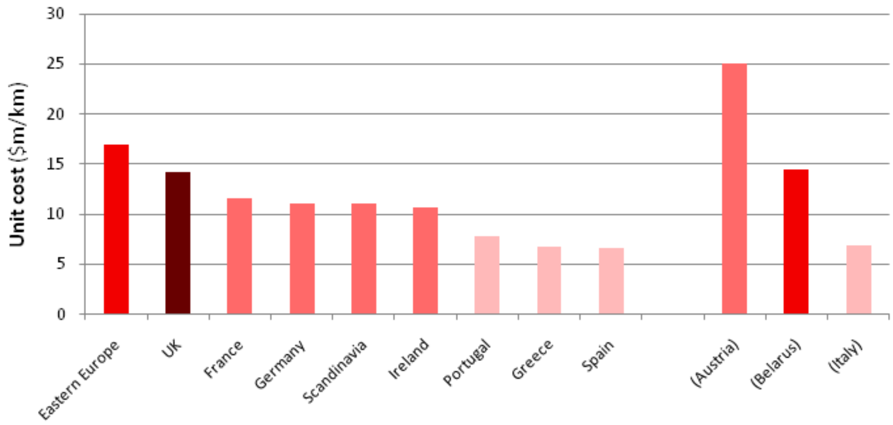
B.6 The benchmark data for the transport sector has been split up into a number of areas, including roads, rail, tram and light rail transit.

Road

B.7 When comparing international benchmark costs for roads, there are a number of normalising factors to be considered, including length, number of lanes and numbers of structures such as bridges.

B.8 Such normalising data on each road was not always available, so to attempt to exclude anomalies, any road with either a very high or very low unit cost was discounted from the analysis.

Chart B.4: Relative cost of road building in the EU



Source: Infrastructure Journal Online, online analysis, September 2010

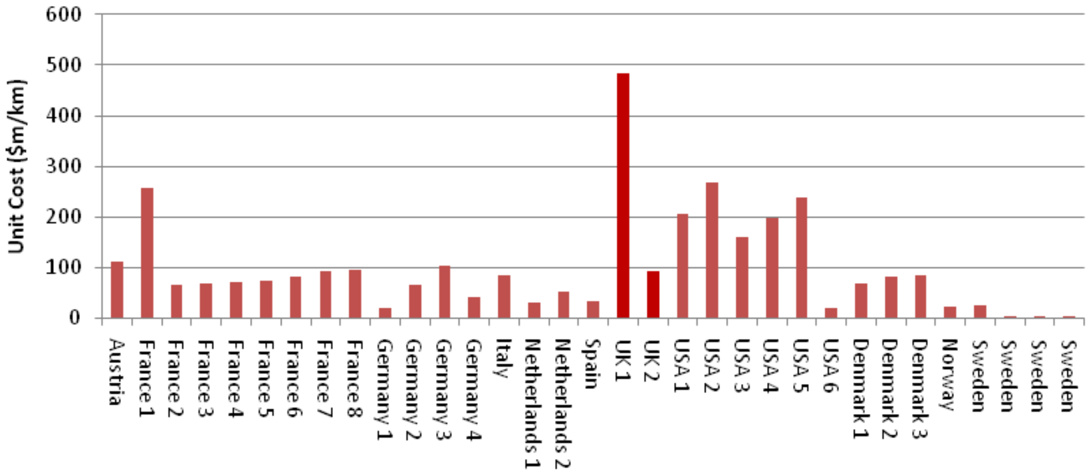
B.9 Chart B.4 above shows the unit costs ($m/km) for road projects across Europe. (Those countries in brackets have very low sample size). The chart shows a clear split in geographical regions. Those from southern Europe have very low unit costs, with those in north and west Europe significantly higher, and those in Eastern Europe higher still. The UK again has significantly higher costs than its north western counterparts, but lower than Eastern Europe.

B.10 Recognising the significance of UK investment in our transport infrastructure, and to gain a more detailed understanding of these figures, the investigation undertook a more detailed highways cost benchmarking exercise that is reported in Annex C.

Rail

B.11 The data collected by the EIB used to compare rail costs came from a number of projects, and was normalised into millions of Euros per kilometre in 2007 prices. This is presented in Chart B.5 below and includes data from a number of rail projects in the USA.

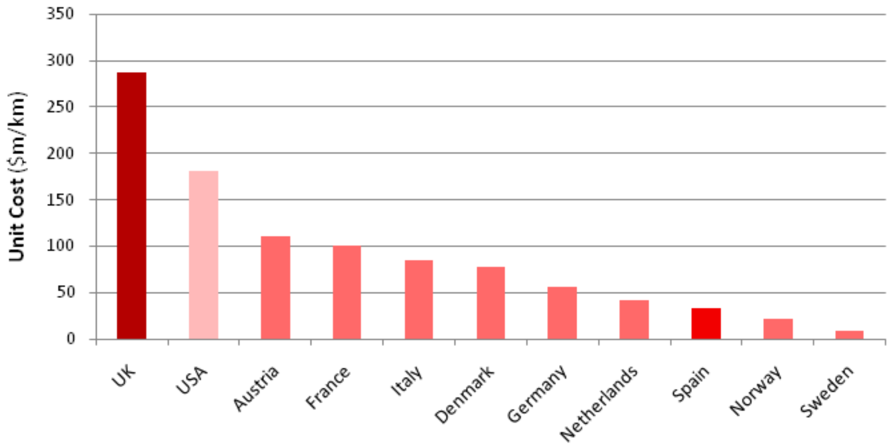
Chart B.5: Relative cost of rail projects in the EU and US



Source: EIB

B.12 Chart B.5 shows the unit cost for a number of individual projects. It shows a wide variation of cost for the two UK projects considered and an average cost higher than other nations in Chart B.6.

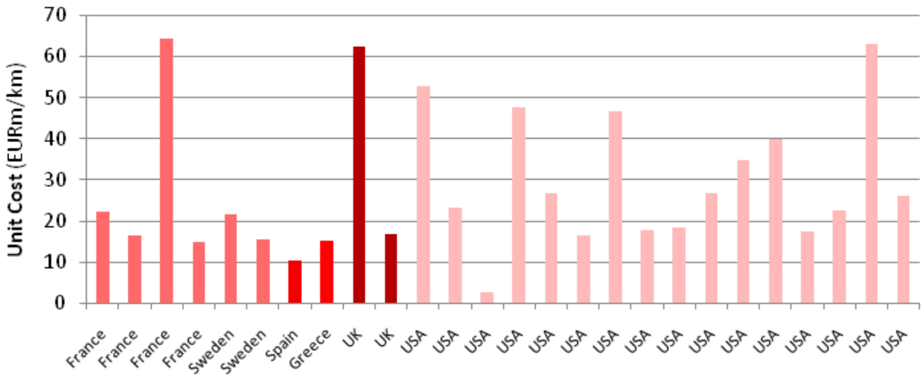
Chart B.6: Average unit costs for rail in the EU and USA



Source: EIB

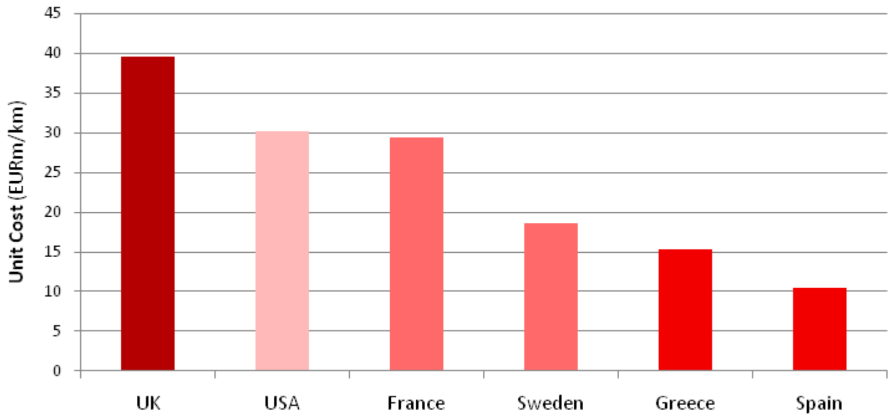
B.13 For tram and light rail transit projects, again the EIB has collected and normalised the data to 2007 prices on a number of projects.

Chart B.7: Unit cost for specific tram and LRT projects



Source: EIB

Table B.8: Average unit costs for trams and light rapid transit in the EU and USA



Source: EIB

Summary conclusion

B.14 Drawing conclusions from such limited top-down data sets may not be appropriate. As such, the study sought more detailed cost benchmarking data which is reported in Annex C to F.

C Benchmarking: highways

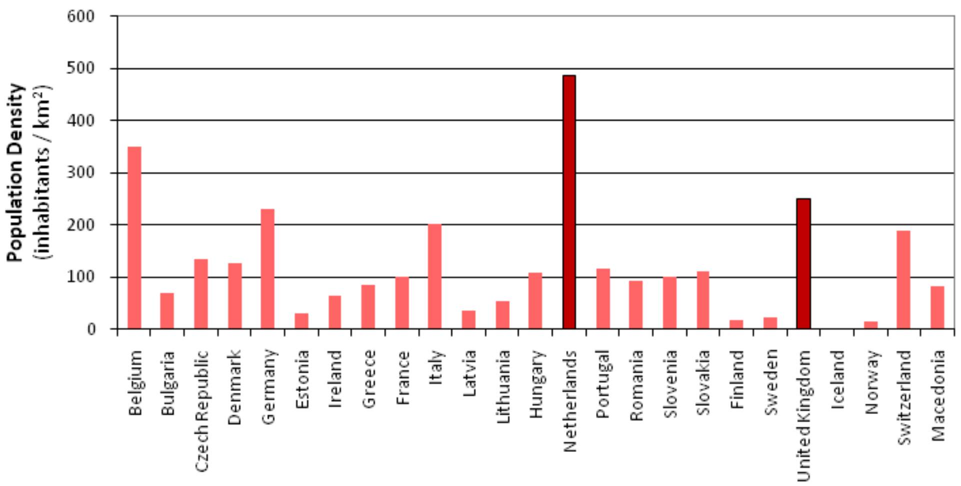
Data Obtained

C.1 Survey participants returned eight completed cost questionnaires for highways projects. Five of these returns were completed in the UK for Highways Agency projects. The data for three further projects has been submitted by Rijkswaterstaat[1] (RWS) in the Netherlands.

Data Analysis

C.2 The Netherlands is one of only 2 EU states that have a population density greater than that of the UK. Further, the 2007 Eurostat index for the volume of inland passenger transport, measured against GDP was recorded at 91.6 for the Netherlands against a similar 91.1 for the UK. This supports the perception that the Dutch highway network is an acceptable comparator to the UK's in terms of intensity of use, a view also held by the Highways Agency.

Chart C.1: Population density in the EU



Source: Eurostat Data, 2007

C.3 The five Highways Agency projects, four of these are highway widening schemes, are either under construction or have been in operation for less than five years. The three Dutch projects, dual carriageway widening schemes, are pre-construction estimates of the project costs. This

[1] The data was kindly supplied by Mr Ton Arninkhof, an estimator in the Utrecht office of RWS.

has been taken into consideration while analysing the cost differences between projects, so care must be taken when attempting to compare like-for-like.

Secondary Data

C.4 Also of importance were the various reports which were submitted to the study team. Of relevance to highways were the following:

- Comparative costs of Highways in Europe, EC Harris, 2008
- European Cost Comparison - Cost differences between English and Dutch Highway Construction, EC Harris and TRL, 2009
- Mission Audit Modernization Report: The European comparison of costs of construction, Maintenance and operation of roads: 2006, General Controller of Economics and Finance, and the General Council of Bridges and Roadways
- Analysis of Costs for Construction of Motorways, Danish Road Directorate, 2005

C.5 The authors of the EC Harris and TRL report observed and reported that traffic conditions in Holland were in fact similar to that of the UK.

C.6 EC Harris and TRL also observed the following differences in specification between the UK and the Netherlands that must be taken into consideration when reviewing the costs:

- Design life for structures is 50-80 years in the Netherlands as opposed to 120 years in England;
- No waterproofing or silane on structures in the Netherlands – The Dutch have a lower specification than the UK;
- Bridge clearance height is lower in the Netherlands (4.6m or less as opposed to 5.03m in England);
- Lower drainage requirements and no contamination separators generally in the Netherlands;
- No dedicated lighting of traffic signs in the Netherlands; and
- Lightweight gantry solutions are preferred in the Netherlands – they are not designed for impact.

C.7 The EC Harris and TRL report compares construction costs between the UK and the Netherlands for highway-building projects. The report focuses on the construction input costs and not on the wider issues surrounding pre-construction costs.

C.8 Early stage costs are not captured and the comparison is only between the construction phase costs. The report seeks to understand the significant differences then normalise them out to obtain a true comparison. The most significant of these are summarised below, with the percentage costs they represent.

Table C.1: Most significant differences in highways design specification (UK and Netherlands)

Difference/Item	Reason for Reason for difference	Impact on overall cost
Drainage	Drainage typically runs directly into the canal network in Netherlands	7.0%
Pavement specification	Ground conditions: UK surface is thicker to reduce maintenance costs and increase life span. Higher raw material costs.	5.0%
Traffic Management	Dutch projects have very similar requirements to UK projects, but the costs are not included in the construction contracts.	3.5%
Earthworks	Different taxes, disposal costs, and transportation costs	3.5%

Source: European Cost Comparison, EC Harris and TRL

C.9 The above observations and table highlight some interesting points but do not represent anything directly portable and of use to effect savings in the UK. Some of the smaller differences identified could be transferred, such as the Dutch shorter design life and lower safety factors for structures. Whether such measures should be adopted or not will depend on the whole-life factors considered at the project feasibility phases.

C.10 The 2005 Danish Analysis of Costs for Construction of Motorways report compares costs for motorways in Belgium, Denmark, England, the northern part of Germany, Netherlands and the southern part of Sweden. The French 2006 study includes a comparison of maintenance costs across France, Germany, Denmark, Spain, Norway and the UK. The results are referenced below to support conclusions garnered from the primary Infrastructure UK cost study.

Primary Data

C.11 The data obtained during the Infrastructure UK cost study, by direct engagement of the commissioning bodies, sought to take a top-down approach. This was to ensure that all costs were captured that may not be visible to all stakeholders, for instance, a contractor is unlikely to be party to the true costs of client activities. The wider, qualitative issues of commissioners' approaches to market were addressed in the interviews with road-building stakeholders at all points of the supply chain, which is discussed elsewhere in this report.

Project Descriptions

C.12 Below is a brief description of each project analysed in the Infrastructure UK cost study.

Table C.2: Brief project descriptions

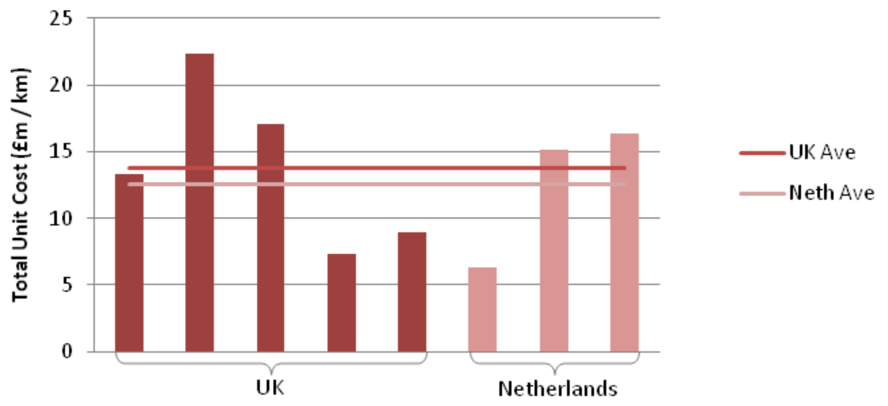
Project Ref	Cost ('09 £m)	Description	Environment	Notable Structures
A (UK)	145	New roads linking 2 major A roads to a motorway and an additional lane in each direction on an A road between 2 major junctions, for a distance of approx 2 km.	Sub-urban	New viaducts and a flyover. Major retaining walls, gantries, masts etc.
B (UK)	360	Motorway widened to four lanes, improvements to junctions, replaced existing drainage, lighting and communications. Provided Controlled Motorway with overhead gantries and lane indicators.	Sub-urban	Over- and underbridges totalling >20, major retaining wall, gantries and comm's masts etc.
C (UK)	345	Motorway widening by converting the existing hard shoulder into a running lane. Added a new hard shoulder where possible. All works within the existing land boundary. No work on any junctions except where the slip roads meet the motorway. Extensive soil nailing.	Rural / Sub-urban	Major over- and underbridge strengthening / widening works (as opposed to new construction). Gantries etc.
D (UK)	80	Widening 3 lane sections of a motorway to dual 4 lanes, between slip roads. All works are within the existing land boundary. Low noise road surfacing and/or noise fencing to shield properties and to reduce traffic noise.	Sub-urban	Widen bridges, gantries, masts etc., comm's upgrades.
E (UK)	345	New dual carriageway. Connections to two major A roads. All excavated material remains within site boundary.	Rural	New under- and overbridges. Tunnelled section.
X (Neth)	120	Carriageway widening from 2 to 3 lanes.	Rural	Widening of underbridges and new viaducts adjacent existing, service/rest station.
Y (Neth)	300	Carriageway widening from 2 to 3 lanes.	Sub-urban	Viaducts (including over water), widening of over- and underbridges, junctions, service/rest station.
Z (Neth)	320	Carriageway widening from 2 to 3 lanes.	Sub-urban / urban	Viaducts (including over water), widening of over- and underbridges, service/rest station.

Source: Infrastructure UK Cost Questionnaires

Unit Costs

C.13 At the highest level, if a comparison of unit costs (i.e. total project cost per lane kilometre) is made, then a large range can be observed in the small sample taken. When averaged, the UK projects cost £13.8m / lane-km as opposed to £12.6m / lane-km for the Dutch, or 9.5 percent higher in the UK. The data was normalised to a base date year (2009) using Eurostat country-specific inflation data and for the Dutch projects, brought into Sterling currency using Purchase Power Parity (PPP) figures from the OECD (as in the above table).

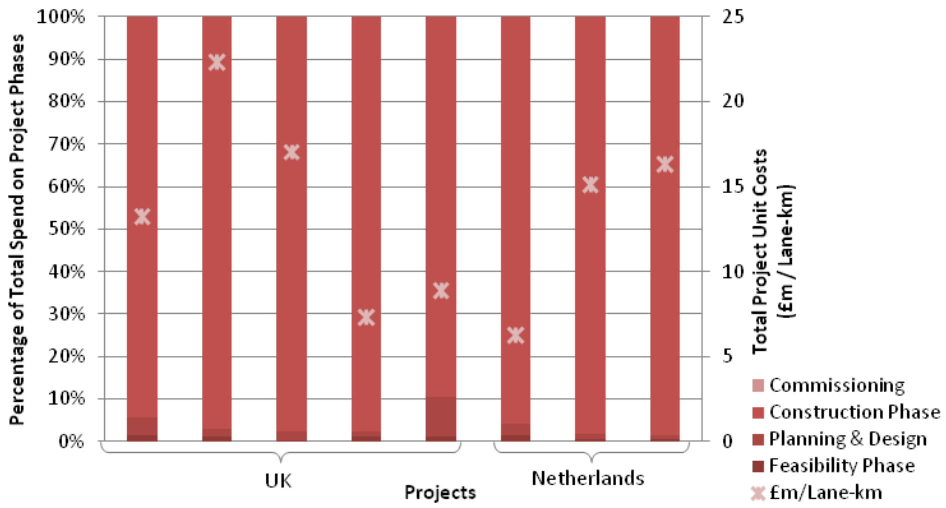
Chart C.2: UK versus Netherlands highway total project costs



Source: Infrastructure UK Cost Questionnaires

C.14 The chart below provides details of project phase costs, shown as a proportion of the total project cost. It also details the cost per lane-km of each project.

Chart C.3: Total project costs per phase and per kilometre

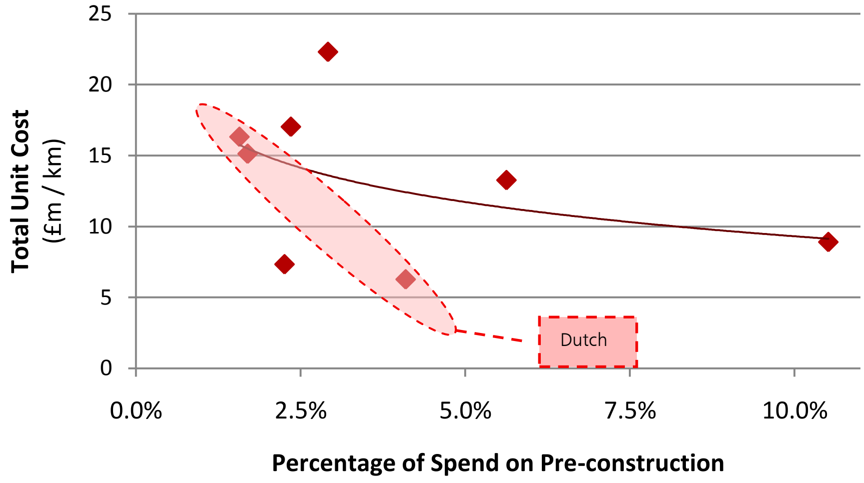


Source: Infrastructure UK Cost Questionnaires

C.15 Of the UK projects, Project A returned the highest unit cost at £22.3m / lane-km (sub-urban). The lowest unit cost was returned for Project X in the Netherlands, at £6.3m / lane-km (rural).

C.16 Analysis in some sectors has shown that increased spending in early phases of a project, especially in construction planning, reduces the construction spend. Chart C.2 shows little correlation between these, but the below suggests such a trend, despite the spread of data points. Such a trend was also postulated by many interviewees in the non-cost elements of the study.

Chart C.4: Effect of pre-construction expenditure



Source: Infrastructure UK Cost Questionnaires

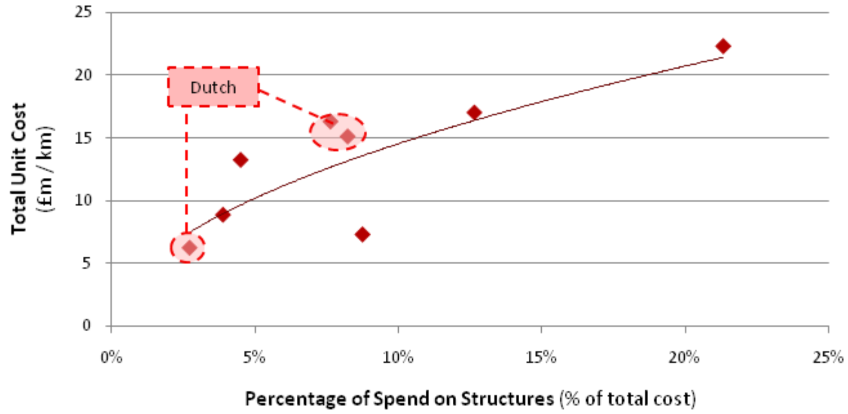
Structures and complexity

C.17 All projects other than E, are largely widening schemes. The average cost for an additional one lane-km on the UK projects is £13.89m. The Analysis of Costs for Construction of Motorways report states that in 2005, the UK cost for widening a single kilometre of motorway by one lane in open land, without interchanges was €12.5m. This inflates to €14.1m or approximately £10.3m at 2009 prices. The difference between the figure determined above for the UK average and the figure noted in the Danish study can perhaps be explained by the sample of UK projects having mostly been constructed in sub-urban rather than rural environments, resulting in a greater complexity: additional interchanges, structures and environmental protection.

C.18 Of the sample, though a subjective measure, there is a definite split in terms of project complexity. It can be considered that projects with higher numbers of new civil engineering structures are more complex than projects with fewer, or projects that merely widen and strengthen structures instead of replacing them. Works to existing highway junctions can also be considered complex, while converting hard shoulder to running lane can be considered relatively simple. The complexity is therefore an obvious explanation as to the higher cost per lane-km for some projects.

C.19 The below graph addresses this relationship and using the percentage spend on structures, as a proxy for relative complexity, plotted against the total cost per lane-km.

Chart C.5: Effect of structures on total project costs



Source: Infrastructure UK Cost Questionnaires

C.20 Clearly the unit cost increases when a (proportionally) greater amount is spent on structures. This would appear to make logical sense, as the relatively simple roadway construction is interrupted by the separate and unique structures sub-projects.

C.21 The projects analysed above show that on average, the UK spends 57 percent more on structures (per lane kilometre) than the Netherlands. This may be due to a combination of effects:

- the unstable ground conditions in the Netherlands discouraging the design of heavy structures where possible;
- the flatter landscape in the Netherlands necessitates fewer structures to cross the land;
- the different design specifications for structures, as discussed in the EC Harris and TRL report (which is quantified and therefore cannot account for the total difference);
- that in the UK highways are designed to make greater provision for crossings;
- that UK infrastructure is rarely designed for future expansion (for a variety of reasons), making subsequent lane widening in the UK proportionally more expensive.

C.22 The non-cost data which has compared the UK to a far greater number of countries worldwide, supports many of the above points, especially the final one; a French contractor reported that French motorways are designed with the drainage sized for an extra lane and all structures placed with provision for an extra lane.

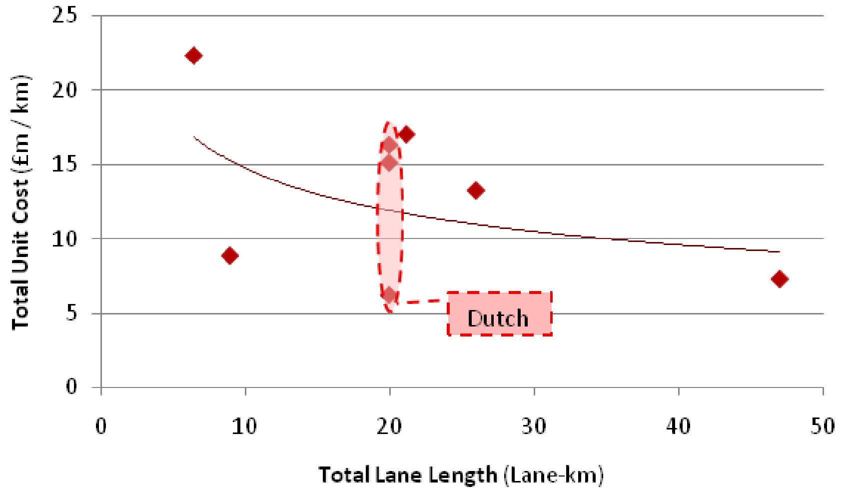
Environmental Measures.

C.23 The cost data supplied was not considered suitable for an analysis of the impact of different environmental measures on costs. However, evidence gathered in interviews suggested that while the Netherlands and other Northern European countries have similar constraints to those in the UK and hence similar costs of environmental protection, Southern European countries differ in their approach.

Total Length

C.24 The chart below displays the correlation between length of newly constructed lane and the cost per lane-km.

Chart C.6: Effect of total lane length on total project costs



Source: Infrastructure UK Cost Questionnaires

C.25 The small sample size and spread again makes it difficult to draw any robust conclusions. However, reading the trendline, economies of scale appear to be evidenced when constructing greater lengths of new lane under one project in the UK. This can most likely be explained by the relatively fixed mobilisation fees of a contractor and increasing efficiency of delivery as tasks are repeated (i.e. the effect of production-line working).

Key Findings

C.26 The sample size obtained in this survey is not large enough to allow definite conclusions to be drawn and hence it is best to treat these results as indicative only. However, as can be expected, the complexity of a highways project directly affects the outturn cost with positive correlation.

C.27 When compared to a network that experiences similar levels of usage intensity, the costs of construction for improving and widening the UK highways network are slightly higher.

C.28 The higher construction costs are partly due to the higher specifications imposed in the UK. There may be scope to consider lowering the UK specification but whole life cost, the asset management plans and legal liabilities must all be considered.

C.29 By specifying high standards in the UK (for example, a long design life for structures) but operating within the spatial and planning constraints that prevent incorporation of flexible plans for future expansion, the UK is designing cost and long life into structures that may require replacement when future expansion is carried out.

C.30 The positive effects of economies of scale and introduction of standardised structures could deliver benefits in future widening and improvement programmes.

D Benchmarking: flood defences

Data Obtained

D.1 The Environment Agency (EA) have completed and returned six cost questionnaires representing flood defence schemes valued between £2m and £30m in the UK. These projects, amongst others, were also studied as part of an internal study at the EA.

Table D.1: Brief project descriptions

Project Title	Description	Total Cost (2009 £m)
A	Construction of 34m length of new harbour wall in front of existing. Wall faced with stone masonry and slate and founded on mass concrete and mini-piles.	2
B	Work to repair, replace and upsize 600m of culverts beneath the streets and the construction of an upstream 76,000 cubic metre flood storage basin.	6
C	Refurbishment or replacement of existing inland frontage at 9 locations.	9
D	Beach recharge along with rock breakwaters to alleviate pressure on adjacent sea wall.	10
E	Refurbishment of 2.2km sea frontage forming part of the sea defences.	30
F	4,000m of improved flood defence, including new flood walls and installation of plastic piles	17

Source: *Infrastructure UK Cost Questionnaires*

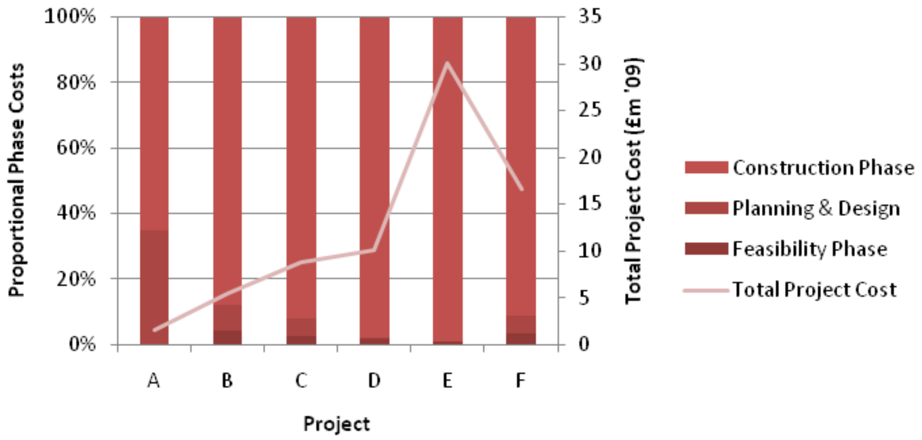
Data Analysis

D.2 The Chart D.1below provides the project costs displayed as a proportion of the total project cost as well as the total project cost.

D.3 In line with other sectors, the combined proportional cost associated with the feasibility phase and the planning and design phase average to 11.1 percent. Notably, project A reported a design phase cost far higher than the average at 34.8 percent. The fact that the total costs of the project are lower partly explains the differences in the percentage figures.

D.4 As can be expected, given the range of total project costs in the sample, generally the proportion of cost allocated to feasibility and design and planning reduces as the value of the project increases. Project F is a minor exception to this rule. This is explained by the untraditional adoption of plastic piles and the learning curve associated with their use.

Chart D.1: Phasing of project costs



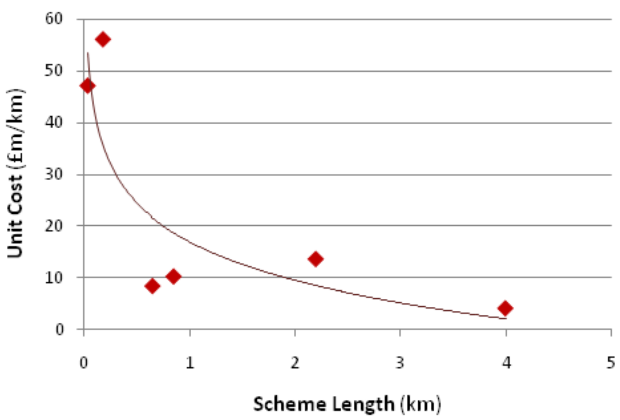
Source: Infrastructure UK Cost Questionnaires

D.5 It is expected that the reasons for the general trend are fundamentally down to the relatively high levels of standardisation on the schemes; the solution offered to protect 1 km of coast line is the same as the solution to protect 10 km of coast line. It should be noted that the EA is currently increasing its library of standard details and promoting standardisation in a bid for efficiency gains. The standard details are being drawn with the collaboration of the EA's framework consultants.

Effects of Project Size

D.6 The following chart displays the total length of flood protection provided by the scheme and compares it to the unit cost of providing the protection per kilometre.

Chart D.2: The effect of length on unit cost



Source: Infrastructure UK Cost Questionnaires

D.7 The small sample taken suggests that there are economies of scale, evidenced by a correlation between larger project sizes and lower unit costs, in support of larger projects. The EA has conducted detailed analysis over a larger sample of projects and have concluded that packaging up projects to offer larger commercial opportunities can generate significant savings.

D.8 EA internal case studies have shown that savings of at least 9 percent on packages totalling £156m have been realised from achieving continuity of work. In the qualitative data gathering interviews, the EA suggested savings of up to 10 percent are expected though bundling projects, and a further 10 percent are expected through efficiencies in frameworks. This has meant packaging up and or arranging consecutive projects on a regional basis. It has allowed the EA to take advantage of the positive effects of keeping teams together. Specifically:

- Core team manages the package of works – senior experienced staff are involved who wouldn't necessarily have been involved if there were smaller individual schemes.
- Value Engineering ideas apply to more than one scheme and the savings therefore merit the investment to make them work – already approaching £1m identified saving.
- Office based core team allows site accommodation to be reduced, saving prelims cost of up to 1 percent of project value
- Volume of work generates discount from subcontractors and suppliers. The schemes have attracted national interest from specialist suppliers increasing competence and competition – targeting 6 percent saving on sublet
- Proximity of sites and similar works encourages balancing of earthworks materials and reuse of demolition arising across package of
- Designers are sharing ideas and best practice
- Contract administration reduced with one progress meeting and progress report for whole package.
- Additional schemes added into package saving EA tendering cost
- Risk management approached on a package basis – controlling the risk pot – managed by assistant PM, who provides built in succession planning should any of site agents / the project manager leave the team

Key Findings

D.9 This analysis supports detailed analysis conducted by the EA (over a larger sample of projects) concluding that larger projects, or bundling of projects to offer larger commercial opportunities can generate lower unit rates.

D.10 Continuity of work has demonstrated savings of at least 9 percent on packages totalling £156m.

E Benchmarking: high-speed rail

Data Obtained

E.1 The precursor for the work undertaken on high speed rail[1] in this study, was the detailed cost study commissioned by the HS2 team in 2009[2]. This study compared the costs of seven high speed lines, one of which was HS1 in England. They found that for a variety of reasons, the total investment cost for HS1 was 2.4 times the next most expensive comparator.

E.2 Such reasons included land costs and environmental measures (both of which were over double that of the next most expensive line), proportion of the route through urban areas (highest proportion of sample), relative length and type of tunnelling (highest proportional length and prevalence of twin-bored tunnels) and stations (six times as much per route km as the next most expensive).

E.3 Paralleling the coverage of the cost study undertaken by the HS2 team, Infrastructure UK cost questionnaires were completed for five of the same high speed rail projects, covering the countries: France, Germany, Italy and Spain; and the two sections of High Speed 1 (HS1) which were treated as separate projects. HS1 was treated as separate projects because it was delivered in two sections, completed seven years apart, in very different environments.

Data Analysis

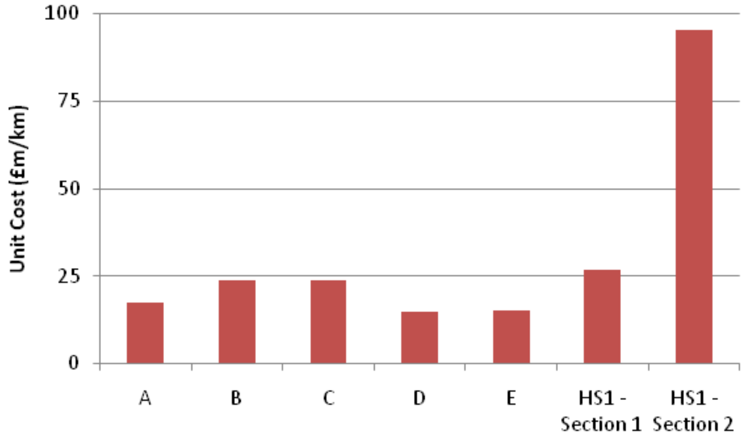
E.4 The base years (for cost purposes) for the five European and two UK High Speed projects ranged from 1997 to 2008. The data was normalised to a base date year (2009) using Eurostat country-specific inflation data and brought into Sterling currency using Purchase Power Parity (PPP) figures from the OECD.

E.5 The chart below details the projects (anonymised for the European projects) with HS1 (sections 1 and 2) identified. Typically data was provided by respondents addressing all phases.

1 "High Speed Rail" is defined as a rail system capable of speeds greater than 300 km/h

2 *High Speed 2 BSL comparison of high speed lines' capex*, (November 2009)

Chart E.1: Unit costs of European high speed rail



Source: Infrastructure UK Cost Questionnaires

E.6 It can be seen that the cost (£m/km) of high speed rail is indeed greater than that found in mainland Europe. Concentrating on Section 1 of HS1, it can be seen that the outturn costs of constructing UK high-speed rail (£27m/km) lie beyond the European range of circa £15m/km to £24m/km.

E.7 The cost of Section 2 of HS1 is significantly higher than the European range, at four times the cost. The use of differing indices or methods of currency conversion, despite their differences, would not affect this finding.

Table E.1: Distribution of costs through project phases

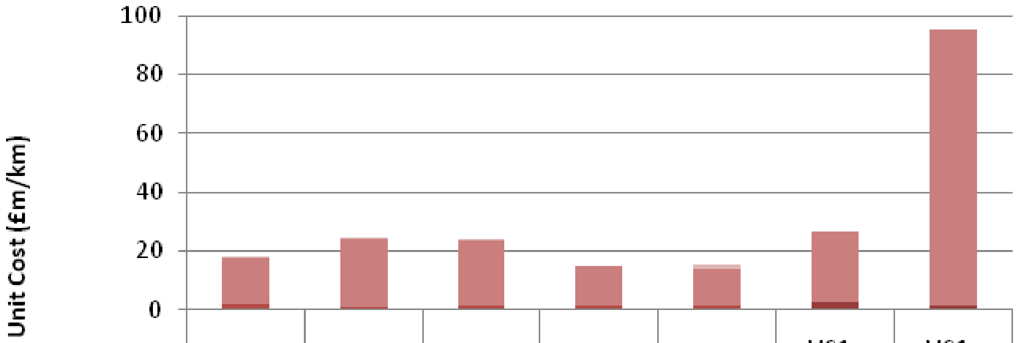
Project	Feasibility Phase	Planning and Design	Construction Phase	Commissioning
A	0.5%	9.5%	89.7%	0.4%
B	0.3%	3.0%	96.1%	0.6%
C	0.3%	5.9%	93.6%	0.2%
D	0.9%	7.1%	92.0%	-
E	3.0%	7.0%	80.0%	10.0%
HS1 - Section 1	9.0%	-	91.0%	-
HS1 - Section 2	1.5%	-	98.5%	-

Source: Infrastructure UK Cost Questionnaires

E.8 The above table shows the proportional distributions of costs through the project lifecycle for the projects. Looking in a little detail at the data, there is some unreliability in the allocation of cost to the phasing according to varying interpretations of the terms, however by including 'Planning and Design' values to the values spent on Feasibility, in overall percentages, the range is between 3 percent and 10 percent of total project cost (with the exception of HS1 Section 2 which showed a minimal spend of 1.5 percent on the early stages of the project.

E.9 However the high construction costs may skew this data for HS1 Section 2, as the actual spend on preliminary phases is still a robust figure and according to the HS2 study (which does not distinguish between sections 1 and 2), far higher than the European comparators. It is difficult to postulate whether there is a direct correlation between the low *percentage* cost of planning and feasibility and the higher outturn cost.

Chart E.2: Cost per kilometre for each phase of works



	A	B	C	D	E	HS1 - Section 1	HS1 - Section 2
Commissioning	64,167	134,528	56,779	-	1,533,599	-	-
Construction Phase	15,534,11	22,932,93	22,139,66	13,485,27	12,268,46	24,273,32	94,038,49
Planning & Design	1,638,076	721,340	1,396,759	1,039,859	1,073,519	-	-
Feasibility Phase	88,685	78,096	65,296	135,634	460,080	2,413,936	1,404,311

Source: Infrastructure UK Cost Questionnaires

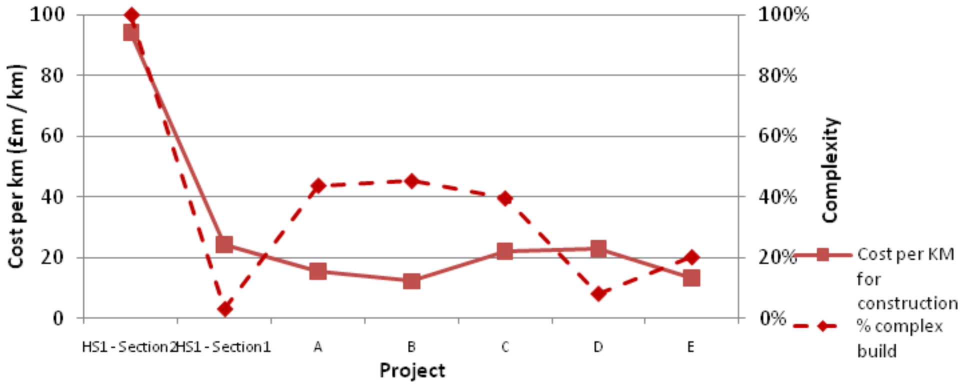
E.10 Comparing the cost per km spend per phase of the project enables consideration of the following factors: By combining both the Feasibility and Planning Stages into a single item addressing pre-construction, there is a value of circa £1.2m/km to £1.7m/km in Europe for these phases of the project (excepting the highest and lowest points), with the costs for the UK projects of £1.4m/km and £2.4m/km.

E.11 There is insufficient data to confirm the exact reasons other than anecdotal evidence that Section 2 of HS1 was routed through a geographical area of high density population requiring increased effort in interfaces with existing assets, properties, and general infrastructure. There is insufficient knowledge of the European reference projects to determine the exact details, though the data supplied on proportions of routes in urban areas is sufficient to support this.

E.12 Analysing the construction costs in detail provides a similar picture, with a cost of £12m to £24m per km of constructed railway, with HS1 Section 1 providing the upper value of this grouping. HS1 Section 2 provides a very different picture with a cost of circa £94m per km. In an attempt to take a view of potential normalising factors, an assessment of complexity was made by analysing the percentage of the railway that was carried out with tunnelled railway, viaducts or railway in urban environments[3]. This analysis indicates that there is no clear correlation between cost per km and complexity (as per this definition).

[3] The calculation was based on the percentages of the routes tunnelled, in urban area and the number of structures constructed. HS1 Section 2 had the highest score, against which the other projects were normalised.

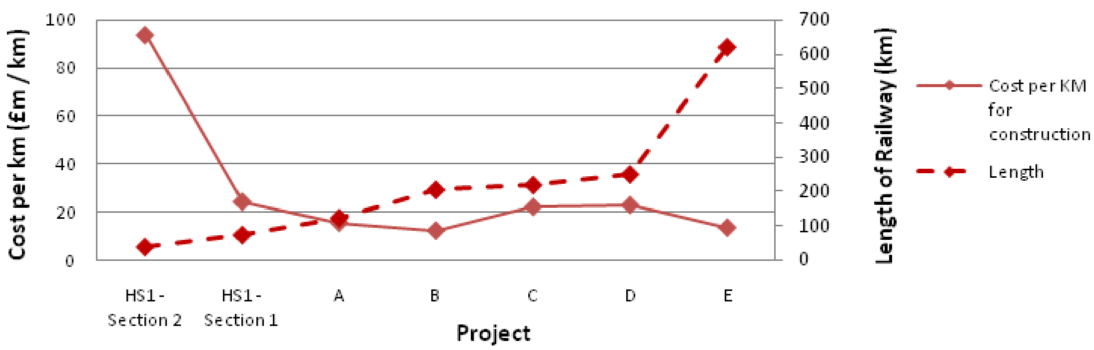
Chart E.3: The effect of 'complexity' on unit cost



Source: Infrastructure UK Cost Questionnaires

E.13 This in conjunction with an analysis of the cost per km versus length of railway provides a generic view of the high cost comparison of HS1 in the UK.

Chart E.4: Cost per kilometre for construction versus length of railway



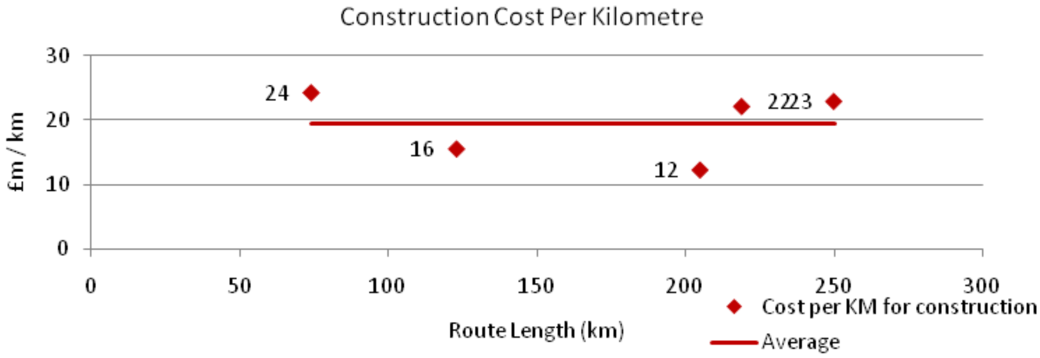
Source: Infrastructure UK Cost Questionnaires

E.14 HS1 Section 2 was indeed a highly expensive railway, however it had some significant factors: it was far shorter than European projects skewing the balance of the fixed as opposed to variable costs of the project; it had the highest factor of complexity in terms of structures, tunnelling and urban environment impact; it also included two major station developments with significant expenditure, unlike the European projects. This probably does not fully explain the cost differential and it must be noted that the HS1 data provided was not necessarily reliable comparable data due to the extremity of the data.

E.15 HS1 Section 1 provides a more comparable project to the European projects, however as a project it is still significantly shorter than the next European project analysed (by circa 50 percent), so this route length clearly plays a part in the cost per km comparisons.

E.16 Taking the five comparable projects (eliminating HS1 Section 2 and the longest route project) based on route lengths, the below graph can be constructed which attempts to establish a relationship between route length and construction unit costs.

Chart E.5: Construction cost per kilometre

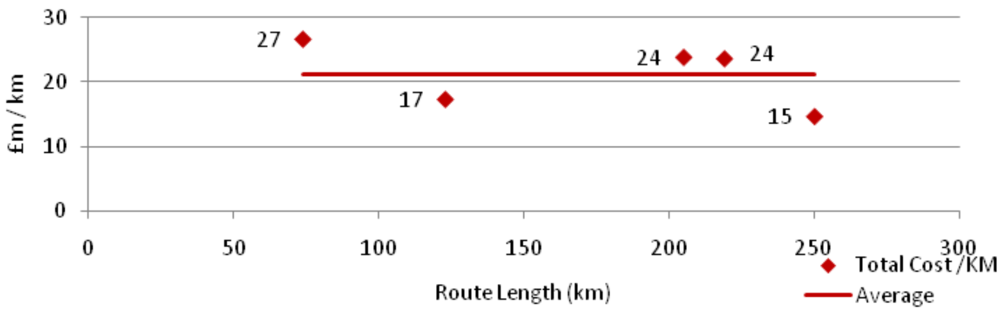


Source: Infrastructure UK Cost Questionnaires

E.17 This data provides an average construction cost (not total project cost) of £19.4m/km compared to HS1 Section 1 cost of £24.2m/km. Based on this measure the UK is 24 percent more expensive.

E.18 The comparable graph (below) which focuses on total project costs, the average was £21.2m/km compared to £26.7m/km for HS1 – Section 1, or 26 percent more above the average.

Chart E.6: Total project cost per kilometre



Source: Infrastructure UK Cost Questionnaires

Key Findings

7.22 Considering a comparable average construction cost from the European projects considered of £19.3m/km compared to HS1 Section 1 cost of £24.2m/km. Based on this measure the UK is 24 percent more expensive.

7.23 Considering a comparable average total project cost from the European projects considered of £21.2m/km compared to £26.7m/km for HS1. Based on this measure the UK is 26 percent more above the average.

F Benchmarking: rail stations

Data Obtained

F.1 Cost data on stations was collected from various sources as part of the study. Data on the cost of stations on seven high-speed rail lines was collected directly from the commissioning bodies. The data from these sources however was very high level, with little or no context as to the nature of the costs (due to this, the data on the high speed rail line stations has not been included in the analysis in this section).

F.2 Sufficient data were collected however for the comparison of stations on seven underground central London metro stations and five other non-UK metro stations[1].

F.3 The data have shown that the UK stations studied are more expensive than the international stations studied, yet there may be mitigating factors which demonstrate better value for this capital cost. However, to truly understand the differences in cost and causes thereof, detailed elemental comparisons must be made.

F.4 Whilst the analysis undertaken here is generally supportive of the rest of this report, the unique circumstances of each station must be considered if more accurate conclusions are to be drawn. For instance: no consideration was given to:

- the proportions of the underground stations constructed above ground;
- the construction method;
- the access requirements to, or connections with existing infrastructure; or
- whether the small international sample introduces other biases.

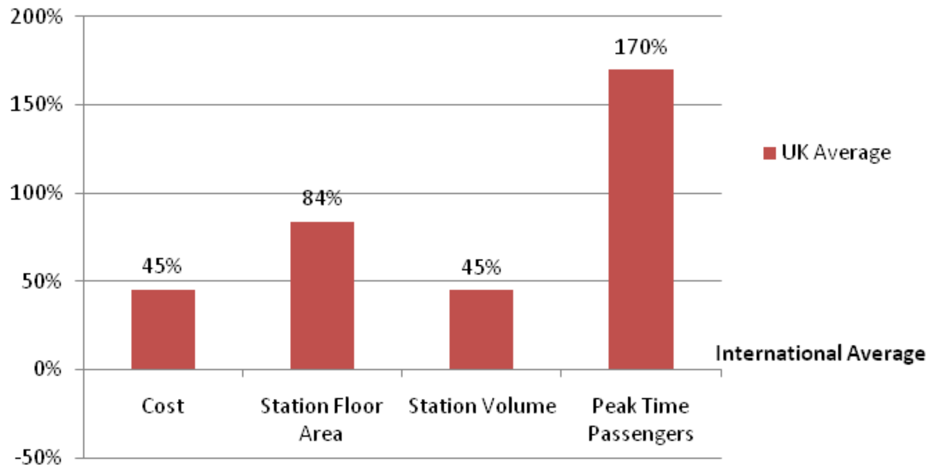
Data Analysis

UK-International Comparisons

F.5 The below Chart F.1 shows how the UK stations differ from those sampled internationally, with regards to metrics of cost, size and passenger throughput.

[1] One Asian, two US and two European stations.

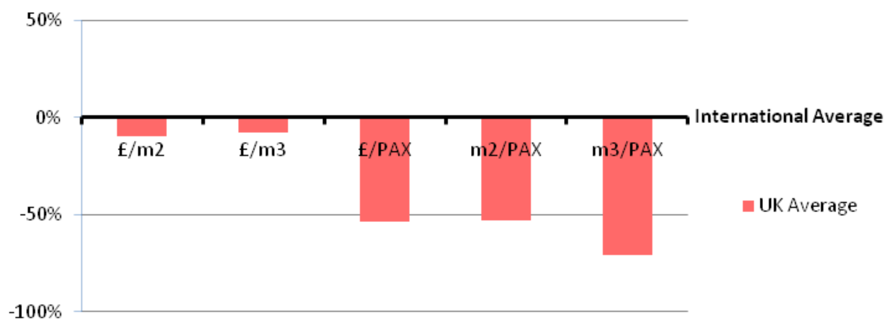
Chart F.1: Differences in absolute terms between UK and international rail stations



Source: Infrastructure UK Cost Questionnaires

F.6 On a station-for-station basis, UK stations appear to be more expensive, on average 45 percent more than the average of the benchmarked international stations. The UK stations are also larger, as measured by floor area and volume, the latter of which is especially important when considering underground stations. The UK stations also have a larger number of passengers passing through in peak hours than the international stations. The below chart (Chart F.2) shows cost normalised by size and passenger throughput, and size normalised by passenger throughput.

Chart F.2: Differences in derivative indicators between UK and international stations



Source: Infrastructure UK Cost Questionnaires

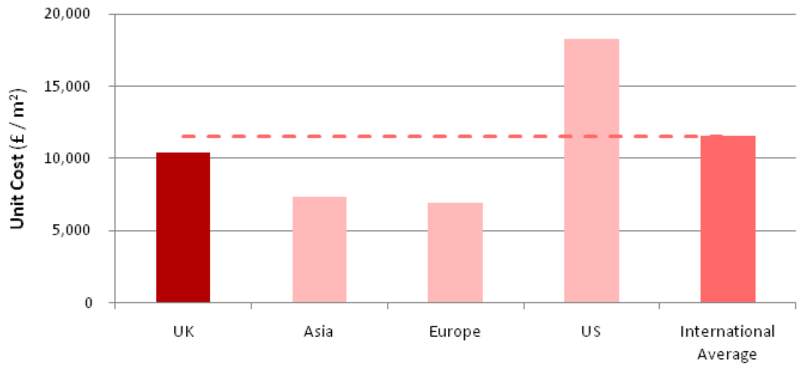
F.7 Taking the spatial and passenger flows into account, the UK stations are better value for money. Spatially, the UK clients are paying 8 percent £/m2 and 10 percent £/m3 less than the average internationally benchmarked stations. Also the UK clients are paying 54 percent less per peak-time traveller.

F.8 The UK stations provide less space per peak time passenger, at 53 percent m2/peak time passenger and 71 percent m3/peak time passenger less than the average internationally benchmarked stations. This is an advantage for reduction of initial capital outlay and a potentially more spatially efficient design, but restricts capacity for growth.

Region-Specific Comparisons

F.9 The below Chart F.3 details the comparison on cost per unit area between UK stations and those in specific world regions.

Chart F.3: Regional comparison of average cost per m2 for rail stations

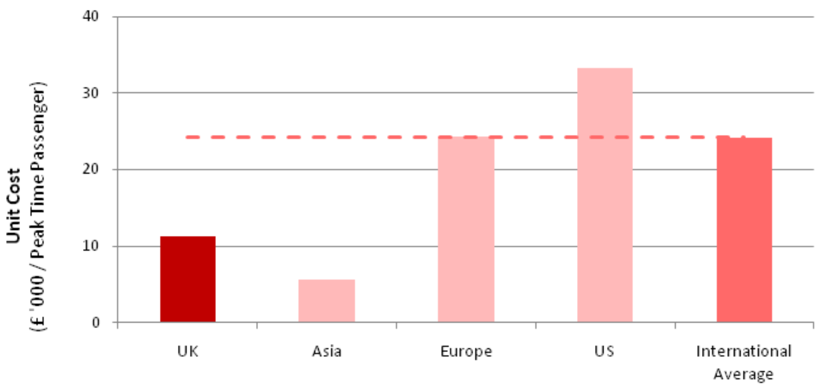


Source: Infrastructure UK Cost Questionnaires

F.10 The mean results of the international samples selected do suggest that the UK, though designing more expensive stations, does achieve better value for money. For example, the small sample of international stations shows wide variability in the metrics, and if the US samples were disregarded, the UK's cost per unit space is in fact higher than the remaining samples.

F.11 The below Chart F.4 details the comparison on cost per peak time passenger between UK stations and those in specific world regions.

Chart F.4: Regional comparisons of average cost per peak-time passenger for rail stations



Source: Infrastructure UK Cost Questionnaires

F.12 The UK stations' higher passenger flows significantly reduce the cost per peak time passenger. This supports a point made elsewhere in this report, that UK infrastructure is often more expensive when compared internationally, but UK infrastructure is used more heavily, requiring higher standards of durability.

Other Data

F.13 The scope for further analysis of the other data supplied was limited, but one clear finding was that for comparable stations in London constructed under a programme of works, as opposed to completely separately procured projects, contractor preliminaries are reduced by 41 percent.

Key Findings

F.14 Data of mixed quality for stations on seven high-speed rail lines, ten underground central London metro stations and five other non-UK stations was received. The data for seven of the central London underground metro stations and five of the international stations was of sufficient quality to be analysed in this section.[2]

F.15 The data has shown that the UK stations studied are more expensive than the international stations studied, yet there may be somewhat mitigating factors which demonstrate better value for this capital cost. (i.e. higher area/volume/passenger flow)

When compared solely to Europe though, there is evidence that the UK is still more expensive per unit area by as much as 51 percent.

[2] Due to the only UK data analysed being for stations in London, the results may be skewed. However, it must be noted that all metro systems researched for this section are in comparable major cities.

G Benchmarking: tunnels

Data Obtained

G.1 Survey participants have returned a number of cost questionnaires for projects that include tunnels, and where possible the data relating specifically to the tunnelling elements of the project have been extracted.

G.2 In addition, the British Tunnelling Society has carried out a benchmarking exercise involving some 14 tunnels in the UK and 21 tunnels in other EU countries[1]. The tunnels are from the rail, highway, water and power sectors, and from Norway, Spain, Netherlands, Austria, Portugal, Germany, Switzerland, France, Greece and Luxembourg.

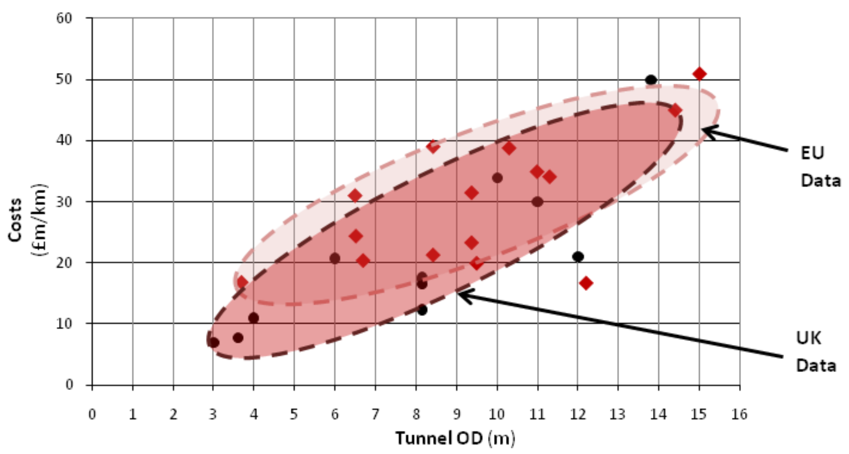
G.3 Tunnelling costs were also obtained from other sources for this study.

Data Analysis

G.4 The data points represent the outturn cost of each tunnelling contract, including portals and shafts, divided by the total length of the tunnel drives.

G.5 Chart G.1 below shows the all-in rate for tunnelling plotted against the tunnel diameter for all the available data points, together with envelopes that encompass the data points of different origins.

Chart G.1: The effects of tunnel outside diameter on unit costs



Source: Infrastructure UK Cost Questionnaires and British Tunnelling Society

[1] Note that not all projects are represented on the below charts due to difficulties obtaining all the requisite data.

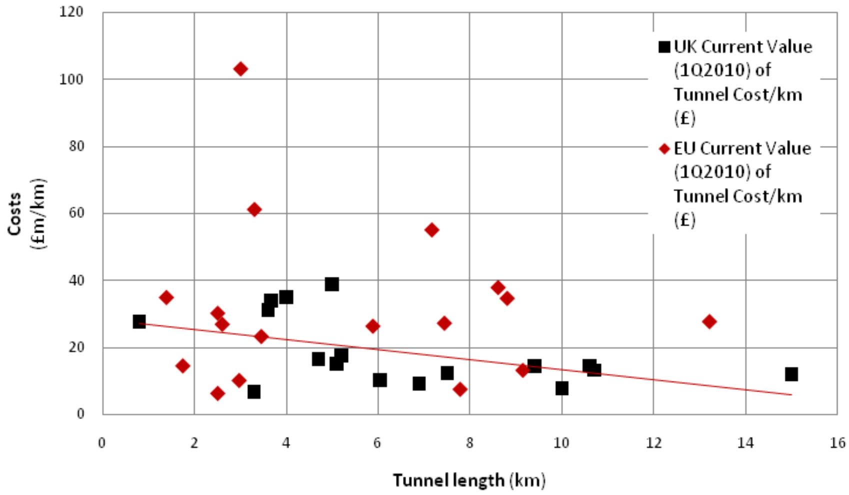
G.6 The light pink envelope encompasses all the European tunnels (red diamonds) with the exception of one outlier. The darker envelope encompasses all the UK tunnels (black circles), again with the exception of one outlier.

G.7 There is a similar scatter of results from the 15 European projects compared with the 12 results from the UK only. There is, however, insufficient data to enable other country-related trends to be established as the 15 EU projects are well-spread amongst the member states.

G.8 There are a number of reasons why a range of results exist, including ground conditions, tunnelling method, lining type. The all-in rate for tunnelling also depends on tunnel length, and this is explored further below.

G.9 Variation of tunnel costs with length of tunnels. The BTS study explored the influence of tunnel length on its cost, and the figure below is taken from their report. Whilst there is a large scatter in the results, a slight trend of reducing unit costs with length of tunnel can be seen.

Chart G.2: The effect of tunnel length on unit costs



Source: Infrastructure UK Cost Questionnaires and British Tunnelling Society.

G.10 It is noted elsewhere in this report that benchmarking of rail projects that involve significant amounts of tunnelling has shown a significantly higher cost in the UK than other European countries. This is explored further in the main body of the report.

Key Findings

G.11 The average unit rate for tunnels of 3m diameter or greater is principally dependent on its diameter. Lesser factors influencing cost include overall length, ground conditions, tunnelling method and lining type.

G.12 The average unit rates for tunnelling construction contracts in the UK are not significantly different to those in Europe.

H ICE Working group findings

ICE Sub-Group report on tunnelling

H.1 The British Tunnelling Society, an Associated Society of the ICE carried out an investigation to compare the costs of tunnelling in the UK and other Western European countries.

H.2 Cost data was collected on the tunnelling aspects of 21 projects, 7 in the UK and 14 from projects in France, Germany, Spain, Switzerland, Greece, Austria, Switzerland, Norway and the Netherlands. Data was adjusted to account for exchange rate fluctuation and construction inflation and presented as a cost per km and cost per m3 (see Annex A).

H.3 The data gathered showed no established trend of greater costs for the tunnelling aspects of projects in the UK. In addition, costs per m3 of excavated material were found to vary significantly within countries reflecting a range of issues influencing the cost of tunnelling including; ground conditions, end use, location, third party constraints, length, diameter, construction method and soil disposal route.

H.4 Whilst the data gathered did not demonstrate a trend towards greater costs on tunnelling aspects of projects, the Sub-Group identified the following perceived differences between UK and West European practice which could influence overall project out turn and were worthy of further study; Compliance orientated Health and Safety regimes, the process of supply chain accreditation and the use of procurement portals, levels of site supervision, quality required by specifications, design process, labour resource costs and ALARP: As Low As Reasonably Practical risk management. Generic drivers of higher cost were also identified including; political decision making, procurement practice, stakeholder management and funding arrangements.

ICE Sub-Group report on Codes and Standards

H.5 The Codes and Standards Sub-Group was drawn from relevant ICE Expert Panels and was tasked with examining the impact of Health and Safety (H&S) legislation and Eurocodes on project costs.

H.6 The group found that new health and safety legislation, notably the Construction, Design and Management (CDM) regulations had coincided with a sharp reduction in death and injury in UK construction in recent decades. The subsequent introduction of tightly controlled and auditable procedures within the design departments of consultants and contractors has had cost implications but indeterminable approaches such as "engineering judgement" were not consistent with industry commitments to prioritise safety, or broader efforts to improve the quality of project management.

H.7 The group did however uncover anecdotal claims that in house health and safety procedures within clients and supply chain organisations have added additional requirements areas such as the checking and review of design work extending beyond what is required by legislation, with limited benefit in improving safety. Further work to substantiate these claims would be of value.

H.8 In relation to Eurocodes, the group noted that in principle, common EU design standards should not adversely affect the cost of UK construction relative to Western Europe. However, as with health and safety legislation, there was evidence that in house design codes and standards interacted with Eurocodes to create a complex and inflexible environment which could drive higher costs. The group also pointed to the impact of interventions from third party heritage organisations in adding to this complexity.

ICE Sub-group Report on Supply Chain

H.9 The Supply Chain sub-group was made up of senior representatives from major contractors, specialist sub-contractors and clients. The group examined issues affecting supply chain performance including structure, capacity and interaction with clients. The group reviewed cost and non cost data and previous studies on supply chain performance.

H.10 This review reinforced the emerging finding of the main study that integration and collaboration throughout the supply side, and early contractor involvement can deliver increased value, including significant efficiency savings. In the area of Client-Supply Chain relationships there was considerable overlap between the group's findings and the improvement priorities identified by the Client sub-group, including:

- Improving the definition of project requirements and reducing subsequent changes to project scope
- Providing greater visibility of forward programmes and where possible committing to work at an early stage

H.11 The sub-group also found that Clients had a key role in driving collaborative behaviour by aligning interests of all parties with commercial incentives which were themselves aligned to project goals.

H.12 The sub-group noted that these issues had been identified in previous reviews but change had not been implemented consistently. However the 2012 Construction Commitments provided an example of a moral commitment by all parties to a set of behaviours which had underpinned effective collaboration.

H.13 The group concluded that there would be value in further work to explore the viability of a similar voluntary agreement which could function at an industry level. Ideally this agreement would commit parties to the following behaviours when working on major projects and programmes:

- Clients: To provide an output based account of needs, appoint an integrated team, encourage innovation and share, on an equitable basis, the benefits of continuous improvement
- Supply Side: To collaborate with each other and the client, and take collective ownership to deliver project solutions that fulfil the brief and proactively look for ways to exceed client requirements.
- Both parties: To ensure that the budget and timeline are realistic for the needs defined

H.14 It was recognised that action would be needed to build confidence that any agreement would be implemented. This should include

- a mechanism for reporting publicly on breaches of the agreement
- an indication from government that abiding by the agreement would be a condition for public clients receiving funding for major projects.
- a recognition of the value of independent facilitation when developing project level agreements.

ICE Sub-Group Report on Clients

H.15 Respondents to ICE's survey of industry stakeholders (see Chapter 5) identified Client leadership, decision making, governance and project management as the aspect of civil engineering projects with the greatest relative scope for improvement and cost savings.

H.16 In this context, senior representatives from Thames Water, Highways Agency, Network Rail and Transport for London shared details of current work programmes aimed at improving their performance as clients. This process identified seven shared priorities:

- Creating greater visibility of forward programmes and where possible committing to work at an early stage.
- Improving the definition of client requirements and reducing or eliminating subsequent changes to project scope
- Creating project governance structures with clear demarcations between client, project sponsor and delivery roles
- Improving the management of project and programme contingency funds
- Developing accurate and up to date data on existing assets
- Creating standard models for benchmarking and cost capture
- Improving client capability, with a particular focus on increasing the proportion of staff with the necessary breadth and depth of skills to be effective project managers

H.17 The group agreed that further knowledge sharing between clients, focusing on these seven areas could deliver further efficiencies. A shared maturity model could provide the basis for such collaboration.

Summary of best practice examples

Table I.1: Best practice reference examples

Client / Project(s)	Sector	Description	Saving
Madrid Metro	Rail	Full commitment at regional political level (President of Regional Authority, Minister of Public Works), ensuring project financing, on-time payments and full confidence from the contractor on getting a profit.	15-25%
		Specific cost reductions in design, supervision and management: - Short time construction programme of four years for 56 km including design and procurement - Small management team. Small team of public administration officials - Scale economies. Shared overheads between 10 different lines and taking advantage of equipment and rolling stock programs for the whole Madrid network.	up to 5%
		Stations on the Madrid Metro extension were entirely adequate and functional rather than unique and/or spectacular architectural achievements. Contrasts heavily with some of the stations on the Jubilee Line Extension.	80% (Stations)
London Underground Stations Improvements	Rail	Since mid 2008, London Underground's Strategic Improvement initiative has saved £283m of the £2.4bn Stations Capacity Programme, equivalent to 12%, through improved project management, re-design, risk mitigation and enhanced communication.	12%
Cefa	Rail	CEFA - bridge inspections contract with Network Rail. Beforehand NR subcontracted 20 contracts to 14 suppliers. As a single bid to replace 14 suppliers across 5 new contracts covering the same area, discounts were given on a sliding scale based on number of areas awarded, leading to efficiencies of circa 8% by bundling all services together.	8%
Great Western Track Renewals	Rail	Moved from highly adversarial relationship to a collaborative approach. 22% reduction on unit costs, whilst increasing quality and reducing HSandE incidents. Also, for the contractor, contributed to a five-fold increase in business volumes, sustained profit margins and significant capital investment in new plant.	22%
MTR	Rail	Cross-project and inter-company co-operation to help move partners towards a more strategic and alliance way of thinking and working. Sessions were held with the key Government authorities to get the right understanding and smooth the progress. Opened four months early. Met all targets for program quality, health, safety. Saved 25% or $600m against a budget of $2.7b with 80% less claims.	25%
Anglian Water	Water	Notwithstanding considerable efficiencies post privatisation in 1990, in 2004 Anglian Water put in place a 10 year contracting strategy, including the creation of @oneAlliance, which has delivered 14-18% efficiencies 2005-2010 and is targeting a further 15-21% in 2010-2015.	14-21%
		Anglian Water has many examples of efficiency through standardisation/pre-fabrication of components / pre-fabricated units.	15-45% (per unit)
Yorkshire Water	Water	Yorkshire Water have a 10 year planning horizon and use programme and performance baselines to measure against past performance. Such an approach has lead to estimated savings of 7% to 8% during the last period, rising to 20% savings in the next period.	7-20%
DCWW AMP3	Water	Far reaching collaborative alliance that encompassed client, contractors, their respective supply chains and stakeholders including regulators. Also developed collaborative understanding and collaborative working and leadership skills. Developed and implemented a strategy of collaborative procurement within the alliance. Delivered Capital Programme, on or ahead of time, for 26% less cost than the best achieved during previous period.	26%
Highways Agency projects	Roads	Early contractor involvement can shorten the time for construction. Comparisons of ECI on HA projects demonstrated a lower price and shorter time for construction (up to 50% shorter).	50% (construction time)
Highways Agency: Welsh projects	Roads	Two major projects developed consecutively with continuity for resources. On both, whole team approach to VE saved up to 35% on target cost. Both delivered within time and TC. Programme and wider stakeholder expectations met/exceeded. Project Director stated that the continuity of the integrated team was the biggest factor in this.	25%

Client / Project(s)	Sector	Description	Saving
Stansted Airport	Airports	Pre-fabrication of steelwork, dia-grids and roof panels off site delivered cost savings of approximately 10% or more.	10%
BAA	Airports	BAA operate to a 10 year planning horizon, with savings of 6% recorded recently over the portfolio, predicted to be 12.5-15% going forward.	6-15%
Environment Agency projects	Flood Defence	Bundling strategy has delivered around 10% efficiencies, plus a further 10% through looking to drive efficiencies through the existing frameworks.	10-20%
Sainsbury's	Retail	Project managers taught improved collaborative skills and discipline into project delivery through ensuring effective partnering workshops at the beginning of each project. Based on a planned programme of work reduced costs 35%; Reduced build time from 42 to 17 weeks; reduced defects - down 15%; significantly increased revenue.	35%

HM Treasury contacts

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